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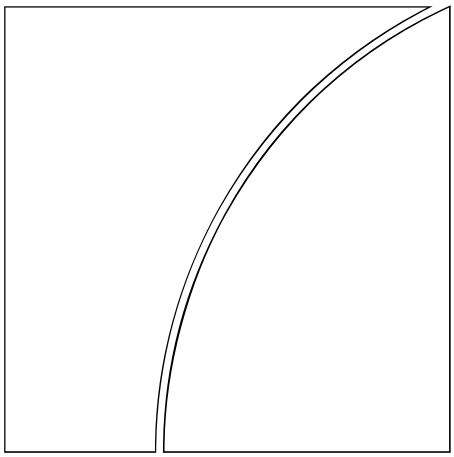

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Electronic finance: a new perspective and challenges

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Foreword

A workshop on electronic finance[1] was convened by the BIS on 2-3 July 2001. The internet and related technology has begun to have a profound effect on how financial services are delivered. Discussion about e-finance is widespread within the financial community, covering both its potential to improve efficiency but also possible challenges it poses to financial and monetary stability. Rapid innovation and the paucity of reliable data are creating considerable uncertainty about the nature and size of these challenges. The workshop brought together a diverse group of experts (listed on pages iii-vi) from a range of economies, backgrounds and sectors; including practitioners, academics and central bankers. It focused on current and potential changes in trading systems and exchanges, payment systems and financial institutions.

This volume starts with an overview based on the presentations given during the workshop, some of which are also included in the volume, and the ensuing discussions. The individual papers cover, inter alia, trading in wholesale financial markets, emerging competition in the payment system and the progress of virtual banks. Implications for financial supervision and monetary policy are also specifically addressed in separate papers. As there are a plethora of technical terms associated with the subject, a glossary is included at the end of this volume.

[1] Sometimes the terms “online finance”, “internet finance”, “virtual finance” and “cyberfinance” are also used interchangeably.

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Table of contents

Electronic finance: an overview of the issues

Setsuya Sato and John Hawkins[1]

1. Introduction

A BIS workshop on e-finance was held in Basel on 2-3 July 2001, focusing on current and potential changes in exchanges and trading systems, payment systems and financial institutions. This overview is based on the presentations given during the workshop, some of which are included in this volume, and the ensuing discussions.

1.1 Perceptions and reality

Since the latter half of the 1990s, the internet and other innovative information technology (IT) have affected the financial system greatly, such as by moving from restricted proprietary systems to open networks. Since mid-2000 there has been a correction in public perceptions about internet-related activities in general, as reflected in the sharp falls in the price of high-tech stocks and disillusion with the earlier e-commerce euphoria. However, there was less speculative mania surrounding applications of the internet in the financial industry, perhaps due to the moderating role of supervisors and improved IT management following the Y2K experience. In many ways e-finance would seem one of the most promising areas of e-commerce as financial services are information-intensive and often require no physical delivery. It is now realised that there are some relatively simple but time-sensitive products such as broking where e-finance is very successful and others where it has been very slow to catch on (eg e-money, e-insurance).[2] There are some areas where new internet-based technology may be transformational, allowing (or forcing) a fundamental redesign of market architecture. In others it will give rise to new business models. But in some areas it will have little impact (eg banks' corporate advisory work). As well as its transformational impact, the internet could represent a modern example of an old problem for banks: a very rapid expansion of lending to a single industry based on excessive enthusiasm about a new technology (earlier examples include steam, rail, electricity, cars and radio) whose implications are hard to predict. The difference this time may be that the technology also directly affects the banking system itself.

It is an irony that while e-finance is all about more efficient transmission and use of data, statistics on e-finance itself are so lacking that analysis of developments is difficult. As a result, many articles merely repeat exponentially extrapolated estimates of dubious provenance and cross-country comparisons are often based on differing definitions. The many gaps in knowledge about the current position exacerbate the uncertainty about the nature and speed of future developments. For the private sector, this provides a reason for caution. However, as initial systems may quickly build up a dominant market position, there is also pressure for market players to adopt quickly the latest technology without awaiting a full evaluation of costs and benefits.

Policymakers face uncertainty about which parts of the financial system will come under stress (see Turner (2001)). They generally wish to be "technology neutral", balancing the desire to set regulatory guidelines before market developments go too far and too quickly (given that with financial crises, prevention is better than cure) against the risk that a heavy-handed regulatory approach may stifle innovation. There are differences in the way authorities in various economies have responded to these

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[1] Opinions expressed are those of the authors and not necessarily shared by the Bank for International Settlements or any individual participants at the workshop or organisations with which they are affiliated. Thanks are due to Helen Allen, Priska Christen, Stijn Claessens, Jos Heuvelman and George Juncker for helpful comments and to Marc Klau for preparing Table 3. Nigel Hulbert, Arwen Hopkins, Alison Spurway and Tom Minic helped with editing all the papers in this volume and Steve Arthur prepared the graphs. Liliana Morandini and Secretarial Service coordinated the production of the volume. Patricia Mosquera provided secretarial assistance for the meeting and the volume.

[2] See Banks (2001) and Sato et al (2001) for further discussion.

trade-offs. Some Asian and European economies favour limiting e-finance to regulated institutions while the United States tends to favour a more hands-off approach (albeit with frequent on-site reviews of unregulated service providers).

1.2 Comparative e-finance developments

Some idea of the extent to which e-finance has developed in various economies is given in Table 1, but it must be emphasised that these numbers may not be fully comparable and should be treated with caution. In general, as would be expected, the use of computers and mobile phones, and access to the internet, is in line with income, and the prevalence of e-finance follows a similar pattern.

Table 1

E-finance: selected indicators (1999)

	Real GNP per capita (US = 100)	Internet users as % of inhabitants	Mobile phones per 100 inhabitants	Bank customers using online banking (%)	Electronic brokerage transactions: % of total
Australia	75	32	34	4	22
Finland	71	41	65		
Germany	74	18	29	12	32
Japan	79	21	45		32
Sweden	69	41	58	31	55
United Kingdom	70	21	46	6	26
United States	100	27	31	6	56
Hong Kong	71	36	64	2	1
Korea	49	23	50		65
Singapore	70	24	42	5	10
Argentina	37	2	12		
Brazil	21	2	9	4	6
China	11	1	3		3
Czech Republic	40	7	19	3	
India	7	0	0		2
Malaysia	24	7	14	<1	
Mexico	25	2	8	4	41
Nigeria	2	0	0		
Poland	26	5	10	<1	
South Africa	27	4	12		
Thailand	19	1	4		

Source: BIS estimates based on data from the World Bank, central banks and Claessens et al (2000, 2001).

There are exceptions, however, such as Korea, which appears to have higher usage of high-tech equipment and e-finance than its income would suggest (partly reflecting relatively low internet charges by internet service providers there). It is very hard to predict the future growth of e-finance: whether it will continue to be PC-based or move towards mobile phones[3] or interactive digital

[3] See the survey by Standage (2001).

television, whether established financial institutions will account for a larger or smaller share of it and whether it will lead to greater or less concentration.

Even among the high-income economies, differences are evident. High ownership of personal computers, and especially high usage of mobile phones, have meant that the Scandinavian countries lead in e-banking and e-payments (see the paper by Leinonen in this volume). The long-standing stock-owning culture in the United States and wide computer ownership has seen e-broking become particularly popular there. In contrast, consumers in the United States appear not to have taken to e-banking in large numbers, perhaps because of the prevalence of small banks, the greater use of non-bank financial institutions and the facilities for automated funds transfer available before the internet. Some of the world's least developed countries may be able to use e-finance to leapfrog; moving straight to e-banking rather than establishing branch networks; see Claessens et al (2001).

2. Impact on trading in financial markets

2.1 Retail markets

Perhaps the area which internet technology has most transformed is the retail broking market. As Itoh (in this volume) discusses, costs here have been slashed and customers can now access vastly more information cheaply from the internet. As a result, online trading now accounts for over half of retail stock trades in the United States and a new category of investors - online day traders - has emerged. This has been associated with an unbundling of research, advice and transactions services by brokers.

2.2 Wholesale markets

E-trading is also transforming the structure of wholesale financial markets, most notably the foreign exchange and equity markets, introducing new architectures with new trading rules. The paper by Allen, Hawkins and Sato in this volume describes how it allows architectural aspects such as access and transparency to be more matters of design choice than the result of physical constraints. However, many new systems are owned by consortia of dealers seeking a stake in the platforms disintermediating them, raising questions about whether the design features may incorporate anti-competitive features.

Regarding foreign exchange, the BIS triennial survey shows that 20-30% of interbank trading in the major currencies was conducted using electronic brokers in 1995 and this rose to about 50% in 1998 and it is now likely to exceed 90%. Electronic systems have made far less impact on transactions between banks and their customers. Many banks have offered customers single-dealer platforms but customers have made known their preference for multi-dealer platforms and banks have feared competition from non-bank platforms. Several internet-based systems are now being rolled out, with the two multi-bank systems, FXall and Atriax, being most prominent. Electronic trading is now predominant in many equity markets and futures markets. It is rapidly gaining ground in bond markets, particularly markets for benchmark government bonds. It may gain further ground as new mechanisms develop whereby small, less liquid issues could be traded as part of bundles offering a set of risk-return characteristics; see the paper by Lin, Geng and Whinston in this volume and Fan et al (2000). Gu et al (2001) take this a step further, suggesting that such bundles could be constructed as a way of replicating an OTC derivative.

Changes to market architecture could affect the resilience of financial markets and price volatility in them. Liquid markets are more resilient than illiquid markets, and prices tend to adjust more smoothly. E-trading cuts trading costs, including through facilitating "straight-through-processing" (STP, ie allowing trades to pass automatically through to final settlement without further manual intervention), which should improve liquidity, even if there is less of a role for market-makers.

Some concerns have been expressed by market participants (for examples, see Morris (2001) and McNee (2000)) that electronic trading may degrade the quality of prices. Firstly, fragmentation of markets may spread transactions among more exchanges operating independently. However, as Allen, Hawkins and Sato (in this volume) note, this concern is most applicable to the heavily analysed

US equity market.[4] As trading there was concentrated on the New York Stock Exchange, the advent of new trading technology led to at least an initial fragmentation in the market. By contrast, markets in other products - notably foreign exchange and bonds - have been mostly bilateral and the advent of electronic trading has led to greater concentration in these markets and so has generally enhanced liquidity. A report by the CGFS (2001) found no evidence that electronic trading was having an adverse impact on market liquidity. The lower turnover observed in some markets is probably due to risk now being appropriately priced, and less need for transactions purely aimed at ascertaining the market price or passing around an unwanted exposure rather than any inherent problem with electronic systems.

The second concern is that a large proportion of transactions may not reach the main exchanges and so not contribute to price determination. They may either be transacted on satellite trading venues or a large broker may internally match buy and sell orders from its own customers, and send only the net balance to the exchange. The price applied to these transactions will be based on prices determined in another market, a procedure known as "crossing". While crossing offers lower execution costs, it has been sharply criticised on other grounds; Lin, Geng and Whinston (in this volume) condemn it as appropriating the outcome of other markets. This raises questions about the extent to which price information is a public good and how exchanges should charge for providing price information.

A challenge for regulators is the blurring distinction between intermediaries, markets and exchanges; (see the paper by Lin, Geng and Whinston in this volume). Exchanges are often "demutualising" into profit-making companies. This raises questions about their former multiple roles in provision of information, clearing and settlement, listing and regulation. A commission of stock exchange experts in Germany concluded that no special regulations are necessary for new types of markets but investors should be warned if the trading system is unsupervised, informed of the size of the trading volume and warned about posting quotes. Wahrenburg (in this volume) notes that often (eg in European equity markets) each exchange has its own regulator but nobody regulates competition between exchanges and trading systems.

It is hard for the authorities to nominate, much less mandate, a preferred market structure. It is possible for sub-optimal market structures to develop. A quandary is that regulations influence market structure but it is necessary to understand the market structure to set effective regulations.

The implications for market microstructure literature of e-finance are discussed by Lin, Geng and Whinston (in this volume). They regard information asymmetry as a competitive advantage in production rather than as a market imperfection, and point out that internet technology is reducing such asymmetries.

3. Impact on financial intermediation

3.1 The nature of e-banking

The opinion that traditional banks were "dinosaurs" that the internet would drive to extinction is no longer widely held. A study comparing new internet-only banks with a peer group of new branch banks by DeYoung (this volume) shows the internet-only banks have been substantially less profitable. They generate lower business volumes and any savings generated by lower physical overheads appear to be offset by other types of non-interest expenditures, notably marketing to attract new customers. However, internet-only banking could eventually prove to be a viable business model: De Young finds that profitability improves more quickly over time for the internet-only start-ups and they may benefit more from gaining experience and be better placed to realise economies of scale than their peers.

The current conventional wisdom is that the "clicks-and-mortar" model (a combination of internet delivery channel with focused bank branches) will prevail, at least in the medium term. There is now

[4] It was noted during the workshop that a lot of academic work had been undertaken on equity markets, especially for the United States, and it would be useful to have more on foreign exchange and bond markets.

increased recognition that, as public trust is so crucial to banking, an established brand name is important and many customers wish to be able to do some banking physically. There is no longer talk about closing all bank branches (indeed their numbers have actually been increasing in the United States), although they are becoming smaller and their focus is shifting to advisory roles. In a developing country, one banker reported that a third of customers cited internet access as an important factor in choosing a bank, albeit much less important than access to branches and ATMs. Once marketing and set-up costs have been incurred, transactions costs (admittedly, excluding the cost of customer support) appear much lower for e-banking, especially in high-wage economies (Table 2). A managerial challenge for "clicks-and-mortar" banks is incorporating IT-savvy, creative staff and visionary managers within more traditional banking hierarchies.

Table 2

Relative costs of banking transactions

	United States[1]	**India**
Physical branch	100	100
Postal	..	40
Telephone	50	18
ATM	27	18
PC dial-up	8	na
Internet	1	12

[1] Simple average of three studies by (i) US Department of Commerce; (ii) Booz, Allen & Hamilton; and (iii) Goldman Sachs and Boston Consulting Group.

Sources: Sato et al (2001); ICICI Bank.

Paradoxically, while many individual banks claim to be making efficiency gains and cost savings from e-banking, there is little sign of it in aggregate banking statistics or in the national accounts. Comparisons of US banks with and without internet operations by Furst et al (2000) and Sullivan (2000) find that large banks offering e-banking have similar costs and profitability to those not offering such facilities. Among smaller established banks, those offering e-banking had higher costs and lower profitability than those not offering it. Nor is there any indication yet that banks' operating costs are falling as e-banking becomes more common, or that they are lower in the e-banking leaders than in other advanced economies (Table 3). One analyst at the workshop went so far as to assert that no major bank had achieved cost reductions through e-finance initiatives.

This may be a temporary phenomenon. Adding e-banking services requires high initial set-up costs (both technological and marketing) with the savings following later. A fundamental restructuring of banks' business models and operations (such as clearing and settlement procedures) and significant retraining may be necessary to reap the full benefits.[5] Or it may be that banks have invested too much, too quickly in new technology without a clear business plan. In some cases, banks may not be achieving potential cost savings because they are not providing strong price incentives for customers to switch to e-banking; they seem to be promoting it more as offering convenience and this is not proving enough to overcome customer inertia or concerns about security. One banker suggested that over 20% of customers would need to be online to cover the cost of a large bank providing such services; Table 1 suggests that in most economies overall penetration is still well below this, although some individual banks would have achieved it. E-banking is likely to grow, but as with telephone and PC banking there may be many customers who prefer not to use it.

[5] See McFadden (2001). An analogy is with the introduction of electric power, which only led to big improvements in efficiency once factories had been redesigned to capitalise on it. See Cohen et al (2000) and Shapiro and Varian (1999).

Table 3

Banks' operating costs as a percentage to total assets

	1993-97	1998	1999	2000
E-banking leaders[1]	1.8	1.5	1.4	1.4
Western Europe[2]	1.6	1.5	1.6	1.8
United States	3.2	3.1	3.1	3.1
Hong Kong and Singapore	1.2	1.3	1.3	1.2
Emerging east Asia[3]	2.2	2.5	2.1	1.9
Latin America[4]	6.2	5.3	5.4	5.8
Central Europe[5]	2.9	3.2	3.1	2.7

[1] Simple average of Finland, Norway and Sweden. [2] Simple average of France, Germany, Italy and the United Kingdom. [3] Simple average of Indonesia, Korea, Malaysia, the Philippines and Thailand. [4] Simple average of Argentina, Brazil, Chile, Colombia, Mexico and Peru. [5] Simple average of the Czech Republic, Hungary and Poland.

Source: update and extension of Table 4 from Hawkins and Mihaljek (2001), based on Fitch-IBCA data.

Views differ about the nature of e-banking customers. Most participants at the workshop thought they were more demanding about prices and the quality of services, made more transactions and opened multiple accounts, making them expensively fickle customers, only staying with a bank so long as it offered the highest interest rate available. However, one banker reported that online customers were more loyal, although it was not clear whether this was due to better tailored services, banks underpricing to build volume or higher switching costs. In either case, banks are looking for new products that will increase customer "stickiness".

3.2 New business models

Banks currently have exclusive access to customer information that they can use for evaluating and pricing loans. E-finance has the potential to create new and radically different business models that will challenge this advantage of banks. *Vertical portals* allow customers one-stop shopping for financial and other products offered by a range of firms. They reduce search costs dramatically and so increase competition in banking and strengthen the position of the customer. But they also pose a further threat to banks. They are able to build up a profile of the tastes and financial status of customers by monitoring their transaction patterns, and would therefore be in a better position than banks to target marketing of financial services and make credit assessments. *Smart agents* automate the comparison process offered by vertical portals to choose the intermediary offering the best deal. *Aggregators* - which may be operated by non-banks such as Yahoo and Microsoft - allow individuals to obtain horizontally consolidated information about their financial and non-financial accounts across institutions. A customer using an aggregator's site for monitoring their account may no longer see the bank's marketing messages unless the aggregation is done on its site. Banks also fear being held responsible for the misuse of confidential customer data by the aggregator. Aggregators are likely to become more important in the United States with its many banks[6] whereas in Europe and other universal banking markets many customers already have all their accounts with one bank. Over time, these new entities may evolve further in ways that make them greater competitors for banks. For example, if non-bank aggregators are allowed to transfer funds between bank accounts or become involved in bill payments, policymakers will need to decide whom, if anyone, should regulate these new entities.

One response of banks to these challenges is to broaden their own range of activities so as to maximise use of their brand names. Internet technology allows more targeted cross-selling of other

[6] In the United States the average customer uses more than three banks and the number is higher still for internet customers. Surveys there and in Singapore showed that a majority of consumers wanted to use an aggregator and many would be willing to pay for it.

financial products (partly by outsourcing and relabelling), or even services such as certification, digital signatures and secure communication. This raises a problem for bank supervisors, who have usually been reluctant to allow banks to expand into non-financial services. This problem becomes more acute when non-financial firms are increasingly encroaching on banking business. For example, in Japan there is now a network of around 10,000 small convenience stores connected by a sophisticated information network which offer basic banking services (see the paper by Itoh in this volume). Telecoms and IT companies are also likely to become important rivals to banks, as they possess the necessary IT skills and have an extensive customer base. This raises questions about whether they need to be brought within the supervisory net. In some cases, these firms may be allies of banks rather than rivals, which then raises the issue of which institution, and which supervisor, is responsible if problems arise.[7]

3.3 Cross-border e-finance

In an e-finance world, cross-border expansion becomes cheaper and less risky. One banker went so far as to describe it as "the death of distance". The resources devoted to foreign e-finance are often situated in the home country so that the same resources can be switched from one foreign market to another. It is thus much easier to retrench quickly from a virtual offering than a physical one. Furthermore, it may be necessary for banks in smaller economies to expand their cross-border operations in order to reap economies of scale. However, so far there has not been that much cross-border e-finance. One reason is that it is harder for an offshore bank to build up trust and it is less familiar with the market conditions. Some bankers avoid international clients as the bankers are unwilling to be subject to dispute settlement rules and consumer protection requirements of unfamiliar jurisdictions. Cross-border finance, and the promotion of it, will require a degree of cross-border coordination of supervision, as evidenced by BCBS (2000). Such cooperation may need to extend to similar supervisory rules and disclosure requirements (for efficiency and to avoid regulatory arbitrage) and some harmonising of legal, accounting and taxation arrangements.

3.4 Outsourcing

Increased competitive pressures and the speed of technology changes are leading to rapidly increasing outsourcing relationships. Outsourcing allows small institutions to benefit from economies of scale and gain access to expertise. For larger institutions, the advantage is more that of being able to concentrate management time on core businesses. Increasingly services are being outsourced internationally; an account enquiry to a UK bank may be answered by someone in a call centre in India. However, supervisors are concerned about the adequacy of due diligence before entering into a relationship, poor documentation of rights and responsibilities and weak ongoing risk management practices employed by banks in conjunction with outsourcing activity. Some banks overestimate the cost savings from outsourcing, have unrealistic timetables and have given little thought to the potential disruption to their operations in the event of problems with the service provider. This in turn gives rise to operational and reputational risks for these banks. It may also give rise to systemic concerns where a large number of banks have outsourced to a single provider or critical aspects of banks' operations have been outsourced. (See BCBS (2001) for further discussion.)

3.5 Other challenges for bank supervisors

E-banking raises both familiar challenges for supervisors and some distinctive ones. The rapid growth into new activities stretches managerial capacity, particularly of smaller banks blindly following trends. Those banks which lose profitability by adapting poorly to e-banking (which could involve either under- or over-spending on new technology) may then be tempted to move into riskier business to maintain returns. This could be analogous to the excessive competition and excessive risk-taking seen during

[7] Banks (2001) gives as examples of alliances crossing supervisory responsibilities E*Trade with UBS, HSBC with Merrill Lynch, CompuBank with GE, NetBank with Fidelity, E*Trade with Ernst and Young and Royal Bank of Scotland with Tesco. Further examples in OECD (2001) include ABN AMRO with Trade.com, Dresdner Bank with eBay and BBVA with Telefonica.

phases of bank deregulation. The greater importance of economies of scale may mean that smaller banks are increasingly relegated to being niche players. While many could be taken over by larger banks, some may fail with disruptive consequences. Systemic risks may rise if e-banks are more vulnerable to runs on deposits. Their risk profiles can change dramatically in a very short period. In some cases, the new technology could be harnessed by supervisors to assist in their work. For example, supervisors could require direct access to banks' risk management systems.

Operational risks are another important area. Security concerns are an important factor discouraging many internet users from e-banking. Supervisors need to be assured that banks have conducted adequate assessments of the vulnerability of operating systems to hackers and denial-of-service attacks (ie deliberate overloading of websites) and their cryptography, back-up systems, firewalls and emergency procedures. The Basel Committee on Banking Supervision's Electronic Banking Group (EBG) has risk management principles but has not yet developed the desirable global but flexible security benchmarks.[8] Common criteria for laboratories certifying that IT systems are secure are being developed by 14 OECD economies. More work is needed on developing common and robust authentication standards for digital signatures and legal recognition for them.

The division of supervisory responsibilities may also be affected by e-finance. Claessens et al (2000) argue that greater competition from alternative e-lenders means banks are now less "special" and there is therefore less need for a safety net - an approach Neito (in this volume) describes as controversial.

E-finance also raises other public policy issues that may affect some central banks, depending on the width of their mandate. There is a risk of a "digital divide" emerging as the poor are excluded from the internet and so from the financial system.[9] E-banking could facilitate money-laundering, although electronic systems may also help in its detection. There are also dangers of false representation and identity theft. In the banking area, some central banks share responsibility for competition issues - see Marcus (2001) - and the growing importance of networks, and associated pressure towards consolidation heading towards undue concentration or monopoly, raises important issues here. Privacy and other consumer issues are involved if e-finance makes it easier for banks to trade information about consumers. Other consumer protection issues are the need to assure consumers that they have the same protection (cooling-off periods, complaints and compensation arrangements) as with traditional products and the development of codes of behaviour and sound practice.

4. Impact on the payment system

4.1 Retail payment systems

At present, the credit card system dominates retail internet payments despite being costly, open to fraud, poorly suited to micropayments or person-to-person payments (although new systems such as PayPal are attempting to address this) and not anonymous (see the paper by Spencer in this volume). It is run by an oligopoly displaying the typical characteristics of low innovation and charges poorly matched to the relevant costs. Looking further ahead, payments on the internet may be made by a virtual "cybermoney", which might be issued by banks, but also by telecommunication or IT companies.

Banks are now integrating retail payments into their systems. In Scandinavia it is now possible to have a reference number which flows through the payment system. A global standard with a common layout is desired, including a globally understood account number (see the paper by Leinonen in this volume). The goal is to achieve delivery-versus-payment at a retail level. In deciding between open and private systems, and centralised and decentralised typologies, a balance is needed between

[8] The EBG's e-banking guidelines are set out in BCBS (2001).

[9] Table 1 shows the digital divide between the wealthy countries in the upper part and the poorer countries in the lower part. It also exists within individual countries. In the United States the average income of people using online banking services is twice that of people not online, according to Forrester Research.

competition and cooperation. Regulation may be needed to promote open and common standards, minimise switching costs and allow flexible pricing.

Electronic money schemes have been around for a number of years. BIS (1996) pointed out some potential issues they raised, such as loss of seigniorage. However, any displacement of notes and coin by e-money is happening very slowly. Indeed, the ratio of notes and coin to GDP has actually risen in some countries. It is possible that this overall stability disguises two offsetting trends: a very gradual displacement of low-denomination notes and coins by e-money, but a greater use of high-denomination notes for various forms of bad behaviour or as a store of value offshore (see Goodhart and Krueger (2001)). The ECB's data for the euro area show e-cash outstanding is less than 0.1% of notes and coin on issue, and its spread has been slowing (see the graph on page 99 of this volume). More recent forms of e-money are more likely to succeed as they are better designed, more robust, may be linked to the internet and have a clear use. However, it still seems likely that they will coexist with physical banknotes for a long time yet, given the security, convenience and anonymity of banknotes and the lack of interoperability of diversified e-money schemes.

4.2 Wholesale payments systems

Critical issues in this area include the linkage of financial markets and payment systems to offer delivery-versus-payment and straight-through-processing. The execution, clearing and settlement of trades can be linked to the procedures for controlling market and operational risks. STP should reduce costs by reducing the amount of labour required and minimising the risk of errors from the different stages involved in reporting and recording trades.

5. Network effects and governance

A few speakers drew analogies between e-finance and industries such as telecoms, electricity and railways, stressing the importance of interconnectedness and network effects (see the paper by Wahrenburg in this volume). There is a tension between benefits and costs of allowing the natural tendency for monopolies to (re)assert themselves in such industries. Just as it would be inefficient for competition to take the form of multiple electricity or telephone lines running down streets into houses or parallel railway lines between cities, financial traders do not want multiple terminals on their desks, or even to have to switch between different sites, to see quotes. However, a monopoly raises the usual concerns about inefficient pricing, technical inefficiencies and abuse of dominant market positions. There may be a trade-off between static efficiency and soundness in a centralised system and dynamic efficiency and innovation in a fragmented system. This is also an issue for supervisors and regulators; a static environment with a well-established monopoly is more secure in the short-term but allowing new entrants is likely to lead to a more vibrant and responsive market. The key is to achieve a governance structure with competing but interoperable systems. This may involve a role for the authorities in setting common standards or at least ensuring they are not established in an anti-competitive way. However, as set out in Bar (2001), this may be difficult as, where the network is itself the market, anti-competitive features may be embedded in the architecture. Furthermore, new governance rules need to be both technically and politically feasible. They also need to be appropriate for the transitional phrase between old and new marketplaces, when experimentation means risks are particularly high; see the paper by Weber and Zysman in this volume.

Following the commercial launch of the internet in 1994 there were great expectations that it would shatter entry barriers. However, across a range of e-commerce areas it was found that while entry is easy, staying is harder. Bill Gates had said the internet would create a "frictionless economy" but as Bar (2001) points out, some friction is needed to get traction! Similarly, while it was earlier thought that e-banking would facilitate new bank entry and increase competition, it now seems more likely that e-banking will speed up bank consolidation as the fixed costs (including marketing) are high but marginal costs very low. Adding e-banking services requires high investment and a willingness to accept lower profits for a time. In the longer term, consolidation is likely to lead to a stronger, albeit possibly less innovative, banking system. However, while many existing banks might merge, some might fail, which would pose challenges for supervisors in ensuring such exits are orderly and do not challenge systemic stability and weaken overall confidence in the banking industry.

Views differ both about the size of economies of scale in the finance industry and how new technology and the network effects of e-finance are changing these. Older studies have generally found economies of scale exhausted at quite small sizes of banks.[10] E-finance is likely to be changing the pattern of economies of scale and scope but it is not obvious in which direction, with the answer possibly differing for different products. Nieto (in this volume) suggests that there are significant economies of scale in the market for large corporate loans (indeed, banks with a smaller capital base may be excluded from this lending unless they form syndicates). However, she believes "a consensus exists that a plethora of financial services (eg lending to small firms, brokerage services, trading systems) have witnessed a reduction in their economies of scale and an increase in competition due to the availability of IT."

6. Implications for central banks

Assessing and dealing with the potential risks posed by e-finance is a key challenge for central banks. The scope of these challenges will vary across countries, not just because of the differing developments in e-finance across economies (Table 1) but also because of differences in the responsibilities assigned to central banks. Monetary policy is a core responsibility of all central banks, and may gradually be affected by e-finance developments. Central banks are able to implement monetary policy in large economies by means of small transactions because they are the monopoly suppliers of liabilities with a special role in the economy. E-finance may lead to a decoupling of these transactions and real activity. If the public switches to using non-bank institutions for banking activities, particular problems will arise for central banks for which required reserves are important. While the central bank has a natural advantage in providing final settlement, this could move elsewhere. This would leave the central bank needing to perform very large transactions, or to try bringing new institutions within its control or to rely on the government requiring that payments to it continue to be made in central bank money. A further challenge would be privately issued e-money on the internet. Even if notes and coin, or indeed banks, were to disappear the central bank could still influence short-term interest rates as its government ownership gives it the ability to carry out large market transactions without regard to profitability. E-finance may also gradually change the transmission mechanism, involving, for example, a greater focus on changes in relative returns and less emphasis on credit rationing effects. (See the paper by Hawkins in this volume for further discussion of these issues.)

In addition, many central banks retain responsibility for supervision of some financial institutions, or at least a general interest in the overall systemic stability of the financial system. As mentioned above, the paucity of data makes assessing the impact of e-finance difficult. Even once the trends are identified, it is hard to distinguish between familiar issues in new guises and totally new challenges, especially given other concurrent forces changing the financial industry. The net impact will vary significantly by product, by player and by market. While retail financial services have been most transformed by the internet to date, there may be a major impact on transactions between businesses in the medium term. The business models for providing financial services will also keep changing as the enabling technologies evolve (eg internet access not just through PCs but also from mobile phones and interactive televisions). But it is very hard to predict which business models will succeed in normal times, and which will remain resilient under stress.

These uncertainties make it all the more important to have a regular exchange of information between central banks, supervisors and market participants. A periodic reappraisal of the global e-finance landscape and the main policy issues is desirable. Various committees meeting in Basel, such as the

[10] This is consistent with observations of equity prices following bank mergers, which often show the combined bank has a lower value than the sum of its components. However, empirical studies have concentrated on the US banking market, where a long history of restrictions on interstate banking has left a large number of banks. Western European banks have attracted more attention recently, but there are still only a handful of studies referring to emerging economies. Hawkins and Mihaljek (2001; see especially their Graphs 1 and 2 and Annex 2) show that in many emerging economies smaller banks are often more efficient on average than large banks. This is partly because the large banks include state-owned banks, which have often performed poorly. Removing these from the sample, it does appear that the average large bank has lower operating costs relative to assets, but there are many small banks that are just as efficient.

Basel Committee on Banking Supervision, the Committee on the Global Financial System, the Committee on Payment and Settlement Systems and the Financial Stability Forum, will play an important role in this assessment, with input from national authorities, the private sector and academics.

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A new perspective to finance and competition and challenges for financial institutions in the internet era

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1. Introduction

New information technology (IT), especially the internet, have revolutionised the finance industry with the rapid growth of electronic finance. E-finance activities include all types of financial activities carried out over the internet or other public networks, such as online banking, electronic trading, the provision and delivery of various financial products and services (for instance insurance, mortgage and brokerage), electronic money, electronic payment and communication of financial information.

E-finance is a driving force that is changing the landscape of the finance industry fundamentally, in particular, towards a more competitive industry. E-finance has blurred the boundaries between different financial institutions, enabled new financial products and services, and made existing financial services available in different packages. But we think the influences of e-finance go far beyond this. The developments in e-finance, together with other financial innovations, are constantly bringing new challenges to finance theory and changing people's understanding of the financial system.

In this paper we suggest a new perspective on financial intermediation and markets. We discuss why and how this new framework of analysis may shed light on the understanding of finance in the age of the internet and IT revolution as well as help explain the financial innovations seen in the past few decades. We also examine competition issues and what strategies financial institutions should adopt.

2. A new perspective on financial intermediation

We propose a new perspective on financial intermediation in which both traditional intermediaries and financial markets can be examined in a unified approach. The present theory of financial intermediation based on the idea of the perfect market posits the role of intermediaries as one that alleviates market imperfections. Meanwhile, research on market microstructure, which studies closely how markets function and operate, illuminates the market mechanism. We think that the traditional distinction between the intermediaries and markets hampers finance theory in explaining the fast and constantly changing financial system.

Financial markets, like all other markets, are created and operated by people and therefore are essentially firms. They are a special type of financial intermediary with higher transparency and efficiency. On the other hand, traditional financial intermediaries, by matching savers and borrowers, are also providing market-making services, though in a more opaque way.

Embracing both traditional intermediaries and markets in one framework, this new perspective enables better understanding of the financial system and makes it possible to solve long-time puzzles in finance theory. Instead of patching and modifying a theory that is constantly challenged by new developments, this more integrated and consistent conceptual framework tends to explain well the revolution that is taking place in the finance industry.

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2.1 Present financial intermediation theory and recent developments

The theory of financial intermediation is based on the classic notion of the perfect market that originated with Adam Smith, was developed by Marshall and Walras and was formalised in the Arrow-Debreu model of resource allocation. According to this theory, financial intermediation exists because of market frictions and imperfections and acts as a remedy to the market system.

Researchers have studied the role of intermediation in alleviating different market frictions and imperfections. One body of literature focuses on transaction cost (see, for example, Gurley and Shaw (1960)), and another stresses the importance of asymmetric information between investors and borrowers (see Leland and Pyle (1977), Campbell and Kracaw (1980), Diamond (1984), Gale and Hellwig (1985), Boyd and Prescott (1986); for a comprehensive understanding, see Freixas and Rochet (1997) and for a brief summary, see Allen and Santomero (1998)).

However, such a passive view on intermediation is obviously inadequate in explaining the reality of the finance industry, especially the dramatic growth, accelerated developments and extensive innovations in recent decades. Although the growth of financial markets and revolution in IT have reduced the transaction costs and alleviated information asymmetries, intermediaries survive, and in fact grow in overall size and importance to the economy. In response, some researchers seek to reconcile the differences between theory and reality and to view intermediaries as value-adding institutions.

In a series of papers, Merton (1989, 1993, 1995) and Merton and Bodie (1993, 1995) propose a functional perspective of financial intermediation in contrast to the institutional perspective. From their perspective, the economic functions of financial intermediation are relatively stable and the institutional structure evolves in performing those functions. Merton (1995) describes a model of the dynamics of financial evolution in which intermediaries serve an important latent function of creating and testing new products before they are “seasoned” enough to be traded in a market. The interactions between financial intermediaries and markets reinforce and improve the performance of their functions and push the “financial system toward an idealised target of full efficiency” (Merton (1995)).

In line with the functional perspective analysis, Allen and Santomero (1998) emphasise the role of intermediation in risk trading and participation costs. They argue that while their role in reducing market frictions decline, they play a crucial role in transferring and managing risk and in lowering participation costs for individuals.

All these theories try to render some active roles played by financial intermediaries rather than a pure remedy to market imperfections. However, these theories, just as the traditional intermediation theory, have the perfect market as their benchmark. While financial intermediaries are studied closely and carefully, the financial markets are still viewed in an abstract way as frictionless and dynamically complete in the limit. Scholtens and van Wensveen (2000) suggest that financial intermediation theory leave its paradigm of static perfect markets, and envisage that in a modern theory, financial institutions should be viewed as independent market parties who create financial products and whose worth to their clients is the transformation of risk, term, scale, location, and liquidity.

We think that to explore a new theory of financial intermediation, taking into account technology developments, it is not enough to look at only traditional intermediaries. Intermediaries should be viewed in the big picture of financial systems. In particular, we need to look at how financial markets work, the study of which is called market microstructure, the topic we discuss in the following subsection.

2.2 The market microstructure literature and other contributions to understanding markets

While economics usually treats markets as ideal and abstract, there are studies that focus on how markets are created and function, the most conspicuous being the market microstructure theory in finance. This literature puts market mechanisms under the microscope and analyses specific institutions of exchange and trading rules, especially their role in price formation; see O’Hara (1995).

In earlier models of the price discovery process, dealers (or market makers) act as providers of liquidity and set prices in order to control inventory levels. Recent work in market microstructure focuses more on the impact of information on market prices, linking advances in the economics of information, rational expectations and imperfect competition. In these models, dealers change prices in response to information considerations; Madhavan (2000).

This information-based game-theoretic paradigm was first introduced in Glosten and Milgrom (1985) and Kyle (1985), and further developed by Easley and O'Hara (1987), Holden and Subrahmanyam (1992) and many others.

In the Glosten and Milgrom (1985) model, there are two types of traders, informed and uninformed. Ignoring inventory and order processing costs, a rational market maker will quote bid and ask prices that are ex post regret-free. For example, the market maker's bid price is the expected value of the security given that a sell order has arrived. By setting the bid and ask spread, the market maker earns zero expected profit by recouping profits from the uninformed traders to compensate for the loss to the informed. Thus, the bid-ask spread may exist even if the market maker has no costs, behaves competitively and is risk neutral.

In addition to price formation, informational research in microstructure also covers various topics such as market structure and design, market transparency (the ability of market participants to observe information about the trading process), and informational issues in microstructure related to other areas including corporate finance, asset pricing, and international finance; Madhavan (2000).

We think that the informed-uninformed paradigm in market microstructure literature does not take into account the role of information technology. Market microstructure research makes assumptions about the information structure of market participants. We argue that information structure is driven by the developments in IT and is decided based on technology and economic incentives. Dewan and Mendelson (1998) study time-based competition in imperfect securities markets, where traders make IT investments to gain faster access to information and thus earn higher trading profits.

As well as the market microstructure literature, there are other studies that have shed considerable light on the market mechanism. Shiller (1993) pointed out that the market system is an invention, a system created by social thinkers who designed it with a purpose. We think that markets are not only social inventions but also inventions based on technology developments. As technologies keep reducing transaction costs, new markets are invented.

Game theory provides powerful tools and techniques in analysing specific market mechanisms. In his book on two-sided matching markets, Roth (1990) presents not only game theoretical models, but also explains how the incentives that a market organisation gives to the participants impose constraints on the outcomes that the market may achieve.

Finally, before we move on to the new perspective on intermediation, we would like to mention the inspiring work by Spulber (1999). He develops a theory in which firms, acting as intermediaries, create and run markets. It is path breaking in integrating both intermediation theory and microstructure theory, and in applying and extending them to a new area. Notably, his theory of firms emphasises that firms operate the market mechanism, most importantly by posting prices as well as providing other related services such as monitoring. He is critical of most economic analysis for overemphasising the idealised view of the market mechanism and downplaying the role of firms in market-making activities.

2.3 The financial system analysed in terms of the new perspective

With the background of literature on both intermediaries and markets, we now introduce a new perspective on financial intermediation, an integrated theory in which both traditional intermediaries and financial markets can be analysed with a unified approach. In order to fully understand the role of financial intermediation, it is necessary to break down the clear-cut distinction between financial intermediaries and financial markets and to study the financial system in one analytical framework.

In essence, all financial institutions act as intermediaries between lenders and borrowers, either by purchasing and reselling with or without transformation (such as a bank taking deposits and transforming them into loans, or a stock specialist trading shares from her own account), or by matching orders (such as an auction market).

First of all, financial institutions produce "matching" between market participants. Financial markets produce matching for standardised products. Traditional intermediaries deal with more customised products and services, thus more transformation is needed within the organisation before matching is achieved. As an analogy to other industries, financial markets act like retailers while the traditional intermediaries are more like manufactures and/or wholesalers.

This new perspective helps to understand the role of market making that financial institutions play. In general, because the market mechanism has been considered exogenous to the analysis, the value added by creating and operating markets has not been fully recognised. Thus the intermediation theory finds itself in an awkward position when trying to define value-adding activities carried out by intermediaries, while in market microstructure theory there is no theoretical foundation for profitable market making activities. We think it is time to pay due attention to the value of market making. By doing so, the value-adding functions performed by intermediaries become conspicuous.

Such a perspective is actually crucial in understanding the finance industry in the internet era. The rapid developments in electronic finance have blurred the boundaries between commercial and investment banks, brokerage firms and trading platforms, traditional intermediaries and market intermediaries. Separate finance theories cannot explain this trend in the finance industry. With this integrated analytical framework, however, we see that the advances in technology have changed the production function in all financial institutions and these firms are differentiating their products and services as well as vertically integrating with each other.

This new perspective also enables analyses of financial markets that were not possible under the idealised view about them. One of the open questions in the market microstructure literature is the "network externality puzzle", referring to the fact that despite strong arguments for consolidation, many markets are fragmented; Madhavan (2000). From the new perspective, however, financial markets are operated as businesses and they compete with each other. Instead of discussing market fragmentation and social welfare, we now study how markets compete and what is the best achievable result. Instead of asking whether market consolidation is beneficial, we now study the empirical issue of whether there will be entry in the "market" for financial markets and what the equilibrium number of markets will be, in other words, we ask whether one global market will emerge.

It may also shed light on the issue of liquidity. Both intermediation theory and microstructure theory study liquidity but in isolated approaches. Diamond and Dybvig (1983) develop a three-period model where banks can provide liquidity to customers with idiosyncratic inter-temporal preferences. In their model, banks are "coalitions of depositors" and have no financial resources other than deposits. In microstructure theory, it is well known that dealers provide liquidity to the markets by standing ready to trade from their own accounts with investors. In light of the latter, we think that banks can also provide liquidity with their own equity.

We emphasise that in this unified theory of financial intermediation, the role of information is still crucial and the role of IT should be fully recognised. Information is crucial in the production process of financial services and IT investment is one of most important strategic decisions for all financial institutions. Financial institutions produce matching by setting prices (in particular bid-ask spreads). If an institution is more efficient than others in price discovery, it may achieve narrower spreads that attract more customers and may gain higher profits. To be efficient a firm has to invest in technology and the expected higher profits may justify the investment.

Informational economics paradigms dominate in both the intermediation and microstructure literature. However, in both bodies of literature the fundamental assumption is that information is free and thus information asymmetry is a market imperfection. As a special case, price, the most important (aggregated) information in markets, is free.

But if information is totally free, firms' incentives to invest in IT will disappear because of the free-riding problem. So we argue that information asymmetry is not a market imperfection, but a competitive advantage in production. As an example of information free riding, electronic crossing systems make profit by being a parasite of real exchanges such as NYSE, that is, they use the prices on these exchanges for free. As another example, on POSIT and Instinet, traders engage in off-market negotiation, using market price as a reference. Economists have made comparisons between negotiation and the market mechanism. However, the two mechanisms are not fully comparable in the sense that the price discovery function of the market provides the negotiators with valuable information. The information free-riding problem can be so serious as to undermine the market mechanism. As more traders directly negotiate with each other and fewer use the market intermediary, the prices in the market are less revealing and informative, driving the spreads higher and perhaps leading to a collapse.

3. Competition issues for financial institutions in the internet era

When we view all financial institutions as intermediaries, or more generally as firms, the question of which competition strategy to choose is central for each institution. Financial intermediaries and markets are deploying e-finance to compete with each other fiercer than ever before.

Traditionally, financial institutions have different geographic locations and physical branch networks that "naturally" differentiate them from each other. The competition between these firms can be characterised by a Hotelling location model. However, the internet is changing the fundamental business environment. As the internet is potentially accessible by everyone, a financial institution can no longer dominate a local or regional market simply by its physical presence. Financial institutions must find their particular competitive edge beyond sheer location and physical branches.

The internet and new information technologies have lowered the barrier of entering the finance industry by reducing the initial investment and the transaction costs tremendously. Both incumbents and new entrants find themselves offering essentially the same products and services and thus often involve in Bertrand competition, or price wars, in order to gain bigger market share. For example, the average brokerage commissions charged by top-10 online brokers dropped from $53 at the beginning of 1996 to $16 in mid-1998, according to Credit Suisse First Boston (1998).

Because of the strong network externality in financial services, each firm is trying to enlarge its customer base, many by mergers and acquisitions, either horizontally or vertically. Another trend in the financial sector, which we think will prevail in the future, is differentiation in products and services.

In the following sections we discuss some competition issues in e-finance activities. Sato, Hawkins and Berentsen (2001) present a conceptual structure for e-finance that consists of six levels: online products, intermediaries, exchanges and trading systems, clearing and settlement systems, legal and regulatory frameworks, and a communication platform. We discuss some of these activities with the integrated analytical framework and the theme of competition strategies for financial institutions in the internet age.

3.1 Bricks-and-mortar banks versus virtual banks

Most researchers and practitioners believe that disintermediation is unlikely to occur and financial intermediation is still essential in the age of the internet; Sato, Hawkins and Berentsen (2001), Beck (2001).

The most important pro-competition feature of the internet is the reduction of fixed costs and transaction costs and this allows new competitors into the banking system. However, the two major entry barriers for virtual banks are reputation (both as an agent for the lenders and as the monitor to the borrowers), and large funds to pool risks. At first glance there is no way for an entrant to overcome these barriers and be able to compete with those long-established and well-trusted traditional banks. But researchers have noticed that large firms with a high reputation among customers and an existing large customer base may be potential entrants. In fact, Sony just opened up an online banking branch, which will focus on individual customers in a bid to attract one trillion yen ($9.3 billion) in deposits within five years.

Besides established large firms, these entry barriers can also be overcome by large initial investment. With large funding, virtual banks can gradually build up their customer base and reputation. Because of the significant operating cost reduction, virtual banks can offer much more attractive rates to their customers. Since most financial services offered by banks are standardised, it is not impossible that virtual banks can build a customer base large enough to be viable. The equity of these banks will help them provide liquidity to their customers.

We are not saying that pure-play virtual intermediaries are the future of the finance industry. While such businesses may emerge and survive, the more successful strategies for financial institutions in the internet age will depend on how they can find competitive edges over others in fully utilising the existing systems and endless new opportunities the technologies have brought. Not only electronic banks should differentiate themselves from brick-and-mortar banks, each bank should demonstrate convincingly how its operations, products and services are creating value for customers that others cannot provide.

3.2 Electronic stock markets: exchanges and trading systems

Securities markets used to be geographically segmented before the advent of the internet irrevocably overhauled the landscape of the finance industry, including securities trading business. Theoretically, the internet has made the notion of a single global securities market possible. In reality, however, innovations in network technology have led to a boom in the business of developing electronic trading systems; see Allen, Hawkins and Sato (this volume) and Fan et al (2001). Various types of electronic trading systems, such as electronic communications networks (ECNs) and crossing networks, have been developed, competing with well-established exchanges. In 2000, ECNs accounted for 30% of the total share volume in Nasdaq stocks and around 3% of exchange-listed stocks, compared to the figures of 13% and 1.4%, respectively, in 1993. On the other hand, existing markets around the world are involved in the process of implementing electronic order books that consolidate orders submitted by traders in that particular market.

In light of the integrated view of financial institutions, we consider such phenomena as fundamental changes in the industrial organisation of the industry. Entry becomes profitable with the tremendous decrease in the fixed and marginal costs of building a securities market. More importantly, financial markets can no longer operate as local monopolies[2] because the internet has broken down the geographic boundaries.

Next we discuss issues concerning competition between financial markets, especially those brought up by the proliferation of electronic trading systems.

3.3 The impact of ECNs

One widely recognised fact is that due to the competition from ECNs, prices on exchanges such as Nasdaq have become tighter, ie the bid-ask spreads have narrowed. ECNs have also affected market operations by improving the flow of information through open order books. However, there is also a serious concern that ECNs may exacerbate the market fragmentation and the inefficiency of multiple trading systems. Though technologies are getting fancier, life for the traders is not made easier. Actually, it is very costly to switch from one trading system to another due to the lack of standardisation among different systems, which causes inefficiency.

ECNs such as Instinet have also blurred the distinction between brokers, market makers, and even markets. For example, Instinet operates a trading desk that is the functional equivalent of a closed order book. Although this often means routing orders to other systems, Instinet can attract more order flow to the trading service. Instinet is a member of all US regional exchanges, the AMEX, the London, Paris, Toronto, Zurich, Hong Kong, Frankfurt, Stockholm and Bermuda stock exchanges, the CBOE, and the European Options Exchange, which gives its customers access to all the securities listed on these exchanges. Instinet is also a part owner (9.9%) of a NYSE floor brokerage unit through its ownership of Lynch Jones & Ryan, a private New York company that specialises in institutional trading and research; Fan et al (2001).

The main reason for investors, especially institutional investors, to use ECNs is that they protect "privacy" because of their anonymity and thus enable traders to transact large volumes without affecting market prices significantly. This in effect conceals their identity to the market makers and causes the information to be revealed more slowly.

3.4 Monopoly or oligopoly - competition view on market consolidation and fragmentation

As geographical constraints are becoming less a problem, the network externality effect makes market consolidation an attractive choice for security exchanges in terms of liquidity. However in practice we have not seen a wave of stock exchange mergers in recent years. Until now, there has been little theoretical analysis of this "network puzzle" (Madhavan 2000). We suggest that instead of a normative view on market consolidation/fragmentation, we should adopt a positive view in which markets are

[2] For financial markets, a "local market" can refer to larger geographic regions than in the case of other industries and sometimes can even mean a national market.

treated as profit-making businesses competing with each other. Next we will discuss possible explanations of the network puzzle with this approach.

One possible reason is that due to the limitations of technologies, the geographical factor is still important and a local monopoly is still possible. Timely data transmission across a large geographical region over the internet is still technically difficult giving the uncertain cyber-traffic. Moreover, as discussed later, the high security requirements for financial data worsen this technical difficulty as security and timely transmission are often at odds with each other.

Another possible reason is the lowered entry cost if we view stock exchanges as profit-making businesses. While the advances in IT have made market consolidation - the extreme being a single global securities market - possible, the technologies also make it financially attractive to establish electronic exchanges, and as a result the markets are more fragmented.

A third possible reason is that markets may differentiate from each other by different trading mechanisms that may fit different demands. Generally speaking, continuous markets can better serve time-critical orders than call markets, albeit normally at a higher cost. As an example, Hendershott and Mendelson (2000) show that less patient traders will go to dealer markets for instant execution, while more patient traders will first try crossing networks for a possibly better price. Stock exchanges with different mechanisms are differentiated from each other such that no competition can lead to consolidation. Gode and Sunder (1999) discuss a specific technical problem in electronic markets: the time lag problem for geographically distributed agents. They think that a call market instead of a continuous market may solve this problem.

A fourth possible reason is the asymmetric information view. As shown in rational expectation equilibrium theory, an informed trader cannot avoid sending information to the market if he wants to reap information rent, thus alleviating the information asymmetry. This creates conflicts among informed traders, as latecomers will suffer from the information leakage, and propels them to different exchanges.

3.5 Electronic market with the provision of liquidity: electronic dealers?

In dealer markets, dealers provide liquidity to the market. Madhavan (2000) refers to a “dealers’ puzzle” - although a continuous market can be accomplished by automated systems without human intervention, most markets still operate with market makers as intermediaries.

Considering the dealers as profit-making and competing intermediaries may help solve the puzzle and further understand the value of liquidity provision. In the context of optimisation, Guo et al (2001) show that providing liquidity may solve an optimisation problem that otherwise will not converge.

Currently, in automated trading systems, limit orders are matched automatically and there is no liquidity provider. However, it is technologically feasible to implement an automated trading system in which the system can provide liquidity. That is, the system may be the other side of a transaction and thus carry inventory. As long as it is profitable to build in such functionality in the trading systems, there is no reason that the companies operating the exchanges will not implement it in the future. To implement such a system, another problem to be solved is the “trading rule” for this automated system (the algorithm).

A theoretical breakthrough in understanding the dealers’ role in providing liquidity may lead to the development of automated trading systems with an embedded “electronic dealer”. However, it is also possible that such systems emerge in practice, introducing new challenges and opportunities for the study of liquidity issues in finance theory.

3.6 Developments in the electronic bond market

The recent developments of electronic bond trading systems best demonstrate how IT may change the landscape of markets and why markets should be viewed as profit-making businesses.

Traditionally, most of the dealers and brokers in the bond market executed trades by telephone and fax. For example, the secondary market for U.S. treasury securities is largely an over-the-counter market, but unlike Nasdaq, the highly automated OTC market for stocks, trading in the treasury market is highly people-intensive; Fan et al (2001).

But major changes have taken place since the last decade. Electronic information dissemination systems such as GovPx and FIPS (Fixed-Income Pricing System) were introduced in early 1990s. Some companies, especially investment banks, have opened their single dealer system for bond trading. For example, Credit Suisse First Boston's GovTrade system started in 1992 and investors can access quote information and trade bonds such as treasury securities, repos and commercial paper through Bloomberg's terminals. Other examples include Autobahn by Deutsche Bank, LMS by Merrill Lynch, Fixed Income Securities. Recently, some electronic bond trading systems with multiple dealers have been launched. The competition between multiple dealers usually leads to narrower bid-ask spread and better prices for investors.

It is interesting that as the bond market progresses in adopting IT, rather than seeing a single, growing electronic bond market, many companies are developing their own electronic bond exchanges and these systems are competing with each other.

First, it is profitable for these companies to operate an electronic market. The advances in technology have significantly reduced the fixed and marginal costs and make such a business profitable. And without other restrictions, entry to the industry will continue until the profit equals the opportunity cost and the equilibrium is reached.

Secondly, as competition gets keener, firms will seek to differentiate to maintain their profit level. Such strategies are often backed up by investment in technology such that the firms can introduce new products and services that others cannot or can only provide at higher costs. By offering different services and expanding scopes of products, bond-trading systems enhance their competitive advantages and gain higher market share and profits. For example, multiple-dealer bond trading systems developed after the proliferation of single dealer systems. The competition among multiple-dealer systems is also highly intensive. TradeWeb started in the first quarter of 1998 and offers real-time trading for US securities. A similar system, Chicago Board of Brokerage's MarketPower opened in July 1998. Bloomberg BondTrader, a component of the Bloomberg Electronic Trading System operational since March 1999, allows clients of participating dealers to execute orders and to make price inquiries for US Treasury bills, notes and bonds on a regular, skip-day, corporate and when-issued basis. During the fourth quarter of 2000, BondTrader was expanded to include the buying and selling of global non-dollar sovereign issues and US agencies on the same platform. State Street's Bond Connect, a complete fixed income electronic marketplace opened in June 2000 and significantly augmented its system in January 2001 with features such as "Indication Of Interest" that can focus market attention on particular securities and thereby release latent liquidity.

Innovations in trading mechanisms can also be deployed as competitive strategies. Fan et al (2000) develop a theoretical model of an electronic continuous bond trading mechanism. The special feature of this model is that it allows bundle matching in addition to single asset auction. In practice, one example of innovation is that Bond Connect implements a call market in three sets of auction sessions, with the first session of each set designed as the primary auction for aggregating liquidity, and later sessions to allow adjustments.

3.7 E-finance-enabled design of financial organisations and mechanisms

The advances in IT have not only reduced transaction costs, but are also changing the way financial products and services are provided. Innovation in organisation and mechanism may be the key for financial institutions to provide value-added products and services and differentiate themselves.

In particular, developments in electronic commerce have enabled more customised services to customers and "customisation" may be one of the most important competition strategies that financial institutions will adopt in the foreseeable future. Saatcioglu et al (2001) introduce a new business model, a "financial portal" that develops proprietary indices that focus on individual and small-business customer needs, as well as corresponding financial instruments based on these indices, and a bundle trading mechanism that helps establish and rebalance portfolios as needed. It provides customers with customised investment services, while not requiring the knowledge and resources for investing in individual securities, is more tailored to specific needs than mutual funds or index-tracking stocks, and is much more affordable, and maybe more comfortable, than hiring financial consultants for investment advice. Such a business model would not be feasible without the internet that can be accessed by anyone from anywhere or the computing power that can support an automated bundle trading system; Fan et al (1999).

Gu et al (2001) develop a new model for the OTC derivatives market. Based on Merton's (1992) theory on the replication of derivatives by a set of risky assets (other than the underlying asset) plus a risk-free asset, financial intermediaries can transform option orders into common format replicating portfolios, and match these orders in terms of replicating portfolios in a bundle-trading market. Thus by hedging and rebalancing the risks in terms of the replicating portfolios instead of a specific derivative, the aggregation and netting of portfolios, in particular the cancellations between orders on the same assets, will result in significant reduction in transaction costs. In essence, financial intermediaries can provide customised options at lower prices by developing replicating portfolios and an internal bundle-trading system.

3.8 Electronic money

As with all new terms related to the internet, e-money refers to various items in different contexts. But most people regard the two major forms of e-money as the smart or stored value card (SVC), and network money or so-called cybermoney. A smartcard is a physical card with an embedded computer chip or magnetic stripe that stores the owner's value, while network money is stored in pure electronic form as 0's and 1's in computers and can be transferred over telecommunication networks such as the internet. Moreover, a hybrid of the two forms can be developed and users may further switch between e-money and conventional deposits or even other payment media. A number of e-money schemes have been developed but most are still in the fledgling stage.

Many researchers have studied the prospects of electronic money while others have examined the policy implications. We think that the proliferation or failure of e-money depends not only on the customer acceptance (though crucial), but also on the firms' incentives to develop and promote this new scheme.

Firstly, the issuer of e-money commits to provide specified quantities of goods at any future time, which can be either instantaneous or far into the future. As a special type of debt, e-money can be used as a source of financing, especially for operation. The influence of e-money on corporate finance opens a new field both in theory and practice.

Second, companies may use the issuing of e-money as a competition strategy. The development of e-money involves strong network effects, just as in computer operating systems, telephone networks and ATM cards, which means that the more people are using it, the better off are all the current users in the network. As it gains popularity, e-money will become more liquid, transferable, convenient and less risky. With the growth in e-commerce, we project that e-money issued by one or more companies may gain higher acceptance than others and circulate well in the cyberspace. By issuing and promoting its own e-money, a company can gain market share, negotiation power over suppliers as well as earn more profits.

4. The challenges of public networks for e-finance activities

It is not surprising that once the internet is utilised, financial institutions have to face its problems. Communications over the internet are insecure and often congested. Next we will discuss the challenges that financial institutions face in e-finance over the internet, including security, quality of service and some aberrations in e-finance.

4.1 The heavily armed e-finance intermediaries

Financial intermediaries are among the most careful businesses in using the internet. One piece of evidence is that there has been no publicised security break-in for e-financial services, compared with dozens of reported accidents for online retailers. Technologically speaking, timely software patching and a real-time censoring mechanism almost suffice to prevent any possible system break-ins. Financial institutions are not hesitating to invest in these technological solutions, given the possible disastrous results if such a security investment is not made.

Although direct system break-ins or information interception/manipulation are always possible, such a possibility is fading away as e-business software is becoming more fault-tolerating and computer security teams are becoming more experienced. Practically speaking, heavily armed e-financial

intermediaries can effectively prevent all attempts to tear down their security walls, except for Distributed Denial-of-Service (DDoS) attacks.

4.2 The dangerous distributed denial-of-service attack

What if attackers do not try to break-in, but simply block the entrance so that consumers cannot visit the e-finance provider? Attackers can circumvent security no matter how heavy is the protection by using this method. This is exactly what happened to E*Trade in February 2000, and it was offline for hours. The attacking technology used then is called the DDoS attack. Two years after its first appearance in 1999, the internet community still has no effective way to deal with the DDoS attack. They are dangerous to all e-businesses, but especially dangerous to e-financial institutions as they are often more time-sensitive than other industries. Securities trading is a good example. A stock trader is likely to be dissatisfied with an e-brokerage if she misses a good trading chance simply because she cannot login to the e-brokerage's website.

The lack of an economically sound pricing structure exposes the internet to DDoS attacks. As long as flat monthly fees are the dominant form of pricing, meaning that the marginal cost of sending out traffic is zero, organisations have little incentive to protect their traffic and so DDoS attacks cannot be effectively prevented; (Geng and Whinston 2000). Unfortunately, such events are still likely to happen in near future as it is repeatedly reported that more sophisticated DDoS attack tools are proliferating on the internet, while at the same time there is no strong signal that the troublesome flat rate pricing scheme will be modified.

4.3 Virtual private networks and service level agreements

In the business-to-business realm, more and more financial institutions are setting up Virtual Private Networks[3] (VPNs) over the internet to cut costs for intra-organisational transactions. They may choose VPNs over leased lines to connect remote offices and users to cut costs significantly. Instead of investing in the infrastructure themselves, they can drastically reduce their capital and operational costs by outsourcing their network services to service providers who offer a robust VPN service and therefore can focus on their core business in financial services.

One of the critical technology components of a VPN is security and in no other industry is security more prominent. The most important technologies for the security component of a VPN include access control to ensure the security of network connections, encryption to protect the privacy of data and authentication to verify the user's identity as well as the integrity of the data.

Another component critical in implementing a VPN is traffic management to guarantee reliability, quality of service and high-speed performance. The internet backbone is congested, and critical business applications running on the internet have to be prioritised and reliably delivered.

Because of these technology challenges of VPN, it is crucial for financial institutions to negotiate carefully the Service Level Agreement (SLA) with their VPN service provider. An SLA is a contract between the service provider and receiver that defines the services and service levels and also specifies the guarantees. In order to give the service provider the proper incentive to provide secure and high quality VPN service, there has to be penalty for non-compliance and the penalty should be decided according to the loss of the financial institutions in the case of failure (Lin and Whinston 2001).

4.4 Shill bidding

Developments in e-finance have brought up new challenges to financial intermediaries and markets. Aberrations such as shill bidding may occur. Shill bidding was first recognised by online auction

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[3] A VPN is a private data network that makes use of public networks, maintaining the security of a private network through tunnelling protocols and security procedures such as access control and encryption. VPNs provide companies with the same capabilities at much lower cost by taking advantage of the economies of scale and management facilities of large public networks. Companies may use a private virtual network for both extranet and wide-area intranet.

houses (eg eBay) as the deliberate placing of bids to artificially raise the price of an item.[4] Similar activities may also undermine financial markets that use auction or any variation of auction mechanism.

For example, there are also frauds that resemble shill-bidding behaviour in the IPO market; Bloomberg (2001). In the IPO market the company pays institutions for bidding up the prices to mislead the public into believing the new stock is worth more than its true value.

Many financial markets are essentially common-value double-auction markets and as more transactions are made over the public network, inadequacy in authentication and other security measures may lead to illegal transactions. Wang et al (2001) study the shill bidding issues in the context of online auctions and propose that auctioneers can properly design a fee structure to prevent shill bidding. Financial markets may also design such mechanisms to deter illegal buying and selling of securities by "shills" of the insiders.

4.5 Payment for order flow

Weinberg and Kruger (2000) have pointed out that exchanges now pay brokerage firms for funnelling orders to the exchanges.[5] This illustrates that financial markets, now fiercely competing with each other, are using any business strategy available. With the rapid growth in online brokerage firms and trading platforms, financial markets, in trying to make profits, are paying for the order flow. Such practices obviously will hurt the customers of the brokerage firms since their orders may be routed to the best paying exchanges instead to those with best prices.

5. Conclusions

We think that both financial intermediaries and financial markets can be viewed as firms producing financial products and services. With this new perspective, we can better understand the new developments in the finance industry in the internet era. In particular, it helps to explain the proliferation of electronic financial institutions such as virtual banks, automated trading systems and electronic debt markets.

It also sheds light on the industrial organisational structure of the finance sector and the competitive strategies of financial organisations. With the development of IT and the internet, financial institutions have to find competitive edges beyond location and physical network. Differentiation of financial products and services is crucial for business success and proprietary development of new services by utilising IT will be the key.

The internet also presents challenges to financial institutions trying to fully utilise this public infrastructure. Security and quality concerns should be well addressed and Service Level Agreements can be a contracting tool for financial institutions to ensure proper performance from their service providers while concentrating on the core business of finance services.

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[4] To avoid the appearance of being involved in this activity, online auction sites often require that family members and individuals living together, working together or sharing a computer, should not bid on each other's items. http://pages.ebay.com/help/community/shillBidding.html

[5] They say "Knight Securities, one of Nasdaq's largest market makers, spent $134 million through the third quarter paying other firms to let it handle their orders. … the nation's five options exchanges hoped to avoid the flow payment system, but relented and embraced it. … The Chicago Board Options Exchange launched its own payment programme in July. The Amex, Philadelphia and Pacific exchanges quickly followed, offering 40 cents to $1 per option contract. … (As Edward Provost, CBOE's business development chief, put it) "Standing on principles sounds good, but since regulators have not prohibited a practice that was eroding our market share, it would have made a lousy business decision" to forgo paying for orders."

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E-finance and the politics of transitions

Steve Weber and John Zysman

1. The core question

The introduction of e-finance allows the modification of old marketplaces and the creation of new ones. It is a moment of transition between marketplace systems. Governing that transition will be critical. The crucial question is how to accommodate financial market experimentation without putting the system itself at risk. This brief research note describes a project in progress to address this.

The emerging digital data network technology creates possibilities for innovative business strategies and organisations, a set of innovations loosely called "e-finance". Importantly, more than one possibility exists as regards how these technologies can be used, and how they will create as well as alter markets. In a sense the "dotcom" era represents a set of business experiments in the use of new tools. These "tools for thought" permit the manipulation, transmission and storage of information. The past five years have seen a sequence of experiments with online business and markets.[1] While most of those companies failed, the experiments have been instructive. We learned that online systems do not simply push aside or replace social institutions. Institutions and business channels that reflect and create social life are not so easily disintermediated, displaced or made irrelevant by new communication arrangements. Even the most visible experiments, such as Amazon.com, have not been unadulterated successes. Some investors who helped sponsor Amazon, and made a good deal of money doing so, drew the conclusion at the time that the underlying model would not be easy to implement as a sustainable business. They should, they concluded, avoid taking on similar investments.

The dotcom euphoria created a sense that the world would be transformed and that the equipment and networks that underpinned the experiments would grow continuously. When the collapse came, it did more than cut down a swathe of businesses. By influencing the anticipated demand for telecommunications data services, it helped burst the data network bubble. In the United States new network providers collapsed and equipment makers who supplied the networks were devastated. Employment, housing markets and entire regional economies were influenced by the crash of the dotcoms and the concomitant network decline.

The traditional notion, of course, is that if the financial market experienced sudden and broad collapses, as were seen with the dotcoms in other sectors, then the integrity of the entire economy would be affected. While single bank collapses, even very large ones, are not in themselves dangerous, if a set of large financial institutions collapsed the consequences could be quite significant.

2. E-finance, experiments and risks

Thus the issue becomes how the financial community should accommodate experimentation and innovation based on the new digital technologies without placing the economy itself at risk. This raises questions about the balance to be sought between innovation and risk, the appropriate governance system to manage this transition and the required rules. To begin to answer these questions, one must ask:

- Which features of financial experimentation put individual firms at risk?
- Which features of the set of experiments would put the system at risk?

[1] See Cohen et al (2000) and Cohen and Zysman (2001) and Zysman and Weber (2001).

The difficulty is that the risk profile in this era of e-innovation is not easily knowable or predictable in any single market and is complicated by the connections among them. The technologies change the way in which markets can operate and firms can be organised. The financial innovations facilitated by the electronic network technologies represent four sorts of experiments, encompassing consolidation of firms, aggregation of activities, the creation of entirely new products and markets, and the entry of newcomers. But categorising the sets of innovations does not tell us enough about the risks and how to regulate them.

Clearly, the key to our analysis is understanding the risks that come in the period of transition. Can one, a priori, determine which innovations or experiments represent significant risks to the financial system and to its constituent markets? Hence, as an exercise, rather than trying to reason out a set of basic principles – which in retrospect would have been a better strategy – we set out to try to infer principles from a set of cases. The risks, we posited, differ depending upon the starting point – that is, the initial marketplace into which electronics are introduced. The difficulty is that we did not get very far in establishing a schema by reasoning through our inductive method from the initial market structure and the innovation to predictable risks and policy implications.

We compared three cases; the Nasdaq market, a firm called E-bondtrade.com and eBay. We asked what were the initial market arrangements, and what happened to the structure and dynamics after the introduction of electronics? The quality of the players in the market, the terms of their entry and the types of products or market innovations they introduced were all critical. But we were drawn continuously to the question of how the new products, players and strategies affected the rules for transactions and their execution.

Since this is just a brief research note, we do not present our results fully, but point to the texture of each of the three cases.

2.1 Nasdaq

This is a fragmented, lightly regulated OTC market with no formal marketplace and assets of uncertain quality that became a relatively transparent, liquid, formal marketplace with highly regulated underlying assets, where the rules evolved to limit risk to investors. There were at least four new risks:

- Transparency: is competition a sufficient “regulator” of behaviour?
- Who owns vs who regulates the marketplace?
- Does electronic trading “re-fragment” the market?
- Will market-makers be pushed out of business?

2.2 Ebondtrade.com

This huge, diverse market of municipal bonds with local marketplaces, standardised assets and opaque pricing became a more transparent, but still highly complex, market with greater possibilities for secondary trading. The new risks include:

- Will transparency that reveals the complexity of the market exacerbate market failure?
- What will be the consequences of competing marketplaces?
- Is accreditation of dealers necessary or is functional transparency sufficient?
- What will be the consequences of the development of a secondary market?

2.3 eBay

A large number of illiquid marketplaces with high search costs and assets of uncertain quality became a centralised marketplace where a reputation system for monitoring the quality of the transactors substitutes for regulation of the underlying assets. The new risks include:

- Will the situation described in Akerlof’s “lemons model” apply due to adverse selection and low barriers to entry?

- Will the reputation system fail, either technologically or behaviourally? The reasons for failure could include lack of contribution to reputation record, which is a public good, or manipulation of selection bias.
- Are there significant counterparty risks and costs of mediation?
- Are autonomous fulfilment services sufficiently reliable?

3. The policy debate

Our frustration was that we did not reach general and systematic conclusions about risk and how the e-finance environment altered the trade-off between risk and innovation confronting regulators. The policy debate plays out around three sets of issues;

- Market dynamics: The interaction of all the players within the institutional structure that forms the marketplace. Too much of the debate focuses on market dynamics and competitive strategies and not enough on how the rules of the marketplace set the balance of risk and innovation.
- Market structure: The identity of the players and what they own and trade.
- Marketplace: The institution that creates the exchange forum with its rules and procedures. All markets rest on rules about who can play and how.

All three cases in one sense or another directly touched the question of the basic rules of the game. The real risks, we suspect, come when the rules of the game are radically and unpredictably altered.

The way the e-innovations are implemented in this transition turns not just on the market strategies, but also on the rules for the marketplace that are created. The transition to the new marketplace means setting new rules, which influences the winning market strategies. The balance of financial market outcomes hinges not just on the regulation of finance directly, but also on the regulation of telecommunications. For example, broadband access, driven by telecommunications regulation, will influence the variety of possible consumer experiments.

By formulating in this way, we found ourselves on more solid ground. When we reviewed the e-innovations against studies of transitions and financial market innovation in Europe, the United States and Asia, we concluded that the real risks to the market system came under two circumstances.

First, risks emerge when the consequences of a rule change for market dynamics and market equilibrium can not be properly judged. This is not so easy, and even firms seeking to take advantage of rule changes often judge incorrectly the consequences for markets and for the risk they themselves are taking on. The California energy debacle, which was encouraged by the energy industry, hinged on misjudgments about what now seem inevitable and obvious consequences of the rules in a deregulated energy marketplace. New rules intended to foster innovation or efficiency often create new risks along the way. This implies clearly that innovations need to be evaluated for the changes they imply in the market system and deviations they represent from established principles of sound market operation.

Second, initial mistakes in setting rules, which engender risk in the system, often cannot be fixed quickly enough. Sometimes this is because an initial reform does not contain the authority to respond to the unexpected market consequences. This is more likely when the regulatory reform is legislated without clearly defining what executive or regulatory body can fine-tune the rules once the market consequences of the initial reforms are evident. In other instances, effective rules could not be established when the question of who won and lost from innovation could not be politically resolved. In our view, the consequences of similar Japanese and French moves from a credit-based administered price financial system to a more market-oriented financial system reflect differing capacities within the politics of regulation for settling in a stable and prompt way the winners and losers from the reforms.

E-finance allows the modification of old marketplaces and creation of new ones. The question is: how does this affect the shape of the market and its inner dynamics? What conclusion did we reach from our struggle with this paper to infer from the explosion of online business and market experiments some principles for regulators to balance the resulting risks and innovation in financial markets? The array of market innovations must be understood for their potential impact on the underlying rules of the

financial markets. The question of balancing risk and innovation turns critically not on the innovations themselves but on maintaining robust processes of rule-making that apply critical and established principles in flexible ways to new circumstances.

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Electronic trading and its implications for financial systems

Helen Allen, John Hawkins and Setsuya Sato[1]

1. Introduction and themes

The adoption of electronic trading systems has transformed the economic landscape of trading venues and is proving a force for change in market architecture and consequential trading possibilities.[2] The term "electronic trading" is used in many ways. In this paper, it refers mainly to trading in *wholesale financial markets* (as opposed to e-commerce more generally - see, for example, Long (2000) for a survey of the latter) and focuses on the central feature of electronic trading systems, automation of trade execution. Such systems usually also feature electronic order routing and dissemination of trade information and may link through to clearing and settlement. Electronic trading both removes geographical restraints and allows continuous multilateral interaction (whereas telephone trading allows only the former and floor trading only the latter). It allows much higher volumes of trades to be handled, and in customised ways that until recently would have been technically impossible or prohibitively expensive. This paper considers areas where these enabling effects have been particularly important in wholesale financial markets and how they raise wider, policy implications.

In this introduction, two of the overarching issues that run through this discussion of electronic trading are highlighted. One is the importance of distinguishing between ultimate and intermediate objectives, for example whether a policy concern over transparency is an end in itself or, as argued here, a "means to an end". Second is the pervasive presence of network-related policy issues, encapsulated in the question of how, or indeed whether, to respond to perceived problems over market fragmentation. This section begins by presenting an analytical framework for the discussion.

1.1 Analytical framework

Much traditional economic literature has little to say about the practicalities of price formation, assuming it away as perfect and frictionless or occurring via the fiction of the Walrasian auctioneer. This "black box" has been illuminated in recent decades as microstructure research has analysed how different market structures and imperfections influence trading outcomes.[3]

This field of research has analysed how *market architecture* - which should be understood to mean broadly the key features of market structure such as participation arrangements, venues and trading protocols - influences trading outcomes of prices and quantities. These decisions about architecture also affect aspects of a *market's quality* - its performance across attributes such as liquidity, trading costs, price efficiency and resilience to shocks. Ultimately, market quality has *broader welfare*

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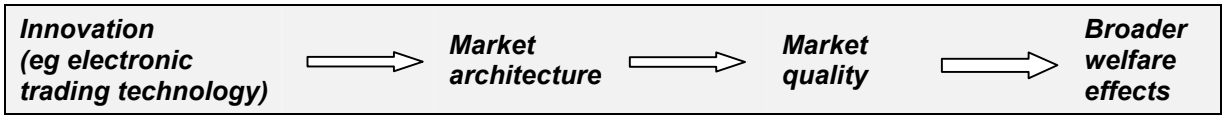
[2] There is now a range of work concerning aspects of electronic trading, as references throughout this paper attest. There is also a considerable amount of work on the effect of technology on market structures and on electronic finance more generally - eg Bar (2001), Mishkin and Strahan (1999), Claessens et al (2000) and Sato et al (2001).

[3] Market microstructure literature studies the processes/outcomes of exchanging assets under explicit trading rules - O'Hara (1995) provides a theoretical review; see also the recent survey by Madhavan (2000b).

implications - such as through the contribution of the efficiency of the financial system to economic growth and through the performance and resilience of markets to financial stability.[4]

Innovations such as electronic trading can lead to changes in this process. The introduction of new trading technology offers greater possibilities in market architecture, which affects market quality and ultimately influences welfare more widely. Box A (overleaf) characterises how, across the many interacting and overlapping elements of market architecture and quality, *the practical choices have widened, enabling trading arrangements to be varied in ways previously infeasible*. The flowchart below provides an indicative summary.[5]



Of course, the "optimal choice" of trading arrangements will mean different things to different parties. For example, owners of trading systems might be trying to maximise market share or income. Traders might be aiming to complete deals at the best prices and at low cost, or with minimum delay or maximum discretion - or indeed, any combination of an enormous range of factors which affect trading decisions. Similarly, there are multiple public policy objectives; for example regulators focus particularly on the integrity of markets and consumer protection while central banks concentrate on systemic financial stability implications.

No single arrangement is preferred by all players and what benefits one set of participants can be disadvantageous to others. The microstructure area is replete with trade-offs, gainers and losers. The multiple objectives at every stage make it unsurprising that there is no unanimity on what constitutes "optimal" trading arrangements, including at the level of public policy. There is no single, widely agreed "social welfare" measure to optimise.

1.2 Ends and means - intermediate and ultimate objectives

Which perspective is adopted clearly affects the terms of the debate. The discussion in this paper is directed towards the right-hand side of the diagram, essentially overall market, financial stability and public interest issues. In this context, it could well be that focusing only on the form of some specific elements towards the left-hand side - be it the details of technology or the specifics of market architecture - could result in a suboptimal outcome from the broader perspective of market quality and social welfare. Indeed, aspects such as market architecture *might more usefully be considered as intermediate objectives rather than as public policy aims in themselves*.

This perspective applies particularly to transparency of information about the trading process (timely information on the prices and quantities of potential and executed orders). The form of disclosure trading systems should adopt is a highly contentious issue. There is debate about how far regulators should, or indeed can, impose transparency rules. Findings about the precise effects of such rules are inconclusive. It is agreed that transparency of trading information is a very important factor in helping markets function effectively, especially for retail interests. However, there is also evidence that after a certain point in certain market segments, insistence on more transparency can be unhelpful and even damaging to market quality (as explained in Section 3.3). This area, long debated amongst market practitioners, is now recognised in policy discussions.

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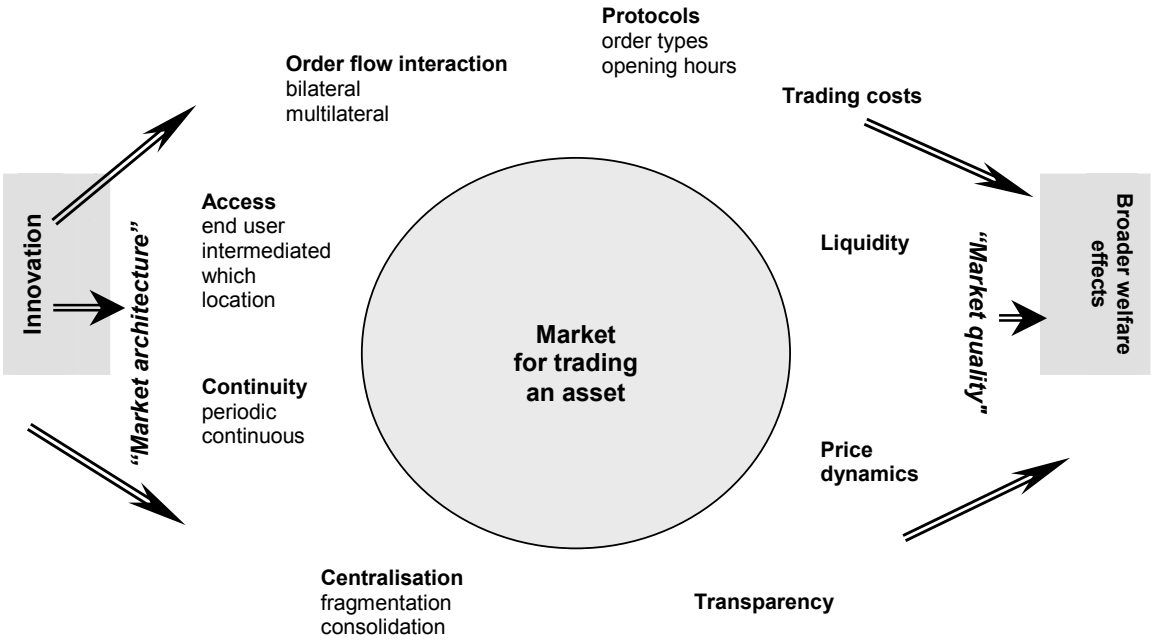
[4] Financial systems are integral to the funding of capital accumulation, one of the fundamental drivers of economic growth. Greater efficiency in infrastructure mechanisms such as trading systems can reduce frictions in financial systems, helping to bring savers and investors together more efficiently, thus aiding growth. Links between the functioning of financial systems and growth are explored in Levine (1997) and more recently, for example, in Leahy et al (2001) with empirical analysis.

[5] The last three out of the four stages characterised are similar to that of the traditional "structure/conduct/performance" framework from industrial organisation literature - see, for example, the textbook by Carlton and Perloff (1999). The process indicated in the flowchart and Box A may well be iterative, as welfare improvements stimulate further innovation, and so on.

Box A – A framework for illustrating the effects of electronic trading

This box shows how innovation in markets - here the introduction of electronic trading - can open up a greater range of possibilities in the trading process, which in turn can affect overall market performance and broader welfare.

Markets can be described in terms of a number of key features which combine to determine the form of the trading that occurs. These aspects of *market architecture* include which participants have access to the trading platform, the degree of transparency in the trading process, and the trading protocols such as order types and opening hours. Related to these are aspects of broadly defined *market quality*, such as trading costs and liquidity. In the diagram they are represented as a circle rather than on two axes as they closely interact and overlap with one another.* They all combine to feed through to "ultimate objectives", ie the *effect on broader welfare*.



In terms of the diagram, any key feature of the market (examples of which are in bold type around the circumference) may in principle take several, possibly many, forms. For example, access can be for end users or intermediated, geographically limited or unlimited - a theoretical list of possibilities would be very long (other indicative examples are placed underneath some of the key features.)

In practice, the trading arrangement for any specific asset in its market segment could be defined by highlighting the relevant items on the lists of key features. For example, in the OTC fixed income markets, access is intermediated by dealers. Transparency is limited. And, so long as this market is telephone-based, there is probably little alternative to these arrangements.

However, the innovation of electronic trading can bring an array of other possibilities within practical reach. In the fixed income example above, order books can become feasible, allowing customers direct access as well as through dealers. Electronic systems can readily disseminate trading information, creating potentially higher transparency.

The result is that electronic trading opens up a far wider range (and combination) of possibilities in the trading process than were hitherto available. This of course begs questions such as "what to choose? - which combination is best? - what are the wider implications?" - issues which are raised in this paper.

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* Naturally, any classification of such features is to some degree arbitrary and the above is intended as a presentational device. There are numerous elements that contribute to the overall trading process.

Regulatory and policy instincts typically - and probably rightly - generally favour more transparency. In many areas of public policy greater openness is widely recognised as beneficial to processes, expectations and outcomes - disclosure practices in accounting and the transparency of the monetary policy process are two important such cases. However, and possibly counter-intuitively, the reverse can be the case in some contexts of trading, where "too much" transparency can, for example, reduce market liquidity.

In terms of the simple framework above, a policy which makes greater transparency an objective in itself risks ignoring potential negative effects on market quality - and hence on broader investor welfare and the effectiveness of the financial system. Indeed, were transparency to be "maximised" as a policy end in itself, that aim could prove precisely at odds with the wider objectives to which policy is typically addressed.

1.3 The pervasiveness of networks and challenges for policy

Network issues permeate analysis of trading. They vary from the network externalities of markets attracting liquidity to practical consideration of physical network access arrangements. The greater use of electronic systems and linkages for trading highlights these effects.

Although network technologies may broaden access and in principle enable "more perfect" markets, the immediate reality may prove less benign. For example, the presence of electronic networks can embed existing privileges, with network access and design choices giving strategic advantages to certain classes of participants (see Section 5). And the effects recognised in network economics (see Box B) are a powerful influence in this area. They can lead to sustained suboptimal equilibria in market arrangements and a tendency to consolidation. While the latter may bring about significant scale efficiencies in market processes, if (near) monopoly power emerges there can be undesirable outcomes such as lack of choice and monopoly pricing.

The prospect of such outcomes creates difficult policy questions. First, identifying a suboptimal situation is not easy given the different, possibly conflicting, objectives of affected parties. Then, even where problems are recognised, they may represent a temporary phase of an immature market, which competitive forces and innovation could well resolve. Intervention may be judged inadvisable unless there is demonstrably a sustained problem plus a response which could clearly improve on the market outcome.

Analysis of such situations carries clear dangers of misinterpretation. The multiple, potentially competing, public policy objectives make it likely that not all can be simultaneously achieved. There are dilemmas between intervention or "wait and see". The former could risk stifling competition and limiting innovation in fast changing environments, while the latter might risk missing opportunities to prevent problems becoming widespread.

Responses to market fragmentation illustrate the difficulties, seen especially in equity markets when alternative trading venues become available. Concerns are associated with whether the liquidity of the "main" market is reduced - which could mean less market depth to absorb large trades and shocks, reduced price efficiency, higher search costs and price comparison being made more difficult. However, the flip side is that the additional execution routes may reflect greater variety of services, competition to cut costs and innovation in trading systems.

This raises significant questions about the efficacy of policy intervention. It is illustrative of the dilemmas that views can differ starkly even over whether there is a problem to be addressed. If the situation is believed detrimental to public policy interests, there are judgments to be made over whether market forces will resolve difficulties (say, through consolidation following competitive attrition of illiquid venues and/or technological innovations offering linkages). Or whether, and in what manner, to intervene actively.

1.4 Outline of the rest of the paper

The development of electronic trading in wholesale financial markets is considered in Section 2 - where it is observed that the widely differing forms and speeds of penetration can largely be explained by the characteristics of the asset traded and its market segment along with specific factors such as regulation and competitive conditions.

Sections 3 and 4 consider changes to particular aspects of markets' architecture and quality closely associated with the use of electronic trading. In the former, changes brought about in the areas of access, transparency and consolidation/fragmentation are highlighted. The latter section discusses impacts on costs, liquidity and price dynamics, drawing particularly on recent evidence. The lessening influence of physical restrictions on all these areas has brought into stark focus questions of what are appropriate choices, the implications of which are appearing on policy agendas worldwide.

The final section highlights some of these policy issues, emphasising the perspective of the overall quality of markets and broader welfare. Particular consideration is given to financial system stability issues along with the oversight-related concerns associated with the range and speed of changes in trading technology. As brought out above, it is also notable how network effects in some way influence all of these - from the practical details of system design, to the problems and solutions of oversight, competition and access to network infrastructure, as well as the economics of networks which pervade the whole subject.

2. Contrasting development of electronic trading

Looking across financial markets, it is clear that electronic trading has penetrated different sectors very unevenly. This varied pattern of development between types of assets (and market segments within each) can, however, typically be explained by the interaction of a number of factors.

Existing market structures, regulatory and competitive factors and the varied needs of traders have all affected the integration of new technology into mainstream trading. And an important element is the asset type, since standardised, homogenous products have proved "easiest" to migrate to electronic trading. In terms of the schema in Box A, there are clear differences in what possibilities are feasible, both between assets and within different segments of any particular asset market.

The following reviews developments in the equity, fixed income and foreign exchange markets,[6] which between them illustrate the varied development path of electronic trading and its wider effects on markets (the latter being explored in Section 3). Moreover, electronic trading is presumably at only an early stage of development - the future may see, for example, distinctions between market sectors blurring as systems develop for portfolio trading of multiple assets; and advances in networks - perhaps with internet use more widely integrated. Similarly, the direction of developments to date inevitably reflects the current technology - advances will widen the choices available in next-generation trading systems, potentially enabling further waves of change to market arrangements.

2.1 Equity markets: United States versus Europe

Equity markets are the best known, most widely studied examples of electronic trading. The contrasting development patterns in the United States and Europe show how electronic trading can penetrate the market for the *same* assets in a very *different* manner. Whereas the US equity market has been characterised by a *proliferation* of alternative electronic trading venues alongside relatively few traditional exchanges, Europe has been more notable for the *absence* of separate systems, with electronic trading instead incorporated *within* its many traditional exchanges. In both markets the common features of the liquidity and relative homogeneity of the major equity issues has made it relatively straightforward and cost-effective to introduce electronic trading.

2.1.1 US equity markets

The so-called "traditional" markets (floor or telephone, albeit with high levels of automation) in the United States are dominated by the three national markets, of which the New York Stock Exchange

[6] While these particular examples have been chosen to illustrate patterns of developments, to a lesser or greater extent all financial markets have been influenced by electronic trading developments. For example, Tsang (1999) reviews automation in futures trading, where electronic trading has been well established for some time. Banks (2001, Chapter 4) describes electronic trading in a range of markets, with particular focus on the role of the internet.

and the smaller AMEX are basically order-driven and floor-based. Nasdaq, the second largest venue, is telephone/screen-based (no floor) and has developed essentially as a dealer market with order-driven facilities becoming available more recently.

Separate electronic trading systems have gained a foothold in the United States over recent decades, but it is within the last five years that alternative venues have proliferated. A particular trigger in the US case was regulatory and mainly limited to Nasdaq - the appearance of several ECNs (Electronic Communication Networks) can be directly associated with regulatory changes affecting the display of orders.[7] All these ECNs offer a model based on an electronic order book (which was unavailable in the main markets), though within that they compete on differences in market architecture. Moreover, the United States has significant retail participation in equity markets, business in which a number of ECNs specialise. These country-specific factors illustrate why results from studies of one market may not necessarily generalise to others, a pertinent point given the dominance of studies of the NYSE and Nasdaq in the literature.

2.1.2 European equity markets

In contrast to the United States, most electronic trading facilities in Europe have developed within existing exchanges. Over a period of some years, continuous electronic order books have been incorporated within mainstream exchanges, offering trading methods that in the United States were only available by routing away from the traditional venues.

This has been able to occur in an environment generally less influenced by regulation than equivalent US markets, making European exchanges more open to competitive pressures. Demutualisation by many major exchanges additionally gives clearer commercial incentives for innovations and efficiencies. Cross-border competition has led to numerous mergers and alliances among European exchanges, particularly in the last five years. Investment behaviour and trading platforms are moving from being wholly split on national lines to a greater pan-European, sectoral emphasis[8], particularly with the launch of the euro. It is uncontroversial to predict a further reduction in the number of separate European exchanges,[9] although currently there are several new contenders targeting different segments of the cross-border European market, notably in the market for larger stocks. This juxtaposition of consolidation with proliferation is explored in Section 3.1.

These developments result in a vastly reduced opportunity, compared to the United States, for separate off-exchange trading systems (especially if designed as an electronic order book) to enter the market - such entrants would presumably have to offer some particular advantage that cannot be obtained on the exchange systems. Bearing this out, there are relatively few separate electronic trading venues operating in European markets.

2.2 Fixed income markets

Moves to electronic trading in fixed income markets have been slower than for equities. For many years, bonds of all types were typically traded in telephone dealer markets,[10] into which electronic systems have made (limited) inroads only very recently. Fixed income systems have recently proliferated in number - an annual survey by the Bond Market Association (2000) identified some 70 systems in 2000, up from only 11 three years earlier, although few have significant volumes. Most market commentators, such as Brown (2001), expect consolidation in the number of platforms.

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[7] The regulatory trigger was the SEC's order-handling rules, implemented in January 1997. McAndrews and Stefanadis (2000) set out the regulatory and technological developments that have affected the ECNs. Separately, there are a range of other electronic trading systems available which offer a considerable variety of market architecture. For a further discussion of the US experience, see Davis and Steil (2001, Chapter 8) and Domowitz and Steil (2001b).

[8] See, for example, Cavaglia et al (2000).

[9] See, for example, The Economist (2001a, 2001b). A list of automated exchange mergers and alliances over 1997-2000 is presented in Davis and Steil (2001, table 7.2). See also the discussion of stock exchange alliances in Gaa et al (2001, p 54).

[10] In a typical telephone dealer market (eg that for UK government securities), customers telephone orders to dealers who either are obliged to quote prices or do so on a "best efforts" basis. The dealers manage their inventory in an inter-dealer market, sometimes intermediated by inter-dealer brokers and sometimes dealing directly with other dealers.

The variety of automated trading system types already introduced is notable (a variety previously more characteristic of equity markets), given the uniformity of traditional bond market arrangements. There are now order-driven markets in addition to several automated versions of dealer markets, offering a range of participation and access arrangements for dealer, inter-dealer and customer sectors (for a taxonomy, see BMA (2000)).

The later arrival of electronic trading in fixed income markets compared to equities *reflects distinct differences between the two*. Fixed income products are far less homogenous, with many more separate and individually less liquid issues than equities, making it technically more difficult and more expensive to introduce automated systems. The Economist (2000) suggests there are over 4 million fixed income securities on issue in the United States (varying in coupon, maturity, frequency of interest payments, etc) compared with a few thousand listed shares. Trading style differs - relative to equity markets there tend to be fewer but larger trades,[11] with many participants holding issues to maturity. Moreover, while it seems likely that the trading of equities on centralised exchanges encouraged early transitions to automation, the opposite position delayed bonds from making the move.

Within the fixed income sector, electronic trading has made most inroads into certain *government bond markets*. It is estimated that in 2000 40% of US Treasury securities transactions were done electronically, nearly double the volume a year earlier (Moszkowski et al (2001)). Similarly, in Italy about half the trades in government debt are now conducted on the MTS system developed with the cooperation of Italian public authorities.[12] Electronic trading in corporate bond markets remains much lower (only 10% of US corporate bond volumes in 2000 according to Moszkowski et al) as they are far more heterogenous. A common pattern has been for platforms to begin trading government bonds, later expanding into other, more heterogeneous, fixed income issues. Though this reflects the greater amenability of the relatively more standard and liquid government securities to current electronic trading platforms, this distinction may reduce as electronic systems develop to accommodate trading of less liquid issues - see the discussion in Section 4.3.1.[13]

2.3 Foreign exchange markets

Electronic trading has had an important presence in the inter-dealer spot foreign exchange market for over a decade; the BIS triennial survey shows that 20-30% of interbank trading in the major currencies was conducted electronically in 1995 and this rose to about 50% in 1998 and was estimated at over 90% by 2001. For some years there have been two major systems (EBS and Reuters) which now tend each to specialise in particular major currency pairs. The development of these systems is described in Chaboud and Weinberg (2002). Both systems have been designed as order books, in which dealers can see the best bid and offer in the market, alongside the best bid and offer that they could trade subject to their institutional credit limit structure.

These electronic systems are now used for the majority of spot inter-dealer trading in major currency pairs. Consequently, the inter-dealer segment of the market has mostly (but not entirely) moved away from voice broking, and the electronic systems now act as a standard reference for pricing. While the structure of the foreign exchange market before the introduction of electronic trading was (rather akin to fixed income) a fragmented bilateral telephone market, the rapid adoption of systems in the inter-dealer sphere reflects *the liquid, homogenous nature of the product* that can be traded in standardised units. The latter points presumably explain the earlier presence of electronic trading in foreign exchange compared to fixed income markets.

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[11] The comparison of the UK equity and gilt markets found in Annex A of DMO (2000) suggests that the average gilt market trade was approximately 30 times that in the equity market. Differences between the characteristics of government bond and equity markets are detailed in Gravelle (2001).

[12] Claessens et al (2001) give examples of platforms for trading in bonds from a number of emerging economies, including Asian bonds, Latin American bonds and Brady bonds. Bank of Japan (2001) notes that since mid-2000 a number of bond trading systems have been established in Japan, but trading volumes are still low.

[13] Fixed income markets are much less studied than are equity markets: Goodhart and O'Hara (1997) noted that "the absence of much market microstructure analysis in (government) bond markets is particularly surprising", a comment echoed by Lyons (1998) and Gravelle (2001). One recent study is Study Group on Fixed Income Markets (2001).

While electronic trading has come to dominate the inter-dealer market, systems have made far less impact on the business of large corporate customers. However, this may be on the point of changing as several internet-based systems aimed at this area are now being rolled out. These systems promise more flexibility (eg. tailored quantities and currency pairs available) and utilise the internet's ability to connect disparate and distant parties at low cost. The largest are two multibank systems (FXall and Atriax, which began operating in mid-2001) automating the process of customers obtaining a range of executable quotes from member banks. Already other systems are moving to offer links to these.

3. Effects of electronic trading on market architecture

This section considers effects on market architecture with which electronic trading is closely associated - focusing on consolidation/fragmentation of markets, decisions about the type of participants' market access and the form of transparency in the trading process. Substantial changes are taking place in these areas in the wake of electronic trading lessening many previous physical rigidities. And as illustrated above, these developments in market structures are closely related to the characteristics of each market / asset type.

3.1 Fragmentation and consolidation

Electronic trading is now closely associated with many of the important pressures affecting ebbs and flows in the number of trading venues.[14] On the one hand, it can stimulate a proliferation of venues, by making markets more contestable as a result of them being cheaper to enter and enabling greater variety of products and specialisation of trading services. On the other hand, electronic systems can enable linkages to bring together sources of liquidity and to harness efficiencies that contribute to consolidation. And affecting all these, the speed of development of the facilitating information network technology has led to a more rapid pace of change.

These effects are of course a feature of any dynamic market, where opportunities for new entrants result in a tendency to fragmentation, typically followed by some reversal when not all attract sufficient business to operate on a profitable scale.[15] The powerful influence of network effects in this area (see Box B) means that a proliferation of similar trading systems which individually attract little liquidity would be expected to be a transitory phenomenon. Those which become established will need both to add some value and - crucially - *to attract, retain or link to a sufficient amount of liquidity*.

While these effects imply a tendency to consolidation over time, in any particular market the extent to which electronic trading is currently motivating a phase of fragmentation or consolidation is very dependent on existing structures. In the previously OTC fixed income market, new trading systems are starting to bring together larger groups of users, consolidating sections of the market which formerly relied on bilateral communication. Similarly, users of the main foreign exchange systems now transact through a centralised market, in contrast to fragmented telephone arrangements. By contrast, in equity markets, which were typically dominated by centralised exchanges, the very presence of distinct alternative trading venues (along with large banks and brokers increasingly able to internalise their order flow by offsetting one transaction against another) can increase fragmentation. Yet in some cases the overall balance may be hard to call - consolidation and fragmentation effects can operate in parallel. For example, European equity markets have also seen numerous recent efforts at mergers, alliances and linkages of various kinds.

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[14] Across the whole trade processing infrastructure, there are wider consolidation issues. Notably, there is considerable scope for consolidation in clearing and settlement procedures, progress on which may be related to exchange consolidation - see eg Gaa et al (2001).

[15] Current pressures affecting consolidation in the financial sector as a whole, including its patterns, causes and policy implications, are examined in the report by the Group of Ten (2001), and in emerging economies by Hawkins and Mihaljek (2001). The effect of technology and the internet on fragmentation and consolidation in US equity markets is explored in Madhavan (2000a).

Box B - network economics effects*

Network economics effects feature strongly in trading systems and help explain commonly observed features of markets - such as consolidation of market liquidity, the advantages experienced by incumbent trading systems, and tipping effects when a market shifts from one centre to another. The underlying economics of these features occur in a number of industries which are structured around a network arrangement - railways and telecommunications are examples.

In these markets, positive network externalities arise because the value of the network to each participant rises as other participants join. Telephones are a traditional example - in the early days of telephony it was relatively unattractive to join the network since there were few other participants to whom to make calls. However, as the number of subscribers increased, the opportunities for making and receiving calls also increased, enhancing the usefulness and value of the network for all participants, making all users better off.

These positive *network externalities* similarly apply to market liquidity. All other things being equal, it is better to participate in a bigger than a smaller trading network, since each trader brings additional trading opportunities/liquidity. Positive feedback comes about as a liquid market attracts more participants, all participants benefit from the additional liquidity, making the network more attractive to others, and so on.

In the absence of rigidities or other barriers, the presence of these network externalities in a market would imply a *tendency to consolidation*. In the trading context, this would work to bring isolated pools of liquidity together.

However, such consolidation may not occur around an "optimal" system. One reason is *first mover advantage*. An incumbent system may have gained a critical mass of users simply because it was the earliest available. Systems that come to the market later may face formidable hurdles to attract a viable level of participation, even if they offer a better product. Potential users need to believe the costs of switching to the new systems are worthwhile. Moreover, they must expect enough other users will also switch to make the new system an effective, liquid trading venue.

These hurdles may mean users feel "locked in" to a dominant system, in which case a *suboptimal equilibrium can be sustained*. This position can arise whether a system has become dominant through first mover advantage or through consolidation. In the latter case, even if the consolidation occurred around an efficient, technically advanced system, if it comes to be a (near) monopoly the incentives to maintain those advantages can be eroded. The well known problems of monopoly pricing, technical inefficiencies and abuse of dominant market position may arise.

However, it is by no means inevitable that dominant market positions will be sustained. If an alternative system manages to attract users, it too can enter a virtuous circle of positive feedback. Once a critical level of participation is achieved, the *market can tip* away from the incumbent and towards the alternative. This switch can be abrupt.

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* The information in this box is drawn from: Shapiro and Varian (1999. Chapter 7), which explains the impact of positive network externalities on industries; Domowitz and Steil (2001a), who analyse how network externalities apply to securities trading; and Economides' (1996, 2001) papers on network economics and finance.

This ambiguity affecting judgments on the degree of fragmentation/consolidation in any market's trading is added to by fragmentation taking many forms. As discussed in Lee (1998), there is no single dimension by which to evaluate fragmentation. To illustrate, even though the number of separate exchanges (or similar marketplaces) may fall, the range of systems through which orders can be placed may grow if venues offer a wide choice of order routing. For example, an exchange may offer a main market, an upstairs arrangement for block trades and onward routing to associated markets. Alternatively, if there are linkages giving traders seamless access to a range of markets, it may matter little how many underlying venues exist. These effects, making judgments about fragmentation/consolidation far from straightforward, are amplified as the range of technological possibilities increases.

Moreover, and in an innovative market, the degree of concern about fragmentation may alter quickly. Even in the relatively short history of electronic trading, there are cases of fragmentation effects being overridden by technology. For example, systems can now offer "virtual consolidation" on a single

screen to combine information from stocks traded at multiple venues. Or solutions may take the form of "smart search agents", automated devices to seek out disparate sources of liquidity (see Section 4.3.1).

From the perspective of market users and policymakers, the important questions are whether the available routes can bring together liquidity in an appropriate manner to meet trading needs and enhance market quality. For example, whether there is sufficient order interaction to allow effective price formation and depth of liquidity, to the benefit of the ultimate end users. Ways in which electronic trading is influencing these matters are discussed in Section 4. However, as brought out in the introduction to this paper and discussed further in Section 5, it can be difficult even to gain consensus on whether there is a problem of fragmentation, and still more difficult to judge whether a policy response is appropriate, and if so what should be the response.

3.2 Market access

3.2.1 Forms of access

Electronic trading can widen access to trading systems across several dimensions. Physical limitations that once rationed access to traditional venues no longer bite, meaning additional users can now participate at minimal marginal cost, removing the economic need to limit access through membership restrictions. At the same time remote linkages remove geographic limitations on the pool of potential users, and continuous multilateral interaction is enabled. From the system providers' viewpoint, the opportunities to enter the market are also greater than hitherto in the light of the fall in costs and enabling technology. And from the perspective of the issuer of securities, there can be opportunity to access a wider pool of potential investors.[16]

This turnaround in the economics of access means that in principle arrangements can be decided more in response to the needs of the market. For example, whether there is a role for intermediaries and whether it is appropriate for different customer types (eg retail/wholesale or by different institutional status) to participate in the market can become more a matter of choice rather than being effectively dictated by external constraints. Changes in these areas can affect the whole design of a market.

This is not to say that limitations on access to markets no longer exist - in practice they still have strong effects, albeit with different forms proving more important. Notably, the legal/regulatory factors associated with cross-border transactions now appear to be the more relevant geographic constraint.

Additionally, there may be differential access to telecommunications infrastructure networks - termed "access asymmetries" by Bar (2001). For example, dedicated private lines or the use of the internet influence which classes of participant can have physical access to systems.[17] Suboptimal outcomes could arise, for example if intermediaries own new trading platforms that in other respects would disintermediate them - their incentive may be to ensure the network design retains their privileged access positions. Implications of the risks of anticompetitive biases in networks are discussed in Section 5.2.

3.2.2 Access and intermediation

The greater access possibilities offered by electronic trading have perhaps most obviously brought into question the role of intermediaries. There has been some shift away from pure dealer structures towards continuous auction arrangements where users can transact directly with one another. This has especially occurred in large, liquid markets (notably major equity and foreign exchange) where

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[16] Longer opening hours may also seem to be cheaper and more feasible - but in practice longer (even 24-hour) trading sessions do not seem valued in wholesale markets. Reasons may include a preference for a distinct end-of-day closing for risk management procedures and, more fundamentally, lack of demand from customers and the problems of thin markets.

[17] Moreover, moving to different or additional systems is far from friction-free. For example, at the most practical level it may involve extra screens, linkages and staff training. While it is likely that such costs will progressively lessen, the point at which they can be virtually ignored seems distant.

end investors are likely to be able directly to match their requirements over a reasonable period of time. This wider access to trading systems increases competitive pressures on dealers and typically forces those which remain to focus more on value added services such as corporate finance, advisory services and risk management. However, in OTC markets, where a larger portion of trades are characterised by asynchronous supply and demand in less liquid securities, the matching services of a dealer have a clearer role and this is reflected in many electronic trading systems in such markets incorporating dealer structures, as illustrated in Section 2.

However, despite the developments (such as customer access to order books) that might have been expected to marginalise much of their role, dealer intermediation remains. Reviewing literature pertinent to this issue, Madhavan (2000b) highlights some features, such as the significant costs a direct limit order trader might face in order to monitor changing market conditions, that could explain their continued importance. Supporting this, anecdotal evidence collected by CGFS (2001a) from customers in foreign exchange and fixed income markets pointed to some valuing the personalised research, advice and execution offered by dealers. Moreover, in practice, systems are some distance from being able to seek out all sources of liquidity automatically, and disparate sources of liquidity (eg due to upstairs arrangements) make this search a valued service of intermediaries.

3.3 Transparency

3.3.1 The uneven effects of changes in transparency

One of the commonly cited benefits of electronic trading is that it can facilitate greater pre- and post-trade transparency.[18] While this is undoubtedly true, there are significant questions, both theoretical and practical, about the extent to which implementing greater transparency across all market segments benefits the quality of a market. Underlying the issue is that transparency arrangements affect the balance of information among participants. Evidence from a range of studies (see Madhavan (2000b)) demonstrates that this influences the degree of information in the order flow, price discovery and liquidity.[19]

Changes to transparency rules tend to benefit one group of participants and their objectives at the expense of another, creating winners and losers. While in many respects the literature on the effects of transparency is inconclusive (see, for example, Ganley et al (1998)), the presence of these trade-offs is very evident. This highlights the importance - stressed in the introduction to this paper - of the perspective of the debate. From the public policy viewpoint, recognition that transparency arrangements can have uneven influence on "ultimate" objectives such as market quality and broader welfare is clearly crucial. Even though understanding of this area is very incomplete, the evidence that there is not a simple, unidirectional relationship between transparency and quality of markets deserves considerable weight in policymaking.

Some flavour of why greater disclosure may not necessarily benefit the overall market is given in the following stylised examples. An illustration of a tension between *post-trade transparency* and liquidity occurs in a multiple dealer setting such as in many government bond markets. Faced with an unpredictable flow of large customer orders, dealers who maintain a continuous presence in the market seek to manage the risks arising from sharp variations in their inventory of securities by inter-

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[18] This section focuses on transparency in terms of the ability of market participants to observe information about the trading process. As discussed in O'Hara (1995), there are multiple dimensions to transparency. Consideration of it can be split into *pre-trade* information on order sizes and quotes, and *post-trade* information on prices and quantities of executed trades. Other considerations include the timeliness of the information made available, which (subset of) participants can observe certain aspects, and pre- and post-trade anonymity (whether identities are revealed).

[19] Madhavan (2000b) surveys results regarding transparency from theoretical, empirical and experimental literature. Much of the work uses underlying models based on asymmetric information - these consist of two classes of market participants, informed traders with private information on future asset values and uninformed (liquidity motivated) traders, and explore how these groups trade under different conditions. Such models are mostly applicable to equity markets in which private information on assets plays an important role. There is also a range of models based around inventory adjustment, consisting of dealers who attempt to restore their inventories to some desired level by adjusting their quotes and trading behaviour. As discussed in Gravelle (2001), these also fit closer with the structures typically seen in fixed income and foreign exchange markets.

dealer trading to rebalance their holdings. Were stricter post-trade transparency imposed in terms of requiring *more rapid publication of large transactions*, it would reduce dealers' opportunity to conduct this inventory adjustment. This could increase their risk management costs - which may be passed onto customers - and could lead to a less efficient allocation of risks in the market. Both liquidity and price discovery could be impeded. (Gravelle (2001) provides more details on the above arguments.)

Equivalent tensions with *pre-trade transparency* requirements can arise where transactions contain (and are motivated by) private information reflecting legitimate investor research/beliefs or portfolio strategy. Were disclosure imposed which revealed "too much" about intended trades, it could effectively expropriate that private information for the public trading venue. The predictable result of such rules would be that traders would act to minimise the cost of the loss, for example by splitting the trade to reduce the observable information content or by switching venues to avoid the regime. Or they might exit the market entirely.

3.3.2 Transparency - potential and practice with electronic trading

Electronic trading creates the *potential* for a very high degree of transparency across the whole trading process. In principle, systems can disseminate real-time pre- and post-trade information market-wide. Conversely, they can operate with minimal information leakage, in a manner that trading based on personal contact could not achieve. As electronic systems become more sophisticated, they make it more feasible to move along the multidimensional spectrum of transparency. They can more readily meet different users' preferences regarding information, some of which were once too complex to put into practice.

For example, the basic demand for anonymous trading is now met through many electronic systems. Some of the systems becoming available are specifically designed to eliminate (pre-trade) information leakage, enabling users to specify precise orders without giving away potentially valuable information to competitors.[20] Other systems offer choices such as "iceberg" orders that are automatically matched if hit but are not visible on an order book. In contrast, the upsurge of electronic order books in equity markets has often led to the arrangements being more transparent than the structures they replaced. Presumably the practical possibilities will grow as the technology develops further.[21]

In itself, this existing variation in transparency arrangements suggests that the form and degree of disclosure vary with largely market-specific factors. Considerations include the perceived role of the information in attracting liquidity to the system, the needs of its range of users and style of trades (eg retail/wholesale, whether market-moving) and the commercial value of the data. And importantly, different classes of trading systems lend themselves to different forms of transparency: the style of information concerning a call market differs from that readily available from an order book or a dealer arrangement. Regulatory requirements may or may not constrain the actual outcome, given that there are strong reasons why systems typically would choose to make available some degree of trade information (eg to attract liquidity and/or for commercial data promulgation).

3.3.3 Some likely effects of electronic trading on transparency

Segregation of trading arrangements largely according to transparency regime has long been a feature of markets. Notably, virtually all exchanges have particular arrangements for block trades ("upstairs trading"), with lower transparency requirements, often in the form of delayed publication. The integration of electronic trading hugely increases possibilities for different arrangements, in principle

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[20] Such systems are a response to the above point, that in a transparent environment, wholesale traders may well disguise these orders in some way to avoid giving away information on their strategy which may lead to the market moving against them. The pre-trade opaque class of systems in contrast actually allow traders to input their true order preferences to the system with complete accuracy since the information is only "seen" by the computer system. These systems aim to meet a demand for trading without losing informational advantage.

[21] Considering transparency more widely, other forms of information dissemination also become more feasible as technology is integrated. For example, information on the characteristics of numerous securities can be made available (as seen in the systems implemented in several government bond markets) while transparency of processes, such as order routing information, can also be offered. However, questions have been raised (see D'Avolio et al (2001) and Ferguson (2001)) about the extent to which the increased quantity of information enabled by technology is accompanied by an increase in its quality.

virtually anywhere on a spectrum, between complete transparency and complete opacity. An outcome may well be an even greater variety in transparency levels across (and within) different trading venues than seen hitherto.

Moreover, if electronic trading enables the implementation of systems which give "appropriate" incentives in trading behaviour (such as to input "truthful" orders, as explained in footnote 20), one result could be greater efficiency of price formation. As set out in the introduction, this argues for seeing transparency as a means to an end for aiding market quality, rather than as an end in itself.

The current regulatory focus on transparency in securities markets largely reflects concerns that greater choice of trading venues/routings raises about level playing fields and fairness of information across the whole market. For the context of the immediate discussion, there are clear risks that a response involving an attempt to impose common transparency standards could be counterproductive if it overlooks the wider repercussions of disclosure rules and creates distortions by neglecting differences between/within markets. These questions are particularly important across wholesale, professional markets. For retail (ie non-market-moving and non-information-carrying trades - albeit not the focus of this paper), the concerns are very different, relating more to consumer protection and informed consumer choice, where the benefits of greater transparency seem less ambiguous.

4. Effects of electronic trading on market quality

Closely related to market architecture are aspects of market performance. This section looks at influences of electronic trading on transactions costs, price dynamics and liquidity, all of which contribute to the overall quality of markets.

4.1 Trading costs

At the outset of this paper, the performance of financial systems was recognised as having broader welfare effects. Trading costs are one of the more direct indicators of this performance. For example, in a recent study of the wider implications of trading costs, their reduction was shown to be associated with a lower cost of equity capital, which has macroeconomic significance - see Domowitz and Steil (2001b).

Benefits such as these could be assuming more importance since electronic trading and associated computing advances have given new impetus to trading cost reduction across all fronts. There is now scope to reduce what was once a "set cost" of business - one reason for the greater focus by institutions on analysing and cutting trading costs. These costs for end users can be divided into explicit costs (eg physical overheads, fees, commissions, taxes, costs of clearing and settlement) and two main types of implicit costs - bid-ask spreads and market impact costs. Electronic trading is offering routes to reduce all of these.[22]

Looking initially at *total trading costs*, empirical studies find these are lower for institutional investors on automated than traditional markets, even after controlling for the different mix of shares traded in the two types of market. For example, Domowitz and Steil (2001b) suggest total cost savings in the United States of around 30% from using automated systems. As for implicit costs, a study of over half a million institutional equity trades by Domowitz et al (2000) suggests they have been falling over time and that they tend to be lower in markets where automated trading dominates.

4.1.1 Explicit costs

Electronic systems involve lower set up costs than trading floors, especially when an existing system can be adapted for a new product. More significantly, by replacing labour-intensive processes, they

[22] Trading cost studies typically measure costs conditional on execution. There are also costs arising from non-execution, which particularly affect the placement of limit orders. There are also opportunity costs associated with any trading decision.

markedly reduce operating costs; Domowitz and Steil (2001a) show such reductions have typically been 50-75%.

The cost savings from shifting to electronic systems will differ for different users. A more competitive market reduces the ability of exchanges to cross-subsidise different types of trading activity, meaning that the allocation of costs may shift under electronic trading.

In addition, electronic trading can further lower costs if integrated into straight-through-processing (STP) arrangements, which allow trades to pass automatically through to final settlement without further manual intervention. As well as the savings due to automation and error reduction, costs can be cut by linking the execution, clearing and settlement of trades to the procedures for controlling market and operational risks. According to CGFS (2001a), some institutional investors believe that the prospect of STP could be the greatest single potential benefit of electronic trading.

4.1.2 Implicit costs

The *bid-ask spread* paid by users of dealer markets could be regarded either as a payment to the dealer for providing liquidity or as a rent charged for accessing the market. It must cover dealers' normal costs of doing business (eg order processing, inventory costs, overheads) and a risk premium to compensate for the losses incurred when trading with well informed traders (adverse selection). Electronic trading may reduce all these components. It obviously allows cheaper order processing and lower overheads in general. Moreover, electronic trading's potential to make markets more transparent in conjunction with anonymity reduces the risk premium and may drive down profit margins, by increasing competition between dealers and aiding price comparison. Some auction markets give end investors direct access, which might be regarded as them earning the bid-ask spread by providing liquidity. Profit margins are likely to be particularly low in electronic order books that allow access to end investors.

A number of empirical studies show that realised bid-ask spreads on electronic systems are similar to, or lower than, those on floor- or telephone-based systems.[23] German bund futures provided a case study when in the mid-1990s they were traded in large volumes under otherwise similar conditions on both the electronic Eurex market in Frankfurt and the LIFFE floor in London. Comparisons by Breedon and Holland (1998) and Frino et al (1998) found that spreads were generally wider on the floor exchange, at least when the two exchanges had similar volumes.

Market impact costs refer to any adverse impact on price as a result of information associated with the trade leaking ahead of execution, or because the trade is large enough to affect significantly supply and demand in the market or signal a predictable trade to come. As discussed above, electronic trading may reduce these market impact costs, for example through the use of the pre-trade non-transparent systems. This is an area where electronic trading is widely held to have great potential - with several new systems aiming at adding value. More generally, studies by Vila and Sandman (1995) and Pirrong (1996) find that prices are less sensitive to volumes in automated than traditional markets.

4.2 Price dynamics

Effective price discovery is important beyond the immediate asset market, since it underlies the accuracy of price signals to agents in the wider economy. This enables appropriate investment (and other) decisions which have widespread economic impact, contributing to ultimate objectives of broader welfare.

Price formation in electronic trading systems is the outcome of precise order execution algorithms, in contrast to the trading floor or phone-based systems where relationships may matter as much as price

[23] See, for example, the articles listed by Domowitz and Steil (2001a). Domowitz (2001) claims "all things equal, average trading costs are lower by 33 to 46 basis points in markets which are largely automated". Jiang et al (2002) show that the introduction of electronic trading in the Hong Kong futures market lowered bid-ask spreads, even after allowing for changes in price volatility and trading volume.

or size.[24] Furthermore, electronic trading is allowing basic algorithms to be extended to better meet trading needs and, for example, some now permit very detailed trading plans with contingent orders reflecting the various nuances of preferences. Systems are being developed for "near matches": when bids and offers do not coincide, a computerised negotiating system may try to reach a compromise price.

In general, electronic processing should allow orders to reach the central market faster because of higher processing speeds than with manual processes. Prices should therefore incorporate information more quickly. Domowitz and Steil (2001a) found that most empirical studies show that electronic systems are more efficient in this sense than traditional trading venues. However, in some studies the difference is quite marked while in others it is rather small.

4.2.1 Effects on price volatility

Studies comparing observed price volatility in traditional and electronic markets generally find that volatility is less or about the same in electronic markets. The following recent studies give a flavour of the findings. Jiang et al (2002) observe that price volatility dropped in the Hong Kong futures market after the introduction of electronic trading but as a similar drop occurred in the spot market, their results suggest that electronic trading itself had little effect on volatility. Chaboud and Weinberg (2002) report mixed evidence for the foreign exchange market. Using over a century of data from the London Stock Exchange, Green et al (2000) find that, other things being equal, lower transactions costs reduce price volatility. Madhavan (1996) suggests that in large liquid markets price volatility is lower when there is greater transparency. These latter results would imply that more widespread electronic trading should lower price volatility.

Some market participants suggest that price volatility is more "visible" as price transparency has increased in some markets - cited by CGFS (2001a). Systems are technically capable of extremely rapid change (eg EuroMTS can absorb 150 price changes per second) and in some markets the use of pricing engines allows orders to be generated more rapidly than hitherto. The micro design of trading systems may also affect price volatility over very short periods. For example, Soejima (2001) shows how changes to the system of execution in the Japanese futures market had to be amended when it was found that traders had insufficient time to respond to new information on the order book.

4.2.2 Effects on price discovery

The effects of the increased opportunities for trades to be executed with little interaction with other orders and/or without reaching a main market are keenly debated. Electronic trading is closely associated with the issue since it enables many systems to perform this order matching but the debate - which is typically voiced with respect to the equity market - goes much broader.[25]

Three factors have a particular influence. The first is where orders become more thinly spread among fragmented venues. The second is increasing internalisation, where brokers match buy and sell orders internally from their own customers at prices (broadly) determined on another market, sending only the net balance to the exchange. The third is the number of formal, non-exchange "crossing" systems for institutional trades that are now also part of the market, which match at the prevailing main exchange price.[26] There seems to be no clear conclusion about the combined effect of these on price formation,

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[24] In electronic systems, price is usually the first criterion, priority being accorded to the highest bids and lowest offers. The most common secondary criterion is time, with orders transacting on a "first come, first served" basis. Other systems spread a new matching bid pro rata over all the offers at that price. In some systems, market orders may be given priority over limit orders, large orders over small orders, openly disclosed orders over anonymous orders, or those from designated market makers over those of other traders. Another possibility would be for a system to trade off automatically price versus credit risk in accepting bids. Domowitz (1993) provides a taxonomy of these algorithms and describes those used by systems in the early 1990s.

[25] For examples of market comments about electronic trading possibly degrading the quality of prices, see Morris (2001) and McNee (2000).

[26] There are other instances - not necessarily associated with electronic trading - where prices in one market are largely determined by prices in another, possibly more liquid, market. Examples include off-the-run bonds, whose price movements largely reflect those of on-the-run bonds. In Japan, yields in the government bond market are largely driven by developments in the more liquid futures market. Between the polar cases of pure price making and price taking there are also systems that set the price within limits of prices from a central market.

despite their increasing importance in markets. However, the following comments give a flavour of the arguments.

One issue is how crossing or internalisation effectively "free rides" on central price discovery and hence the extent to which price information is a public good. For example, Lin, Geng and Whinston (in this volume) describe crossing as a "parasite of real exchanges" while Picot et al (1995) argue it impinges on the "property rights on the price discovery" of an exchange. There are also regulatory concerns including whether internalised transactions are conducted at a "fair" price and whether crossing systems encourage attempts to manipulate the main market just ahead of the price taking for the crossing trades. Transparency can also be reduced by internalisation or crossing, though this depends on the trade publication rules prevailing in any centre.

However, significant cost savings are available[27] from crossing and internalisation - although the extent to which customers benefit from this can vary. Additionally specialist crossing systems are used by institutions to avoid information leakage. Both these may have some bearing on pricing.

Another aspect of the question is whether there is a "genuine" problem regarding pricing. Other markets (for example, many commodity markets) operate on the basis of the "central" market reflecting more the net balance of buy and sell orders rather than gross volumes. The resultant price should be the same, as all the supplies and demands are still contributing to price formation. It could be argued that this form of price determination is more cost-effective and hence generally beneficial to broader welfare provided the regulatory safeguards operate satisfactorily, such as ensuring customers have the means to access a fair price.

The policy questions closely relate to those surrounding the problems of fragmented markets and of transparency. Problems might be expected to be self-corrected if arbitrage processes, especially in combination with more effective information systems and market linkages, lead to the natural migration of business to platforms where there is confidence in the price formation and integrity of the market. On the other hand, there is scope for self-correction to be limited by rigidities (such as the dominance of some cartel or private incentives of intermediaries) while it may also be held damaging to allow even "temporary" problems to continue (eg the practical problems of thin, illiquid markets).

4.3 Liquidity

Liquidity is essential for trading systems. It enhances the effectiveness of the market overall, reducing costs by narrowing spreads and giving depth such that prices are less affected by particular trades. Liquid markets are typically better placed to absorb shocks than less liquid ones, contributing to the robustness of financial systems. Moreover, as discussed in the previous section, liquidity is an essential ingredient of price discovery and hence price signals for the wider economy.[28]

Despite the technological and strategic efforts of electronic trading systems to attract liquidity (see below), it is generally those with existing access to order flow (particularly within an existing exchange) that have experienced viable volumes. Few "standalone" systems have achieved this. This, however, probably reflects the powerful network effects of liquidity as much as the characteristics of the electronic systems themselves - with liquidity attracting (and "locking in") liquidity. There are converse hurdles to attracting business to new venues in the absence of many other users, even if a technically "better product" is on offer (see Box B).[29]

Nevertheless, in a world of electronic trading, liquidity is much more mobile. Orders can be rerouted to the preferred system and to the best prices, and franchises can be quickly lost. This "tipping effect" was seen when Eurex within around six months in early 1998 took all the volume in the futures on the 10-year German bund contract from the previously dominant LIFFE floor.

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[27] Conrad et al's (2001) study of the US equity market finds that for crossing networks average implicit cost is 0.23% and explicit cost 0.07% compared with 0.54% and 0.27% respectively for full service brokers.

[28] Characteristics of liquidity in markets are discussed in the policy context in BIS (2001) and from a theoretical perspective in O'Hara (1995). There is discussion of the impact of the internet on equity market liquidity in Madhavan (2000a). Some evidence on electronic trading and market resilience is discussed in CGFS (2001a,b).

[29] Analogies can be made with other areas of e-finance, such as the difficulties and/or high costs of internet-only banks attracting funds (see the paper by de Young in this volume).

4.3.1 Electronic trading systems' ability to build liquidity

Focusing on the level of the trading system design,[30] electronic systems are developing a number of ways to attract liquidity and seek it out from disparate sources. For example, systems can link to institutions' order management systems to interrogate potential orders on their blotters of prospective trades to seek out possible crossing matches. In due course, traders may be able to use "smart agents" to search across systems to locate disparate sources of liquidity.

Electronic trading systems may encourage issuers to standardise their offerings (which can concentrate liquidity), particularly in more heterogeneous securities such as fixed income. There has been some suggestion of this in government bond markets with the tendency to reduce the number of separate issues. Minimum size limits on issues to be eligible for certain trading systems similarly encourage issues to be made in larger size or reopened to maximise liquidity.

Though electronic trading has typically come later to less liquid assets (as illustrated in Section 2), routes are being developed to enable their cost-effective trading. Here, the most effective automation solutions may not be those which reproduce traditional procedures. For example, in fixed income markets, there is an expectation that small, less liquid issues could get swept up into automated trading of portfolios which offer certain characteristics, rather than being traded bilaterally on their own merits. This kind of development offers the potential to garner individually disparate, illiquid securities and pull them into a larger liquidity pool - for example, see the discussion in Fan et al (2000).

Another way in which electronic systems are enabling the more effective trading of illiquid securities is by reviving the use of periodic call auctions (explored in Schwartz et al (2001)). A number of stock markets now trade less liquid securities in call auctions, commonly one to three times a day, concentrating liquidity that otherwise would have been thinly dispersed across a longer period. Such securities may not trade effectively in the continuous auctions that typically form main markets - for example, Steil (2001) describes how the Warsaw Stock Exchange, re-established in 1991, initially traded stocks in a weekly call, moving to daily calls and later (for some stocks) to continuous trading as volumes grew to give sufficient liquidity.

5. Concluding remarks: wider implications and policy

This final section does two things. First, it draws together some wider implications of the effects of electronic trading in three areas: the regulatory framework/oversight issues; networks and competition; and financial stability. Second, in each of these areas it draws some tentative policy conclusions. As already set out, there are multiple, possibly competing, public policy objectives along with uncertainties about the net effect of changes in markets and their transmission to broader welfare. The recognition of these uncertainties and ambiguities in itself deserves considerable weight in policymaking.

5.1 Regulatory framework and oversight issues for markets

Developments associated with electronic trading test long-standing institutional structures and appear on regulatory agendas worldwide.[31] Notable issues include:

- frameworks for regulation: notably whether to (continue to) differentiate the institutional status and oversight regimes applying to exchanges and non-exchange trading systems;

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[30] Clearly the enhanced possibilities for market access offered by electronic trading themselves can garner liquidity. Electronic trading's other effects on liquidity can come via influence on fragmentation and consolidation and, connected to this, its influence in allowing trades to be executed away from main markets, for example by internalisation of order flow. Lower trading costs in themselves also attract more trading.

[31] For example, US SEC (1998); proposals by the Canadian Securities Administrators (2000) concerning alternative trading systems - discussed in Boisvert and Gaa (2001); discussions in the United Kingdom - see Financial Services Authority (2000) and Wisbey (2000). This section highlights some key, underlying issues. Details about the debates and the complexity of considerations can be found in the documents referenced.

- the appropriate level of detail for official involvement in microstructure matters - for example, whether transparency rules are required or can be enforced, and in what degree of detail; or whether fragmentation of markets requires an active response; and
- cross-border issues raised by remote access to trading, including whether countries' different regulatory regimes lead to problems caused by regulatory arbitrage; and clarification of jurisdiction over legal and regulatory arrangements.

It is worth reiterating that in immature, fast-changing markets, some perceived problems may be temporary effects perhaps associated with early stages of product cycles, whereas others may reflect sustained suboptimal positions. The questions associated with fragmentation illustrate this. Policy treads a difficult line between imposing requirements that restrict innovations, while maintaining market integrity and confidence in periods of rapid change. Even if aspects of markets are perceived as functioning suboptimally, it is recognised that specific intervention can be counterproductive. Greenspan (2000) captured the concerns, stating that the authorities "would do well to heed the advice offered to the medical profession and, first, do no harm". Since market structures that had given rise to concerns may change rapidly, the presumption may be that specific intervention is inadvisable unless there is demonstrably a sustained problem.

Where action is deemed preferable (say, where correcting market forces are believed to be weak), there will also be differing regulatory stances about solutions. These could range from ensuring facilitating frameworks such as clear legal codes, action on competition policy such as removing restrictive practices, to specific micro-rule-making on, say, trading protocols. When weighing choices, the differences between and within markets are important - as already evidenced by the varied adoption of electronic trading and the variety of services becoming available. Added to this is recognition of the imprecise understanding of the net effects of changes in market structures/rules - such as the mixed impact of transparency rules. All this supports the avoidance of a "one size fits all" approach and argues in favour of being wary of imposing detailed, cross-market rules at a high level.

Electronic trading systems still have further to go in capturing the subtleties of trading - and a similar comment applies to market structure research and its application to policymaking. However, while technology's effects raise many difficult issues in markets, technology can also contribute to solutions:

- It can be applied to enable more efficient and effective collation of data on market performance and behaviours - helping both oversight and understanding of markets. For example, the fulfilment of market-maker obligations could be monitored automatically, or erratic market movements, whether due to trader errors or more fundamental reasons, could be identified rapidly.
- It may directly offer solutions to problems, such as the means to build information systems or link fragmented pools of liquidity.
- It can help participants make better informed decisions, for example by enabling more appropriate transparency arrangements, providing greater information about order routing and features of the assets.

5.2 Networks and competition

The raised profile of "physical" (or indeed "virtual") network issues in trading comes in addition to the better known, powerful network economics effects. Some associated policy issues, such as fairness of network access, may be akin to those faced by regulators of other industries such as telecoms where the networks have been opened to competition. From the interest of financial authorities, there are also parallels with oversight of payment systems, in which, quoting from Bank of England (2000), "as with other significant components of the economic infrastructure, there is a public policy interest in ensuring that a competitive environment exists and that any competitive abuses are curbed".

As highlighted in Box B, the competitive landscape can shift rapidly. For example, outcomes of competing but interoperable systems are likely to become more common in securities trading (as seen in, for example, telephone networks). This occurs as network interoperability and linkages between systems contribute to the lessening of physical hurdles to entering markets, for example removing the disadvantage of requiring separate screens for alternative systems. Moreover, while it is never easy to compete successfully with a dominant system, the effects of electronic markets open up more possibilities for tipping to occur, a prospect reinforced by the lower cost base of electronic networks.

Overall, while electronic linkages might in principle open up markets to competition and enable more "level playing fields", it is not the technology but its implementation that determines the fairness of arrangements. As described by Bar (2001), architectural biases can exist in electronic network markets at least as strongly as, and possibly less visibly than, in traditional structures. Networks can be designed with strategic advantage to certain players, and anticompetitive practices (which restrict the scope for self-correction) may be hard to recognise if they are embedded in the system protocols themselves.[32] However, electronic network architecture should in principle be more adaptable than traditional market structures, implying that, where identified, problems may be easier and speedier to address.

5.3 Financial system stability

Many financial stability issues closely associated with electronic trading are common to discussions of technological innovation and e-finance more generally. The magnitude of uncertainties in conjunction with potential for rapid, wide-ranging change in themselves motivate interest in the whole area.[33]

The concerns typically are due to shifts in emphases rather than completely new risks. For example, the impact of operational problems can be greater in a technologically dependent market. Moreover, and as discussed in Turner (2001), potential systemic implications can arise from the involvement of new and different firms in financial markets, making it more difficult to monitor the linkages and assess the risks to which sectors may be exposed. Especially, the increased importance of non-financial firms, such as telecoms and IT companies, in processes could make channels through which systemic threats arise harder to identify and anticipate.

Many recognised effects of electronic trading - which include opportunities to harness efficiency gains, better market information, handle higher volumes and lessen physical constraints on trading practices and participation - have a role in contributing to the adaptability and stability of the financial system. And while, as with the expansion of any new market, the route will doubtless end up littered with underperforming and failed systems - this in itself does not necessarily carry systemic threats. Indeed, if this brings about greater strength in the remaining platforms, it should contribute to financial stability.

The ambiguity of effects on market performance remains striking. Most observations highly relevant to policy remain in some way equivocal. For example, liquid markets are more resilient than illiquid ones; yet electronic trading is credited with both fragmenting liquidity and enabling it to be brought together from disparate sources. Nevertheless, the potentially volatile nature of liquidity and markets in general, combined with the speed and unpredictability of technical developments, remain in themselves reasons for vigilance.

While electronic trading has brought a range of policy issues to the fore, the associated technological advances may offer routes to solutions. This paper has not attempted to predict outcomes. But it seems likely that the direction of resolution of many of the current questions may lie with the technology itself. And likely too that, as with the assimilation of previous technologies, "electronic trading" will before long cease to be considered as a distinct issue.

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[32] Three main categories of network bias are described by Bar (2001), as follows. Information asymmetries are where the market is structured so some players have better/earlier market-relevant information. Matching asymmetries are where market clearing algorithms are programmed to favour some participants. Access asymmetries are where different players have differential access to the telecommunications infrastructure.

[33] Several official speeches elaborate on these points, for example Crockett (2001) and Greenspan (2000).

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Trading system competition and market-maker competition

Mark Wahrenburg[1]

1. Introduction

The recent success of some alternative trading systems (ATSs) has had a strong impact on the traditional stock exchange industry and many observers expect even more dramatic changes in the future. This paper investigates the nature of competition between stock exchanges and ATSs and argues that the introduction of ATSs weakens the level of competition between market-makers in the traditional exchange.

According to a popular argument, competing stock markets lead to a fragmentation of the market and a reduction of liquidity which in turn increases spreads and search costs for traders and threatens the efficiency of the overall price discovery process. However, this argument is valid only in a world with high information barriers. With functioning arbitrage links between markets the traditional fragmentation argument breaks down.

This paper takes another view on stock market competition by looking in more detail at the different levels of competition. Stock markets offer a bundle of products and may best be described as a vertical production chain. The first element of the chain is the supply of immediacy by market-makers or individual traders. By providing privileges to certain members such as the specialists of the NYSE, the Nasdaq market-makers or the "Aktienbetreuer" on the German stock exchange, stock exchanges actively engage in the production of immediacy. The second element is the trading system. Different exchanges compete in technical dimensions such as speed, reliability and information services as well as in design dimensions such as the details of trading rules. The third element in the vertical production process is the settlement and clearing operation. Today, these functions may be provided by different entities. However, two of the three elements are often provided by one entity. For example, the German stock exchange is the owner of both the trading system and the clearing system. Another example is the in-house systems of banks that usually encompass the market-making function and the trading system function. Most European ATSs are at least partly owned by securities trading firms, indicating that the trading business may be more profitable if trading firms achieve control over trading systems. This paper concentrates on the relationship between trading systems on the one side and the business of making markets on the other side. The analysis shows that the two areas are interrelated. Changing the level of competition in the area of trading systems has an impact on the level of competition at the market-maker level.

Although the seminal work on collusive behaviour by Nasdaq market-makers by Christie and Schultz (1994) has directed much attention to the issue of competition between market-makers, this issue has so far received little attention in the theoretical literature. The market microstructure literature usually assumes either perfect competition between market-makers or monopolistic market-makers. This strand of the literature is not suited to studying the determinants of the level of competition between market-makers. Kyle (1989) models imperfect competition between informed investors but does not focus on imperfect competition between market-makers.

A paper by Dutta and Madhavan (1997) shows that implicit collusion between market-makers may occur when they compete by choosing intertemporal pricing strategies. The idea is that collusive equilibria may be sustainable if market-makers use tit-for-tat pricing strategies, ie penalising a deviation from the collusive equilibrium by quoting a low spread in later periods. However, collusion is only one out of many equilibria in their model. It is therefore difficult to draw conclusions on the impact of ATSs on the level of competition. In a different framework, Dennert (1993) shows that competition

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between a limited number of market-makers does not eliminate their profits when they use linear price schedules. However, he does not investigate the relation between competing stock markets and the level of market-maker profits. Kandel and Marx (1997) show that a Bertrand equilibrium with spread exceeding marginal cost may result from fixed minimum price increments. However, this paper is also not concerned with the issue of competition between trading systems. In a recent contribution, Hendershott and Mendelson (2000) analyse the interaction of dealer markets and crossing networks. They show that the introduction of a crossing network may increase or decrease the equilibrium spread in the dealer market. However, their model assumes Bertrand competition between market-makers which always ensures a zero profit equilibrium in which price equals average costs.

This paper presents a new approach to modelling the price setting behaviour of market-makers within a simple one-period framework. The paper deviates from the usual notion of Bertrand competition by assuming that market-makers who do not quote the best bid and ask prices still receive some order volume. Unlike Dutta and Madhavan (1997), the approach yields unique equilibria with non-zero profits for market-makers and allows an analysis of the impact of ATSs on equilibrium spreads and equilibrium market-maker profits.

Within the popular press, opposing views on the likely impact of ATSs on market spreads are expressed. Some commentators expect that increased competition among trading systems through the advent of ATSs would help to tighten spreads.[2] On the other hand, concerns have been raised that the vertical integration of trading services through the entry of bank-owned in-house trading systems will in the end lead to a monopolisation of the trading industry.[3] The European regulatory authorities currently follow a comparatively liberal policy and believe that a "laissez-faire" policy is best suited to promote competition among marketplaces and achieve economic efficiency. However, the European Commission has recently expressed concerns that the trend towards vertically integrated trading systems could dampen competition and is considering regulatory actions against vertical constraints in the stock exchange industry.[4] The model presented here elaborates this view by showing how vertical constraints in the form of order-preferencing arrangements between ATSs and market-makers may affect the level of competition between market-makers and increase the equilibrium spread in stock markets.

2. The regulatory situation

The European securities markets are characterised by regulatory fragmentation. Stock market regulation in Europe is usually shaped by three different kinds of regulatory bodies:

1. Institutions regulating insider trading and the flow of information from companies to investors (insider regulation).
2. Institutions regulating the capital adequacy of participants in the trading process (capital adequacy regulation).
3. Institutions which regulate stock exchanges or oversee the self-regulatory bodies of stock exchanges (stock exchange regulation).

As a new fourth body of regulation, one should mention the competition authorities, which have just recently begun to become interested in issues of stock market competition.

Unlike the situation in the United States, the bodies regulating stock exchanges work on a decentralised basis. This approach is sometimes called the "silo approach" to regulation since every authority is concerned with only one or few stock exchanges. An extreme example is the situation in Germany, where the local states have the duty of overseeing stock exchanges. This led to the curious situation of a local state government having to approve the planned merger of the German stock

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[2] Moskowitz (2000).

[3] Munz (2001).

[4] Heusinger (2001b).

exchange with the London Stock Exchange - a decision which obviously affects the interests of much more people than the voters of the local state government.

Due to the decentralised nature of competition, the regulatory actions concentrate on the business processes within the particular regulated stock exchange. The competition between different exchanges naturally lies beyond the horizon of decentralised authorities. In other words: no institution is responsible for providing a fair level playing field between competing stock exchanges. The relations between competing stock exchanges are beyond the scope of today's stock market regulation.[5]

Regulatory councils such as the Federation of European Securities Commissions (2000), or the German Stock Exchange Council (2001) discuss at length the extent to which principles of stock market regulation should be applied to ATSs but are silent on the regulation of competition between trading systems. The discussion is mainly concerned with the threats to market integrity and systemic risk posed by the new trading platforms. There is little or no discussion on an economic role of protecting new trading platforms against the dominant incumbent exchanges or vice versa.

The issue of competition between trading systems requires a broader scope of regulation than currently practised. In particular, it raises the question of external effects in other areas as the current focus of the various regulators' investigations. This paper highlights one of possibly many external effects of trading system competition: a weakening of market-making competition. Although the conclusion will show that it is hard to draw clear regulatory implications from the analysis, some blind spots in the current regulatory landscape are identified by the analysis.

3. The impact of alternative trading systems on market-maker competition

The following model tries to explore the effect of introducing an ATS on the competition between market-makers. It is a very simplified and stylised, based on the following assumptions:

1. The market consists of two types of individuals: traders and market-makers. There is no asymmetric information about the value of stocks. All traders are thus liquidity traders.
2. Initially, stocks are traded in a pure dealer market (the incumbent market), in which two market-makers compete for order flow. Both market-makers simultaneously choose bid and ask quotes and commit to execute an unlimited order volume at this price.
3. Market-makers act as Bertrand competitors in the incumbent market, ie their action variable is the quoted spread. The market is in equilibrium when no market-maker wants to alter his own spread given the spread of his competitor.
4. When an ATS is introduced, every trader chooses one particular trading platform before he places his order.
5. In order to attract order volume, the ATS provides a best price guarantee, ie traders receive the same transaction price on both markets and thus are indifferent between both markets.
6. Traders cannot place limit orders within the spread on either the dealer market or the ATS.
7. Before the start of trading, a contract is signed between the ATSs and the market-makers which commits both market-makers to assume and execute all orders routed through the ATSs. For simplicity, we assume an equal division of the trading volume between both market-makers.[6] Note that the contractual allocation of the ATS's order flow to the individual market-makers takes place before the orders are placed by traders. It is this sequence of events which drives the main results of the model. By committing to buy a portion of the

[5] The "Committee of Wise Men" (2000) of the European Union has identified the urgent need to develop transnational regulation. However, given the legal and institutional barriers in the area of stock market regulators, the paper proposes to rely on competition policy as a complementary source of regulatory action.

[6] The model abstracts from any payments made to the ATSs for acquiring the order flow, which would lead to a redistribution of profits between the two parties but leave unaffected the overall profits. Examples are the German Quotrix system and the planned trading system of Knight. See Heusinger (2001a).

ATS's order flow before trading in the incumbent market takes place, the market-makers are able to precommit to pursue a less competitive pricing behaviour in the latter trading session. Intuitively, following aggressive pricing strategies in the incumbent market becomes less attractive because lowering the spread, ceteris paribus, leads to a smaller increase in volume as compared to the situation without the ATSs.

8. Market-makers' cost function is linear in turnover. The constant marginal cost may be interpreted as order-handling costs following the usual microstructure literature.

9. For simplicity, transaction costs are assumed to be zero for both markets.

10. In an important deviation from the usual Bertrand model, we assume that a market-maker quoting a lower spread does not lose all trading volume.

In traditional market microstructure models, the market-maker quoting the best bid or ask price attracts all trading volume. This assumption has the consequence that Bertrand competition drives down the spread until the spread equals marginal cost. A market spread exceeding the market-makers' marginal cost cannot be an equilibrium because every market-maker would have an incentive to slightly undercut his competitor(s). He loses little in terms of the spread reduction but gains a lot in terms of order volume because he is able to attract 100% of the trading volume. It follows that the only equilibrium is a symmetric equilibrium in which all market-makers set the same spread equal to marginal cost.

This extreme reaction of trading volume is unlikely to be a good description of real world markets. Although price priority rules ensure that limit orders with better prices are served before any other order with worse prices at any point in time, strict price priority is not a good market description when we are concerned about modelling spread setting strategies over somewhat longer time intervals. Suppose a market-maker is an employee of a securities trading firm and gets the order to follow a particular spread setting strategy, ie he will keep a spread of 100 base points. Suppose another market-maker working for another securities firm has an order to quote a 101 base point spread. Standard theory predicts that the second market-maker will not be able to do a single transaction. However, he can expect a non-zero turnover in real world markets for a number of reasons not acknowledged by the standard theory:

- At any specific point in time, competing market-makers may post different bid and ask quotes because of differences in their current inventory positions.
- Both market-makers may quote different bid and ask prices as they have different expectations about the fair (mid-market) value of the asset traded.
- After a transaction has erased an order from the order book, the market-maker will need some time to place a new quote there. Within this short time period, another market-maker, who is quoting a higher spread, may attract trading volume.
- Every market-maker must continuously update his bid and ask quote in order to adjust to changing market prices. If this adjustment does not take place exactly simultaneously, a market-maker with a higher spread will at some points in time quote the best bid or ask quote.

All these arguments support the view that the reaction of transaction volume to spread changes is less extreme in real world markets as compared with the usual Bertrand models. A good model of market-maker competition should have the property that expected trading volume is a smooth and decreasing function of the quoted spread, ie a market-maker quoting aggressively receives more, but not all trading volume.

In order to formalise this idea, assume that aggregate demand for dealer services is inelastic such that the aggregate trading volume is given by a constant X. Furthermore, the share of trading volume that a market-maker attracts is a smooth function of his own spread and the spread quoted by his competitor. For simplicity, assume that the fraction of trading volume attracted by each market-maker x_i is a linear function of the spreads s_i and s_j quoted by each market-maker:

$$x_i = ½ - s_i + s_j$$

When both market-makers set the same spread, they both receive 50% of the trading volume. If one of the market-makers lowers his spread, he is gaining market share but not the complete market and vice versa. Note that x_i and x_j sum up to one.

Finally, the cost function of market-makers is assumed to be linear with constant marginal cost of *c* per unit of trade. Each trader sets the profit maximising spread given the spread set by his competitor. We are interested in the equilibrium spreads of this Bertrand competition for order flow.

The profits of trader *i* given the spread chosen by trader *j,* is given by

$$\pi = x_i X^*(s_i - c)$$
$$= \left(\frac{1}{2} - s_i + s_j\right) X^*(s_i - c)$$

The market-maker sets the profit maximising spread. The first order condition is

$$\pi_i' = X\left(\frac{1}{2} - 2s_i + s_j + c\right) = 0$$

The two first order conditions of the market-makers define the two reaction functions of the game:

$$s_i = \frac{1}{4} + \frac{s_j}{2} + \frac{c}{2}$$
$$s_j = \frac{1}{4} + \frac{s_i}{2} + \frac{c}{2}$$

The symmetric equilibrium is given by the intersection of the reaction functions. In equilibrium, the spread exceeds marginal cost:

$$s_i = s_j = \frac{1}{2} + c$$

Equilibrium profit for each market-maker is given by

$$\pi_i = \pi_j = X\frac{1}{2}\left(\frac{1}{2} + c - c\right) = \frac{X}{4}$$

Bertrand competition in this setting does not erase market-maker profits. Due to the assumed market imperfections, market-makers are able to realise a profit margin in equilibrium.

Now, suppose that an ATS is introduced into this setting. The ATS convinces a fraction α of traders to direct their trades away from the incumbent market. It offers a best price guarantee stating that the trader pays the same spread as he would have received in the incumbent market. Due to the best price guarantee, traders are indifferent between both markets. The ATS then signs a contract with both market-makers in order to ensure the promised order execution. For simplicity, assume that the ATS charges the market-makers no fees for the right to execute the ATS's orders. This implies that any rents earned in the trading business stay with the market-markers and are not appropriated by the ATS. For simplicity, we assume a symmetric setting, ie both market-makers contract for half of the order volume generated by the ATS. Each market-maker's profit now has two components: the profits earned in the incumbent market and the profits earned on the contracted ATS's order flow. The profit earned on the ATS's orders depends on the benchmark price from the best price guarantee. When the two market-makers quote different prices, the derivation of the benchmark price is not trivial. We assume that the best price guarantee has the purpose of making traders indifferent between both markets. In order to ensure indifference, the benchmark price must be equated to the expected spread that the trader pays in the incumbent market. The benchmark price will be either s_i or s_j, depending on whether trader *i* or trader *j* is setting the spread at the moment when a liquidity trader enters his trade. Since both cases happen with probabilities x_i and x_j, we can compute the expected spread on ATS's orders earned by the market-makers:

$$s^{ATS} = x_i s_i + x_j s_j$$
$$= \left(\frac{1}{2} - s_i + s_j\right)s_i + \left(\frac{1}{2} - s_j + s_i\right)s_j$$

After the ATSs has been founded and the order flow has been contracted, the trading session starts and each trader again has to set a profit maximising spread. When setting their spread, the profit function of market-makers has changed as compared to the situation without an ATS for two reasons: they compete only for the remaining fraction of overall trading demand (1-α)*X* and when setting a price, they have to take into account the effect on the benchmark spread on the precontracted ATSs trading volume. The new profit function is:

$$\pi_i = (1-\alpha)X\left(\frac{1}{2} - s_i + s_j\right)(s_i - c) + \frac{\alpha}{2}X\left(s^{ATS} - c\right)$$

The first order condition after introduction of the ATSs becomes:

$$\pi_i' = (1-\alpha)\left[\frac{X}{2} - 2Xs_i + Xs_j + Xc\right] + \frac{\alpha}{2}X\left(\frac{1}{2} - 2s_i + 2s_j\right)$$

Solving for the new equilibrium as above, we find the new equilibrium spread:

$$s_{i,j}^{ATS} = \frac{1}{2} + c + \frac{\alpha}{4(1-\alpha)}$$

For the special case α = 0 (no trading volume contracted to the ATS), the equilibrium spread coincides with the above result for the market without ATSs. For positive α, the spread increases and is a monotonic function of α. Thus, market-makers are able to raise their spread in equilibrium due to the existence of an ATS with best price guarantee. The effect of introducing an ATS into the dealer market is a reduction of the level of competitiveness. The ATS allows market-makers to quote spreads which are closer to the monopoly situation. (As α approaches 1, the spread grows without bound. This result is due to the assumed inelastic demand for market-maker services which enables a monopolistic market-maker to demand an arbitrarily high spread.)

While the model is highly stylised and simple, the basic intuition for the spread increase after introducing an ATS is straightforward and continues to hold in many possible extensions of the model. When a trader calculates the marginal gain of lowering the spread in a situation without an ATS, he has to consider three effects. First, he earns a lower profit margin on his trading volume. Second, he enjoys an increase of trading volume because he attracts a larger market share. Third, he has to take into account the reaction of his competitor. Since the reaction functions have a positive slope, the competitor will also decrease his spread, resulting in a decline of trading volume. After the introduction of an ATS, the situation changes. Concerning the trading volume left in the dealer market, the same effects are present. However, the trader now has to take into account the additional effect on profits from his ATS's trading volume. Since the volume has been contracted in advance, there is only the price effect left: lowering the spread thus unambiguously decreases the profits from the ATS. The fact that he cannot gain more market share in the ATS's market makes a reduction of spreads less favourable ceteris paribus. In other words: the ATS serves as a precommitment device which weakens price competition in the later trading stage by lowering the returns from decreasing the spread.

Note that the model has a unique equilibrium that allows a clear-cut analysis of the effect of introducing an ATS. In a related model, Dutta and Madhavan (1997) show that order-preferencing arrangements increase the potential gains from collusion for individual market-makers. But their model has multiple equilibria and collusion is just one of them. Their model is also consistent with the empirical hypothesis that ATSs do not have any impact on the spread. Kandel and Marx (1997) also analyse the impact of order-preferencing arrangements within their model, which is qualitatively equivalent to introducing an ATS. They conclude that order-preferencing does not change the spread as long as the marginal market-maker has no preferenced orders. This result does not continue to

hold in the context of our model. Even if only one market-maker receives all ATS trading volume, the equilibrium spread in the market would increase as one of the two reaction functions shift. The result of Kandel and Marx depends on the usual Bertrand assumptions and therefore has little robustness when the individual demand curves become downward-sloping and smooth as assumed here.

4. Conclusion

As we have demonstrated, the introduction of alternative trading systems may have the undesired side effect of decreasing competition at the market-making level when ATSs use best price guarantees in conjunction with order-preferencing arrangements as often seen in European securities markets these days. If regulators try to intensify trading system competition by recognising or promoting ATSs, they may have to trade off the efficiency gains through intensified competition at the trading system level with a decrease of competition at the market-making level. If one tries to compare both effects in terms of practical importance, there is a clear indication that market-maker competition should be much more important than trading system competition: commissions for using a trading system are an order of magnitude lower than the bid-ask spread in most markets.

This poses the question of the raison d'être of ATSs: do these systems exist because they can successfully compete against inefficient and costly trading systems of traditional exchanges? Or are they better described as vehicles to increase market-maker profits by limiting the ex post competition for orders by using order-preferencing arrangements? The model outlined here suggests that the second motive may be a valid reason for founding ATSs. This view is supported by the fact that the owners of ATSs are almost always securities trading firms or banks actively engaged in securities trading. In conversations, some representatives of European ATSs openly admitted that the spread income made by selling the order flow to securities firms is much more important than economies realised in operating a cost-efficient trading system.

If the second motive of operating ATSs should be the dominant one, it is still an open question whether customers are worse off after introduction of an ATS and whether regulators should intervene in the competition between traditional exchanges and ATSs. As long as there is free entry into the market-making industry, any profits made on order-preferencing arrangements with ATSs should be competed away, presumably by the usual practice of paying the ATSs for the access to their order flow. Competition between market-makers should therefore ensure that profits are passed over to the operators of ATSs. However, there is competition between ATSs for customer order flow. This competition will ensure that the payments received by market-makers are passed over to brokers and finally reduce the commissions paid by customers for trading stocks. If one follows this view, the gains from monopolisation of the market-making process are passed back to the customer and help to lower the fixed transaction costs of placing orders.

Two final remarks on this chain of reasoning are in order. First, it is questionable whether competition on all levels works smoothly and ensures that the extra fee paid by customers for market-making services will in the end flow back to them in the form of lower brokerage costs. Frictions and rigidities in the vertical chain may well leave part of the rents within the securities industry. Second and more important, the argument highlights the importance of understanding the multidimensional nature of transaction costs paid for securities trading services. The overall cost of trading includes brokerage fees, fees and commissions for settlement and related services and finally the spread paid to market-makers. While fees are an obvious and transparent cost of transacting, many investors have only a limited understanding of the amount of money they pay for market-making services in the form of the bid-ask spread. The shift of trading volume away from traditional exchanges towards ATSs may result in a general shift of transaction costs away from transparent items such as brokerage fees towards non-transparent items such as the spread. Future regulation should ensure that customers have access to all necessary information in order to make an informed decision between trading systems.

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Developments in retail payment systems

Harry Leinonen[1]

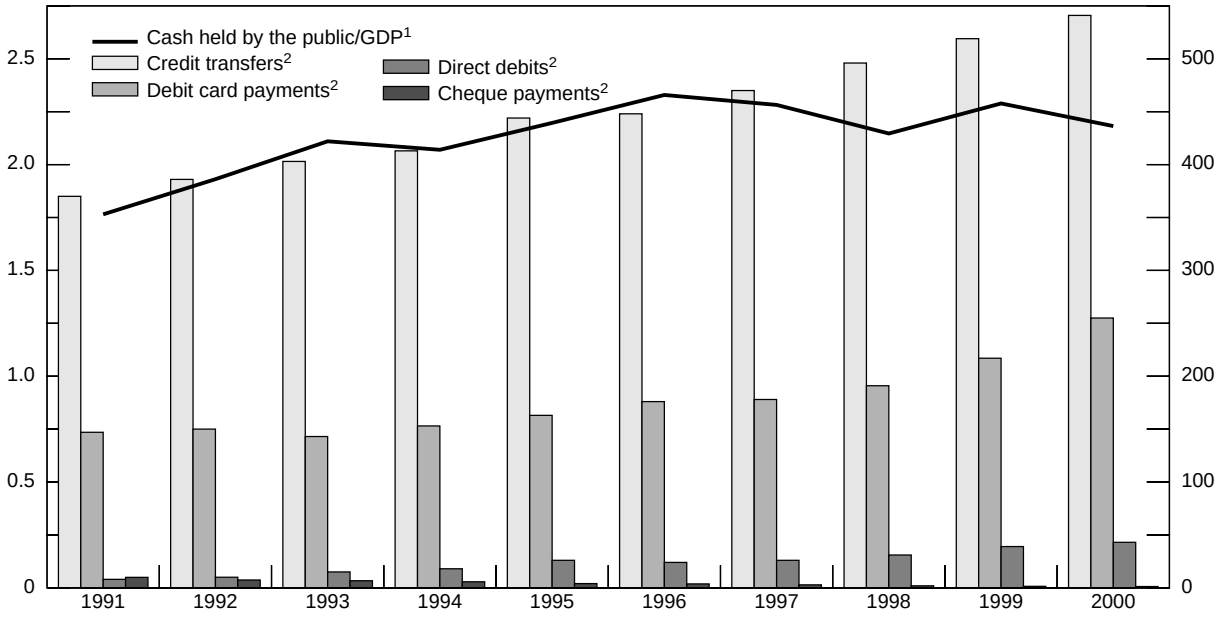
1. Introduction

Banks face three notable challenges in developing retail payment systems: integration of bank and customer systems, use of new technologies to improve the efficiency of payment systems, and international standardisation and integration of banking systems.

Retail payments - routine settlement of invoices and purchases by consumers and firms - are clearly the dominant type of transaction handled by payment systems in terms of numbers of transactions. On the other hand, wholesale payments, ie money market, securities system and interbank settlements, are considerably more important in terms of aggregate value.

Graph 1

Retail payments in Finland



[1] Left-hand scale, in percentages. [2] Right-hand scale, in millions of payments.

Source: Finnish Bankers' Association.

In recent decades, retail payments in Finland have shifted from cash towards giro transfers and debit cards (Graph 1). The use of cheques has essentially vanished. This trend is driven by the practicality and cost-effectiveness of new payment instruments. Functions once performed manually and based largely on paper are now completely automated. For customers, the switch makes things easier and affords a small reduction in forgone interest earnings, as compared to the use of physical cash. Finnish banks usually charge lower fees for executing payments based on self-service than for those requiring staff assistance.

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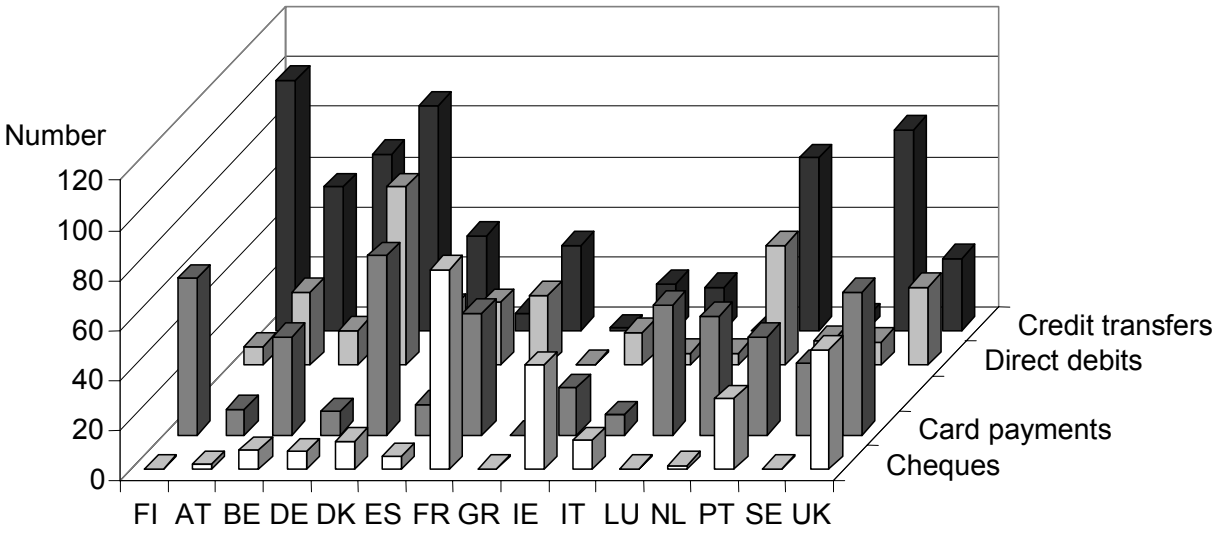
2. International situation

Finland is a pioneer in advanced payment systems (Graph 2), and today electronic banking services are widely used. In other countries, national systems have developed with different emphases and at different speeds. Thus, while all countries rely on the same basic payment modes, their relative importance and technical sophistication may vary considerably. This inconsistency arises from differences in the organisational structures of banking sectors, the prevailing payment arrangements,

Graph 2a

Payment practices in EU countries

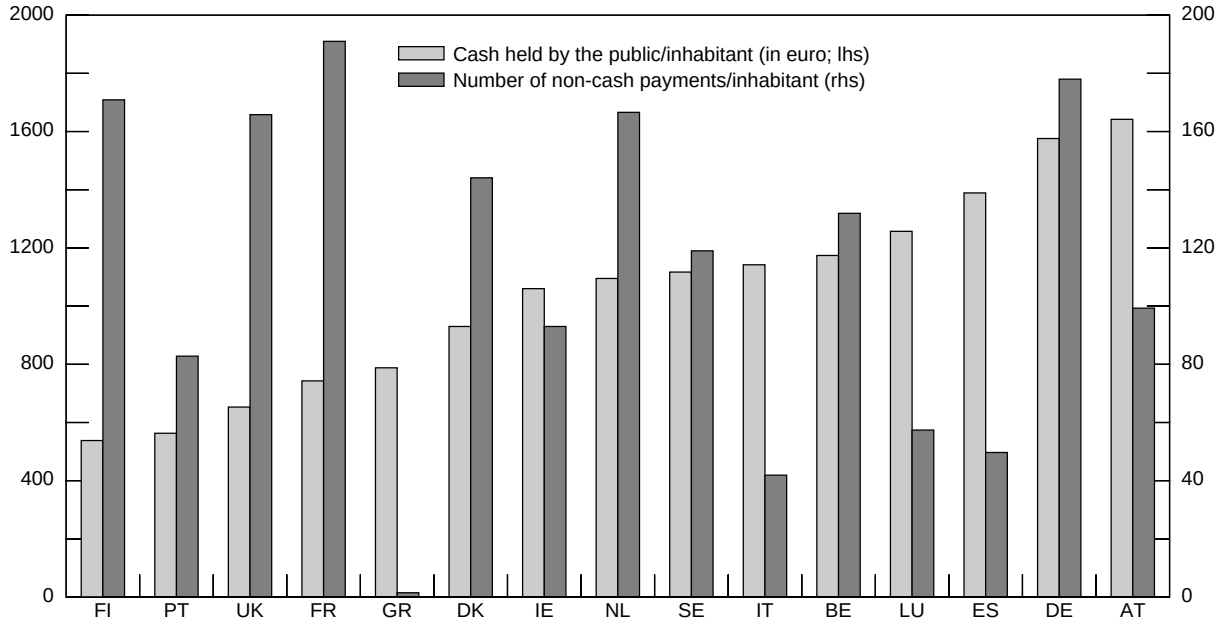
Number of payments per EU-area resident, 1999



Graph 2b

Cash balances and the number of non-cash payments in EU countries

Per inhabitant, 1999



Source: European Central Bank.

the willingness of customers to accept change, the prevalence of IT, regulatory issues and the technical infrastructure itself. Such national differences currently constitute the main obstacle to achieving efficiency in international payments. Indeed, clear international standards and practices have only been established for credit card payments.

3. Development trends and future challenges

Electronics-based solutions and integration with customer systems have recently been the dominant themes in the development of payment systems. There has also been a notable shift from physical storage media (eg hard copy records and magnetic tape) to entirely network-based transactions. Moreover, the significance of international payments has grown along with global integration. In Finland's case, stage three of EMU implies a high degree of international integration in the coming years. Increasing use of the internet is reinforcing this trend. The internet already takes little note of national borders, which may eventually lose their significance for electronic commerce. The role of the internet in electronic commerce, trading systems and associated payment transfers continues to steadily increase.

The main challenges ahead in the development of retail payment systems are:

- effective integration of customer systems with bank payment systems;
- exploitation of new technologies to improve the efficiency of bank payment systems;
- international standardisation and integration of banking systems.

Box 1. Will wireless devices revolutionise payment systems

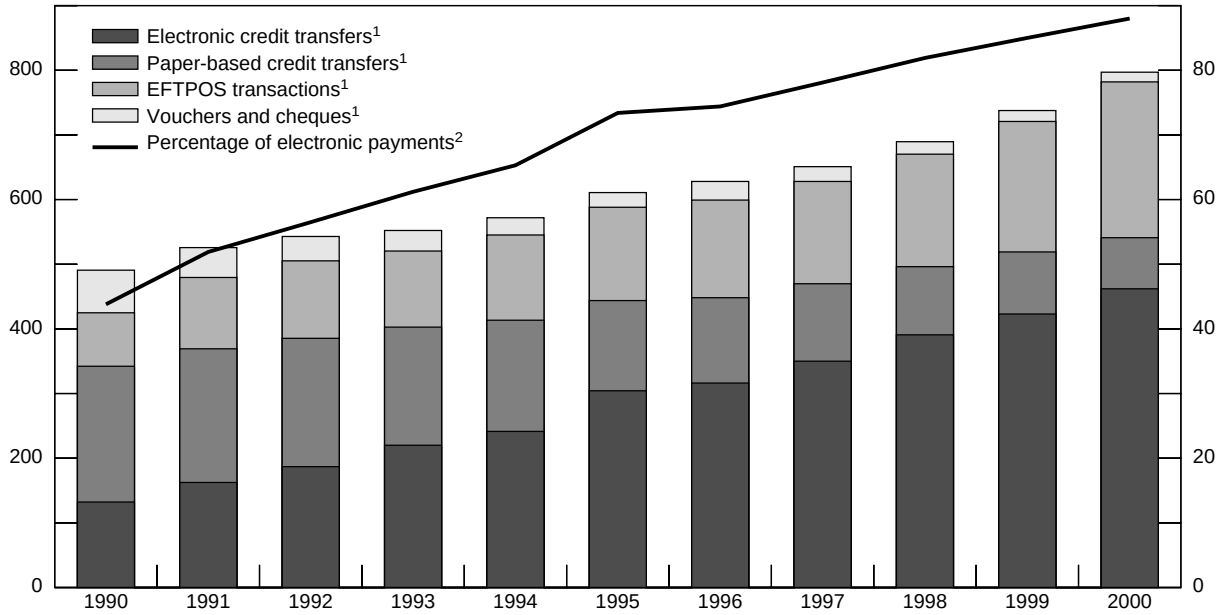
Will new payment systems arise with the convergence of technologies? Today we see the emergence of powerful chips with built-in secure identification, strong encryption and data handling possibilities, as well as industry initiatives such as Bluetooth, which seeks to allow fast radio-frequency communication over very short distances (eg room-to-room) among all sorts of electronic devices. Moreover, there is the ever greater presence of digital mobile devices that incorporate a user-activated chip, a keypad and a display, and operate in wireless networks with ever increasing capacity and speed. There is also wide agreement on international mobile standards. Indeed, the typical GSM handset includes features that already allow it to function as a debit card or as cash if the services are available. What could be easier and more secure than pulling out your phone and letting it communicate with the checkout computer to see a total or itemised bill? All you would do is push a button on your phone to approve the payment. With web-enabled phones, you can go online, find a hotel in another country and pay for the reservation all in a single transaction and for the cost of a local call. You could also use your phone to repay a small loan from a friend by selecting the payment function on the mobile phone and keying in your friend's bank account number and the amount, and pushing "pay". All this is technically feasible today. But is the threshold to wide acceptance too high? Are the benefits too minor to justify abandoning traditional payment methods?

4. Effective integration with customer systems

Finnish banks are among the world's leaders in integration with customer systems. All large, medium-sized and even most small corporate customers handle payments automatically with their bank over networks. An ever increasing number of private customers also handle their payments online via home PCs or even mobile phones. The automation level in Finland is probably the highest in the world (see Table 1 of the overview paper in this volume). 88% of banking transactions are handled in self-service mode, mainly via the internet (Graph 3).

Graph 3

Total bank-intermediated payments in Finland



[1] Left-hand scale, in millions of payments. [2] Right-hand scale.

Source: Finnish Bankers' Association.

The main technical factors in integration with customer systems are:

- uniform and clear data communication standards;
- universal messaging standards that enable direct transmission of messages from customer systems to banks in electronic form;
- universal messaging standards for payment receipts that can be transmitted directly into company accounting systems (eg in Finland the bank statement also serves as an accounting record);
- payment identification data, ie a reference code whereby invoice issuers/customers can reliably identify transfers in their own systems;
- standardised security systems that ensure protection of customer-to-bank and bank-to-bank transactions.

Finnish payment systems[2] already incorporate these features and, in conjunction with effective marketing campaigns and good support from customers, they have played a productive role in developing effective payment arrangements in Finland.

Internationally, however, the degree of integration with customer systems is much lower. Perhaps the greatest challenge to the banking industry is how to achieve an international standard that supports further integration with customer systems. Major benefits in payment systems can clearly be realised through effective, wide-ranging customer integration.

[2] Details and statistics on Finnish payment systems can be found at the Finnish Banking Association's website (www.pankkiyhdistys.fi).

5. Effects of technology

The application of technology to payment systems constantly generates new opportunities: multi-purpose smartcards, sophisticated encryption and identification systems, a growing selection of services available on wireless devices, and higher network speeds. Based on these new technological possibilities, we are seeing a range of experiments with new payment modes, eg e-cash and payment by e-mail and by mobile phone.

New technologies enable all parties to a transaction to be instantaneously and simultaneously available, regardless of the physical distances that separate them (from a few centimetres to thousands of kilometres). The key to all this is a secure network. Payments should be executed without delay, because in a real-time environment all delays generate costs.

Even though the requisite information for making a payment remains the same, inputting the data for the transaction continues to be simplified. But advanced payment systems must also ensure that the customer's money is available to her. This, in turn, requires that the security of the payment system be sufficient to ensure absolutely that the customer (and no one else) always has access to her own funds. The principle of account-to-account funds transfers does not change with new technologies, since monetary value is still transferred from the payer's to the receiver's account. This concerns all payment service products (eg giros, debit cards, direct debiting). In an electronic environment, all money is account-based and all computer accounting (from chip cards to mainframes) involves determining how many monetary units are in a particular account.

Internationally, customers seeking to pay for something online typically must turn to a major credit card issuer such as MasterCard or Visa. The increase in the use of the internet and online shopping challenges banks' position as significant providers of payment services.[3]

6. International standards for payment systems and convergence

Compared to the relatively sophisticated national-level systems, international giro transfers are still surprisingly inefficient, often involving manual operations and data conversion to different formats at several stages. There is still no internationally accepted account numbering system; transfers are usually routed on the basis of the recipient's name, address and bank branch. There is also no standardised international reference (standardised remittance) data; in fact, only a few countries even have domestic reference systems. There are no common standards - electronic or paper-based - for sending or receiving customers' international payment orders or invoices.

Several standards have been proposed, but none enjoy sufficiently wide support to gain broad international acceptance. The leader, perhaps, is the SWIFT network and SWIFT standards, which are generally used in international payment traffic between banks. These standards are relatively loose and still require several manual (or semi-manual) steps when a customer payment order is transmitted from sender to receiver. The interbank settlement method currently used for cross-border payments is quite intricate. Future systems will need to be more efficient and uniform. (See Leinonen (2000) for a more thorough review.)

The creation of standards has a great deal to do with technical development. Standards make interconnection of systems feasible, they allow software providers to develop off-the-shelf solutions, eg for accounting and payroll programmes with payment system interfaces, and they create synergies in the marketing efforts of different organisations and suppliers. The wider the acceptance of common standards, the more effectively customers and banks are served in international and domestic payment operations.

A good example of creating effective standards that take advantage of new technologies, such as embedded microprocessor chips and security solutions to support payment via the internet, is the joint international effort of credit card companies and bank debit card issuers.

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[3] For further information on developments in payment systems and payment via internet and mobile phone, see the websites of Finnish banks, Avant, SWIFT, MasterCard, Visa, Nokia and Sonera.

The objective should be to develop standards at bank-to-customer and bank-to-bank levels so that these interface seamlessly with each other.

Box 2. Key elements of international standardisation

An ***international account number*** is needed for efficient routing of payments. For example, IBAN (International Bank Account Number) is a standard currently being implemented within Europe. It is based on an international prefix and the domestic bank account number. When the user inputs the IBAN, a bank directory can automatically provide other basic bank-related information. This represents a major advance over the current international situation: where routing is weak and remains comparable to earlier clerk-assisted transfers by phone, where calls were routed based on the name and address of the receiver.

An ***international reference number*** is needed for automatic identification of payments in customer systems. This is the most important piece of information for integration with customers.

The basic payment messages (for sending and receiving payments) between customers and banks and standardisation of the information they contain create a basis for a uniform network-based customer interface and thus increase the opportunities for the customer to input most of the transaction himself. New standards need to be based on the latest internet technology and to combine the presentation of information in a visual format with data fields. Payment standards based on Extensible Markup Language (XML) include the Open Financial Exchange (OFX) solution promoted by US developers and the Electronic Payment Initiator (ePI) standard under development by the ESCB's European Committee for Banking Standards.

Bank-to-bank messaging (SWIFT MT103+) in international payment transfers is currently being implemented. These payment messages are more precisely defined than hitherto and support automated processing.

7. An efficient approach to developing infrastructure

Payment transfers require a common infrastructure that combines systems, structures and service providers to create an overall functional payment system. When developing a new infrastructure, it is difficult to evaluate which new approach is the most promising or how difficult it will ultimately be to implement it. Furthermore, every solution and standard comes with proponents arguing that their own idea is superior.

Promoters of new payment systems also face scale effects and the classic "chicken and egg" conundrum. Obviously, the more widely used the payment mode, the more advantageous it is. In the initial phase, however, it is difficult to get a novel payment technology to market precisely because it is not used anywhere, and this in turn makes it hard to sell to potential users. Moreover, because nobody uses it yet, potential payment receivers remain reluctant to invest in the system.

There is a natural resistance to change. First, there are the transition costs of changing while maintaining redundant, overlapping systems. Moreover, when banks introduce more efficient systems, there are investment costs at the same time that fee income from customers is normally shrinking. Finally, those who benefit most from the old system's existence can be counted on to defend their positions.

The challenge then is to create a development process efficient enough to implement an infrastructure that takes into consideration the constraints imposed by the need to foster cooperation among individual banks and customers, to give suppliers competitive opportunities and to meet the reliability demands set for the system. As a rule, systems should be both open and standardised. The pricing of every step in the processing of a payment should be transparent. A decision process is also needed to guide the implementation of the new infrastructure, so that it promotes full use of the new technology and ensures adequate commitment among all parties. In addition, there are the technical requirements: a functional network, a transaction routing mechanism, security systems and an interbank settlement method for concrete transmission/transfer of payment transactions. As internet technology changes many aspects of payment transmission, top priority should be given to improving the development process itself to ensure effective development over the long run.

Box 3. Core elements of infrastructure development

A ***decision-making body*** that resolves which standards will be used, as well as processing rules and infrastructure components. This organisation would also work to ensure commitment from all parties and coordinate implementation of new features and solutions. This may also be a group of decision-making bodies handling tasks appropriate to their designated areas.

A ***payment system network*** through which payments are transferred directly between banks on the basis of a common international account numbering system. The payment system network should be open to all parties authorised to engage in payment transfers. Such a system could be established by extending SWIFT's new SWIFTNet interactive communication services.

One promising solution that allows ***identification*** of parties, ensures the authenticity of payment orders and protects users from system abuse and fraud is the open public key infrastructure for secure business-to-business internet transactions. Such secure systems require, however, a transaction authorisation unit/centre that grants authorisations and administers the system.

An ***interbank settlement system*** that transfers funds (settlements) to cover payments between banks in a real-time network environment. Central banks are likely to play a major role in developing real-time settlement systems.

8. The role of the central bank and other authorities in developing systems and services

If for any reason (eg a lack of competition or cooperation) failures occur in the development of payment systems, society pays the price. The pressure on officials to promote effective development is greater, the further that existing systems lag behind desirable and feasible developments.

Officials have a duty to oversee the state of payment systems, and to support and study the possibilities of new alternatives. They need to publish their findings, make recommendations and set development targets for the market. On the other hand, there need to be substantial deficiencies in the market mechanism before authorities will undertake to issue guidelines and regulations or draft legislation. Further, they need strong justification before they intervene in an effort to improve the situation.

Central banks have played a major role in offering payment services, in providing the processes that support the use of physical cash, and in establishing interbank settlement systems. All these functions need to be developed in accordance with evolving market needs. Authorities can also act as venture capitalists in promoting new infrastructure when other market participants lack the wherewithal or interest to make the initial investment. The creation of a common payments infrastructure that supports the European Union's single market and electronic commerce requires cooperation from all sides - and possibly a more active role on the part of authorities - to launch the next stage of development.

9. Alternative paths of development

Development seems likely to happen in waves as pressures for change reach a certain level and overcome the forces holding to the status quo. In such situations, we can expect significant and rapid shifts that may result in substantial changes in the division of labour in respect of payment systems. Traditional service providers unwilling to avail themselves of the possibilities of technology will have difficulties in maintaining their positions against aggressive newcomers. For example, digital watches and calculators caused a major change in market shares in the 1970s. If banks wish to continue to act as parties to payment transfers, they must be ready to exploit new technological opportunities. Central banks will also need to develop and more effectively implement new technologies in their services.

Over the next few years the following three scenarios seem most likely:

- the banking sector reaches a common understanding on developing payment systems and creates a new payment systems infrastructure based on banking services and new technology;
- bank cooperation fails to produce a new infrastructure and competitors create a new payment system infrastructure that wins official approval;
- development driven by market forces is too slow and social pressures force officials, particularly central banks, to create a new and more effective payment systems infrastructure, partly by using their regulatory power.

Development is rarely so straightforward. It seems reasonable to expect a combination of these three scenarios with shifting focus and pace.

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Regulation of the payments market and the prospect for digital money

Peter Spencer

1. Introduction

The growth of the internet and e-commerce raises some interesting questions for those interested in the monetary system. Why have digital cash systems failed to penetrate the payments market while electronic trading of securities has been a success? Why is the rate of technological innovation and adoption so much faster in the markets for telephony and digital television? Does this have something to do with the way that these markets are organised and regulated?

This paper reviews the problems that have held back the adoption of digital money and the ways in which these are now being tackled by commercial organisations. It considers ways in which the regulatory framework could encourage or impede the development of e-money.

2. The modern payment system

Digital money has made little headway in the payments market. At the moment, almost all internet transactions are settled using credit and debit cards. These are widely held, convenient and accepted by most retailers.[1] Yet, plastic cards are by no means ideal for a digital world. They were originally designed for making face-to-face transactions in the real world. Despite recent attempts to tighten security, including the introduction of microchip-based cards, they remain prone to fraud and moral hazard. These systems involve a lot of paperwork and are costly to operate. They are expensive for merchants and cannot be used efficiently for making small transactions or for person-to-person transfers.

Electronic media have clear advantages over card systems in all of these respects. Security is easier to maintain online through encryption and dedicated servers than offline, where operatives handle security information in readable form. Because they eliminate paper billing and other costs, all-electronic media are much cheaper than hybrid paper-electronic systems. The processing costs of digital cheques are about a third those of paper cheques, for example. Like paper cash and cheques, their digital equivalents can also be used in person-to-person transactions.

2.1 Money as a network good

However, like all new payment systems, electronic money has an initial hurdle to jump. That is because money is a prime example of a "network good". These goods are monetary, language and other communications devices that depend for their effectiveness upon the number of other people using them. As the textbooks say, money has to be "generally acceptable in settlement of transactions".

Because network goods enjoy a positive consumption externality, they are likely to be underprovided by the market. In this sense network goods are akin to public goods such as broadcasting, where consumption by one person does not reduce the amount of the good available for others. Indeed, network goods are "super-public goods" because consumption by one person increases the usefulness of the good to others. The argument for public subsidy (and ultimately provision) holds a fortiori.

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[1] Moreover, in the United Kingdom, credit card purchases of over £100 are covered by the Consumer Credit Act, so the purchaser need not worry about security and delivery.

This consumption externality leads to a catch 22 problem: people are reluctant to buy network goods until their associates have them. This means that promoters must invest huge sums of money in subsidising appliances and other costs of joining the network before they reach commercial viability. This was the case, for example, with BankameriCard, the first credit card. Bank of America sent out millions of unsolicited cards in an attempt to reach critical mass, knowing that they would be hit by huge fraud and other costs as a consequence. Similarly, in the United Kingdom, it took Barclaycard a decade to turn in its first profit.

However, once the system is established, the promoter is likely to enjoy a first mover advantage or incumbency effect. This is most likely if it is expensive or inconvenient to switch provider. The most notorious example in the technology industries is Microsoft, which has a dominant position in PC software, which it is alleged it is using to dominate associated markets.

Ginguly and Milne (2001) note that the clearing house at the centre of any payment system is usually organised as a mutual organisation by its member banks. This clearly raises competition concerns. Indeed, Cruikshank (2000), a former telecoms regulator, has argued that a payment system is a natural monopoly like a public utility. It is hard for newcomers to enter the market, because it involves a great deal of duplication. It is also difficult to get customers to switch providers.

The credit card market is arguably more contestable than the payments market. However, having made a large investment in plastic, the credit card companies and the banks have been reluctant to develop a rival payment system. Indeed, Visa and MasterCard are now in court to answer the US Justice Department's allegation that they suppressed competition by abandoning plans for new technologies such as smartcards and internet payment systems.

2.2 Money as a convenience good

Money is also a *convenience good*: wanted not for its own sake but as a way to access other goods and services. This has several implications. First, it means that money acts like a joint good with the item being purchased. This immediately tells us that the price elasticity of demand is low. If the cost of transactions goes up, we can try to switch provider, but this may not be possible (monopoly) or practicable (switching costs). We are certainly not going to change our demand for goods and services, banks or the level of transactions that we make. This is where payment services differ from network goods such as telecommunications and share dealing services where the demand for services is price-elastic.

This point is particularly pertinent when set alongside the monopolistic features identified in the previous section. A natural monopoly with a low elasticity of demand clearly raises important public policy issues.

Second, because it is a convenience good, money should be multifunctional. However, the first-generation digital systems were unifunctional. For example, the first Mondex devices were designed for settling small transactions in the real world and Digicash's Ecash product for internet use. The proliferation of different e-money systems and standards was also a handicap, as was the cumbersome and expensive hardware. These systems met stiff resistance from consumers who were happy with their credit cards, knowing that the provider would guarantee the transaction and pay the cost of misuse, at least in the United Kingdom.

2.3 Conventional payment media

Network and convenience features are very apparent in modern payment systems. Table 1 summarises the attributes of the four main conventional monetary media. The main distinction here is between cash or currency, which does not involve a financial intermediary, and the other types, which do. A token system involves the exchange of anonymous tokens or coupons, while the other models are notational or accounting systems, involving a notional transfer of funds from one account to another. Bank accounts and credit card systems are good examples.

Table 1

Conventional payment media

	Cash	Bank cheque	Credit card	Debit card
Transaction medium				
Intermediation cost?	No	Yes	Yes	Yes
Micro-suitable?	Yes	No	No	No
Settled instantly?	Yes	No	No	Yes
Payer anonymous?	Yes	No	No	No
Verifiable?	Only with receipt	Yes	No	Yes
Peer-to-peer?	Yes	Yes	No	No
Offline?	Yes	Yes	Possibly	No
Positive inventory?	Yes	Yes	No	Yes
Risk factors	Loss; theft; postal interception; forgery	Fraud; bankruptcy; counterpart credit failure	Fraud; stolen cards; counterfeiting; data intercept	Fraud; stolen cards; data intercept; bankruptcy
Defensive solutions	Policing; frequent format change	Caveat emptor; bank regulation	Swift detection and card cancellation	Swift detection and card cancellation

In addition to the transaction media shown in Table 1, there are vendor-specific devices such as storecards, air-miles and gift coupon schemes. However, these are not general currency because their use is restricted to specific stores or products. Incentive stamps and casino chips are other good examples of restricted payment devices. All of these payment media, restricted and unrestricted, have parallels in the electronic marketplace.

2.4 Electronic payment media

The new electronic community is trying to replace paper and plastic with electrons, just as medieval bankers replaced gold with paper and modern bankers substituted plastic for paper. Monetary history is essentially a story about saving the costs of making transactions. Moving to paper saved the costs of holding gold, but left the issuer with the problem of replacing worn banknotes. Notational systems economised on these costs, but left the intermediary with expensive ledger and billing costs. Now, all-electronic systems offer the chance to remove these costs altogether. Table 2 reviews these electronic payment systems and their main features, using some commercial examples.

Electronic payment systems are not new. Electronic Funds Transfer for settling large banking and commercial transactions has been in use since the middle of the last century, based like large-scale commercial procurement operations on the telegraph/telex; Standage (1998). Online credit and debit card systems are also electronic. However, these transactions are conducted through closed commercial networks, the main obstacle to wire fraud. Their security is enhanced through encryption - the Enigma cipher machine was based on this technology. In contrast, the internet is an open system, making security much more of a problem.

The challenge is to develop open systems that are secure, convenient and cost-effective over a range of micro- to macro-transactions. Anonymity would also be a commercial advantage for many types of internet transactions. How do these new systems score on these criteria?

Table 2

Conventional payment media

	Prepayment card	Smartcard	Pseudo-cash	Digital cheque
Example	Library copier card	Mondex	Digicash's Ecash	PayPal
Transaction medium				
Intermediation cost?	No	No	Yes	Yes
Micro-suitable?	Yes	Yes	Yes	No
Settled instantly?	Yes	Yes	Yes	No
Payer anonymous?	Yes	Partially	Optionally	No
Verifiable?	No	No	Optionally	Yes
Peer-to-peer?	No	Yes	Yes	No
Offline?	Yes	Yes	No	No
Positive inventory?	Yes	Yes	Yes	No
Risk factors	Minimal (low inherent value)	Forgery	Fraud; double spending	Fraud
Defensive solutions		Security hardware; updates; policing	Security software; format updates	Security software; format updates

2.5 The smartcard

As Table 2 indicates, the big advantage a smartcard has over a prepayment card is that it is a decentralised multipurpose system, which could eventually be used in peer-to-peer transactions, just like cash. It is decentralised in the sense that a commercial organisation provides the hardware and then stands back from the interchange. This means that there is no costly paperwork. Originally used for making face-to-face transactions, it is being adapted for use on the internet.

In this case, the provider's first defence against misuse is provided by the chip built into the card. However, although little is known about commercial applications, it seems that some policing of transactions must be undertaken to provide advance warning of large-scale fraud. The 1997 Vodaphone scam showed how quickly losses can mount if there is a flaw in the system, and how important it is to obtain an early warning of this. It may prove impossible to maintain the integrity of the system without allowing anonymity to be unravelled to trace fraudulent activity.

Smartcards have a potentially important role to play in reducing the risk of social exclusion from the electronic payments system. Like gas and electricity meters and, more recently, prepaid mobile phones, they allow those who cannot obtain credit access to network systems. They also offer an efficient way of organising social security payments. Smartcard technology is currently being adopted by many social security systems, notably in the United States.

2.6 Pseudo-cash

In the real world, token money is based either upon items like precious metals and stones that have intrinsic or alternative use value, or on objects such as notes and coin that are essentially valueless but generally accepted as media of exchange. To retain its value, the first kind of token must be scarce and the second hard for counterfeiters to reproduce.

Digital products, such as software, are generally useful and valuable, but can be reproduced by the provider at zero marginal cost. This characteristic immediately rules out a token money of the first kind. It also makes it difficult to devise digital tokens that cannot be reproduced by forgery. In view of these

obstacles it is not surprising that no one has yet been able to devise a true token money for the internet, something that circulates without trace. Digital currencies are actually "pseudo-cash", because they involve an intermediary and are not in continuous and decentralised peer-to-peer circulation like real-world notes and coin.[2] They look like decentralised token money and can be used for person-to-person transactions. However, these transactions are in fact intermediated by the service provider. To make the system secure against "double spending", each digital coin is returned to the provider by the seller and cancelled after being used once. The coin is then reissued with a different serial number to the seller. These systems are notational and not token money media.

2.7 Digital cheques

Although these facilities have been available for some time, they are as yet little used. This is surely because of the network effect - to catch on, they need more people to accept them. However, PayPal have turned this effect to their advantage. Their members make peer-to-peer transactions by sending digital cheques that the recipient can either cash or use to set up an account with PayPal. This system now has half a million members, but is largely confined to California.

Digital cheques have all of the advantages and disadvantages of paper cheques but, being electronic, have only a third of the processing cost. They can be used for peer-to-peer transactions. They are also subject to counterparty risk. This is a major drawback at the moment given the difficulties of assessing creditworthiness and identity in the electronic marketplace. However, digital certificates and signatures (see below) have the potential to resolve these security problems effectively. So does real-time settlement, which is technically feasible but not deployed in the market.

3. The prospects for digital money

Futurology is fraught with problems, and speculation in this area has proved very wide of the mark. Yet, it seems clear that in the near term, credit and debit cards will remain dominant for large domestic transactions. These are convenient for the consumer and carry a subsidy in the form of a zero interest period and, more recently, bonus points.

3.1 The ubiquitous credit card

Encryption is likely to buttress the position of the credit card by relieving the shopper's fears about internet confidentiality. It should also make it harder for criminals to intercept card details across the internet, although, as APACS (1999) note, there is as yet negligible evidence of this type of crime. This hazard is actually a more serious problem in the case of telephone sales and mail order. That means that the cost of fraud is likely to remain high in the case of multipurpose (as against internet-only) credit cards. A security system, like any system, is only as strong as its weakest link.

However, as the internet spreads, the drawbacks of the credit and debit card networks will become increasingly apparent to its users. At the same time, technological developments will enhance the security and reduce the cost of dedicated digital media. As this happens, uptake and acceptance should increase, overcoming the network handicap and turning it into an advantage.

This may be a gradual process, as rival technologies compete for supremacy. It could still be a long time before a winner begins to emerge and gains critical mass. This was the case with VCR and DVD systems. This would be an expensive investment process for the promoter. However, the internet is spreading much faster than earlier technologies. Moreover, there are developments that could get the ball rolling much more quickly in this case. The most obvious is the growth of small-scale repeat business over the web: providing digital products such as music and entertainment hire, gambling and

[2] The prime example is provided by Digicash's Ecash system. This is available through Mark Twain Bank of St Louis in the United States. Users of this system hold a dollar or euro account with the bank, which can be used to buy digital "coins" that are downloaded onto the user's hard disk. This is just like getting cash from an ATM. These digital coins can then be "spent" on the internet, offering the user a multipurpose facility with the option of anonymity or traceability.

game-plays. The AOL/Time-Warner and Seagram/Vivendi mergers underline the commercial potential for such “content” provision over the internet.

3.2 Technological convergence

The convergence of internet, television and telephone systems means that there is a huge digital market to be exploited. Organisations that realise this too late are in for a shock, as the music industry found with Napster and MP3. These industries will require a suitable medium for flexible, small-scale payments. If the plastic card incumbents fail to provide a more effective system for such electronic micro-transactions, this will force the development of digital devices. Indeed, the content providers may promote their own payment mechanisms. Mobile phone and satellite broadcasting companies already have a lot of expertise in electronic accounting and billing systems, and these can easily be expanded using current technology. For example, in Finland you can already use vending machines with your Nokia phone, paying at the end of the month through your mobile account.

The irony is that the credit card companies have recognised the potential of this market and the threat of competition from mobile phone companies just as the US Department of Justice has brought a case against Visa and MasterCard for failing to innovate. Visa and Nokia are now field-testing a device that allows customers to pay for goods on the internet using information stored on a chip in their mobile phones. Electronic cash can be stored on a second chip. MasterCard is collaborating with the innovative Finnish telecoms group Sonera on similar mobile systems.

3.3 E-purse and other debit systems

These developments show that e-purse systems (such as the Belgian Proton) that require a smartchip may be able to reside on a person’s credit or identity card, effectively piggy-backing off current systems. This would reduce cost and increase convenience. They would be useful for offline use as well as micro-transactions.

The explosive adoption of pre-pay mobile phones suggests another way in which debit-based systems might achieve take-off. Inter alia, these have proved very attractive to those who do not have access to the credit system. This reduces the danger of social exclusion and allows a large expansion of the network, reinforcing the membership externality. Debit-based systems may also be attractive because they carry limited liability - the maximum loss is restricted to the amount programmed into the card.

Another characteristic of e-purse and other bearer e-money systems that could help in their promotion is that it is much easier to pay interest on these balances than on conventional bearer money units such as notes and coin. This is true of any notational money system. E-banks are increasingly relying on the payment of interest as a marketing tool in the deposit market.

These second generation systems are generally multifunctional, combining systems that can be used in both the real and electronic worlds. The hardware is highly portable, designed for use in m-commerce. Its price is falling rapidly, to the point at which the credit card providers are offering free smartcard readers to their customers, ideal for use on the internet.

3.4 Digital cheques

Another impetus could come from the use of digital cheques to undertake the peer-to-peer transactions which plastic money systems do not accommodate. This is where the adoption of new encryption systems is critical. These new systems incorporate digital certificates and signatures that tackle the electronic identity problem. Digital certificates are designed to authenticate websites, so that users know that they are genuine and can submit credit card or other personal details without fear of compromise. Digital signatures are the electronic equivalent of the handwritten signature and unique to the holder. They verify identity and address and can be used to validate digital cheques and other payment instructions. Importantly, the recipient of a digitally signed instruction can ascertain whether it has been tampered with during transmission. Cheap fingerprint or handprint readers could provide another form of internet identification.

As with any payment system, the legal status of digital transactions will be important. In this respect the Electronic Communications Bill being drawn up by the UK government and the new E-Directives being considered by the European Union will strongly influence the development of e-commerce. However,

they may not be critical for e-money. As the widespread use of bank cheques in the English-speaking countries has demonstrated, what really matters is acceptance by the general public and not legal tender legislation.

3.5 Anonymity and the demand for digital currency

Whether digital notes and coin will be successfully developed remains doubtful. Even if they are, I think these networks will be notational systems. That is because the ease of replication makes it technically difficult to devise a token e-money. The lack of anonymity would greatly reduce the appeal of such media to criminal and black market operators. However, this may not prevent take-up by other operators.

Goodhart and Krueger (2001) argue that the informal economy will maintain demand for physical cash. However, this would not necessarily prevent the adoption of digital currency by the formal economy. Arguably, notes and coin remain in use in the legitimate economy only because notational transactions are costly to process. The cost of EFT is already much lower than the cost of paper transactions. This will make notational systems progressively more efficient for small legitimate transactions, especially if the problem of fraud is resolved. Transactions must be traceable if this remains a problem. However, pseudo-anonymity is surely sufficient for most users and it is possible to achieve this in a notational system.

Many commentators have argued that the introduction of digital money would reduce the velocity of circulation and pose problems for the monetary authorities. This might make conventional monetary aggregates a much less useful lead indicator, for example. However, on this point I agree with Goodhart and Krueger in thinking that there would still be an important role for the central bank.

Indeed, if digital money were to be adopted by the formal economy, leaving notes and coin circulating in the informal economy, this could actually make monetary indicators more useful. The cash-in-advance effect would make credit balances associated with pre-pay devices such as cards and phones a useful lead indicator for the formal economy. The correlation with GDP as currently measured should improve. At the same time, physical cash could be used to monitor the development of the underworld economy. At the moment, the issue of large-denomination notes provides an indication, but such holdings may be legitimate, reflecting hoarding and international currency substitution effects.

4. How will the regulatory framework affect the development of digital money?

The successful development of a new digital payment system would raise many other questions for monetary and fiscal policymakers. These issues have been explored by Bernkopf (1996), Dowd (1990), Wallace (1983) and many others. However, such debate begs the question of whether such a development is likely. Instead of debating these issues, the remaining sections of this paper discuss ways in which the supervisory framework could encourage or impede the development of e-money.

Markets should only be regulated when they fail. This can happen if there are agents with market power or externalities; or if there is asymmetric information. Market power is a problem in this context because payment systems are like natural monopolies: duplication is inefficient. The banks that operate these systems are vertically integrated, enjoying economies of scale and scope in a wide range of money, credit and other banking markets. The network externality means that we also have to consider the second type of imperfection. Asymmetric information would seem to be less important in the transactions market than in other financial markets.

4.1 Market contestability and customer switching costs

Competition issues have arisen in this area recently, largely as a result of bank mergers. Naturally these competition inquiries have focused upon the shares of different banking markets that the merging banks would enjoy. They have also considered the contestability of these markets - the ease with which outside organisations can move into or out of them without incurring irreversible entry or exit costs. On the consumer side, the main question concerns switching costs - the ease with which depositors can switch between banks. Finally, some inquiries, notably the United Kingdom's

Cruikshank Committee (Cruikshank, 2000), have looked at the operation of the payment system and the clearing house.

Entry, exit and switching costs are naturally very high in the case of a payment system. This means that an external regulator is arguably necessary to simulate a competitive environment. In the absence of such oversight, these systems exhibit classic signs of oligopolistic inefficiency: low rates of innovation and inefficient pricing structures.

As Ginguly and Milne (2001) note, retail payment systems are characterised by a slow adoption of new technology. This paper offers several reasons for this, including the scale of investments in computer systems and the expense of retraining staff. This is the essential basis of the case that the US Department of Justice is bringing against Visa and MasterCard.

It is remarkable that although similar considerations should apply in the case of mobile telephony, they have not held back investment and innovation in that area. The introduction of the new second- and third-generation systems must surely devalue the investment made in the existing systems, even if the rapid expansion of the industry means that some additional capacity is needed. However, incumbents and new entrants alike rushed to bid for the new UMTS licences. These companies clearly believed that the fashionable nature of new mobile devices would ensure a successful take-up.

Entry, exit and switching costs are also significant in the mobile telephone industry, frustrating contestability. Nevertheless, the spectacular success of new entrants against the incumbents at the first-generation stage suggests that an open market can spur technical adoption, even if such costs are significant. This suggests that, in the case of digital payment systems, it will be important for the regulator to ensure open entry to companies with digital security and settlement experience migrating from technology, communication and entertainment (TCE) industries. This should spur innovation and combat the inertial tendencies seen to characterise this sector.

4.2 The regulation of pricing structures for conventional payment media

The second point concerns oligopolistic pricing structures. These usually incorporate cross-subsidies, which often have the effect of stifling competition in processes that would otherwise be contestable (such as the production of telephone and other appliances).

This is another telltale sign of abuse of market power. That is because, in a fully contestable equilibrium without consumer switching costs, we would expect benchmark cost structure to be reflected in the charging structure. If costs and charges are not aligned, new entrants are able to pick off the clientele that finds the benchmark structure more attractive. This leaves the incumbents exposed to adverse selection, unravelling the cross-subsidy. This is the argument used, for example, by Rothschild and Stiglitz (1970) to analyse contestability in an insurance market equilibrium with asymmetric information.

Payment systems differ from TCE industries because they involve three parties (merchant, customer and intermediary), not just two (broadcaster and viewer). The credit and debit card systems were initially promoted by subsidising the provision of merchant equipment and charging merchants a turnover fee. At the same time, consumer interest payments were subsidised. However, this structure became fossilised. It is remarkable that the low cost of online debit transfer is not passed on to the merchant via a reduced fee, as we would expect it to be in a contestable system. Indeed, it is now passed to the customer through loyalty points. Having become used to this system, the merchants are arguing that the providers should pay for the cost of the new equipment needed for processing the new chipcards.

Bank account charges have also adhered to a pattern that is out of line with the cost structure. In equilibrium, we would expect to see banks offering a market rate of interest on their deposits and levying account fees related to the cost of transactions. However, in practice we tend to observe zero interest transaction accounts, with low or negligible transaction charges.[3]

[3] The interest bearing current (ie transaction) account was invented in Scotland during the free banking regime of the 19th century but only began to make inroads into the UK market when interest payments and bank charges were deregulated in 1971. Uptake was encouraged by high interest rates during the 1970s and 1980s. However, even in the United Kingdom current accounts normally offer a zero or negligible interest rate, while transaction charges are waived.

In the absence of entry, exit and switching costs, such a market would be penetrated by new entrants offering high interest low-transaction accounts, aligning charges with costs. These would be attractive to cash-rich customers with relatively low transaction needs. However, in practice entry, exit or (more likely) consumer switching costs clearly frustrate this outcome. This is why Cruikshank and others have argued that regulators need to pay particular attention to switching costs. It has been suggested for example, that bank account numbers, like mobile telephone numbers, should be portable, the property of the user rather than the system operator.

These considerations largely concern the regulatory framework that is appropriate for long-run industry equilibrium. However, they are pertinent to the discussion of financial innovation, because there are reasons for thinking that a misalignment of cost and charging structures for existing media can hold back the uptake of new media.

That is because the consumer, on convenience or cost considerations, largely dictates the uptake of new technology products. This makes it hard to see how the transaction cost advantage of digital money can assert itself as long as consumers are artificially shielded from the much higher transaction costs associated with conventional monetary media.

The implication of this line of argument is that the regulator needs to pay careful attention to the pricing of existing transaction media. Credit card charges would seem to require particular scrutiny. New digital media have found it difficult to displace this product given its current pricing structure, which effectively forces the vendor to give interest-free credit, security and even loyalty points to the purchaser. I have already discussed this problem in the context of the US Department of Justice case. Another way to help the market to work would be to allow vendors to offer discriminatory prices that reflect this subsidy, but in most countries card providers and competition authorities rule against this.

4.3 The regulation of networks

I now turn to the second reason for market breakdown: consumption externalities. I have argued that network goods are “super-public goods” because my participation actually encourages yours (as with telephone networks). These goods are underprovided by the market. This could be used to make a case for public subsidy or provision, but this is rarely necessary. New technology goods usually become fashion items, helping the promoters to secure acceptance within an elite community and use this as the springboard to critical mass (mobile phones). This normally happens so quickly that the question of subsidy to overcome inertia and encourage take-up rarely becomes a public policy issue.

The regulatory issues normally emerge once the network is up and running. First, there is the question of technical standards. Many commentators have noted that these are a public good. Sometimes, an open system is developed (Linux software), requiring little regulation. Usually, a closed system wins out, requiring other producers to pay a patent or licence fee at least initially (VHS video). In the case of Microsoft’s Disk Operating System it is claimed that this virtual monopoly of the key software component of the personal computer allowed market power to be extended across a wide range of software applications, resulting in the US Department of Justice’s case against the company.

Collaborative ventures represent a halfway house (eg Symbian, the partnership developing the UMTS phone operating system). In this case, the primary role of the regulator is to prevent abuse of market power by incumbents and to ensure reasonable access to new entrants. Ginguly and Milne (2001) suggest that clearing house payment systems are essentially of this type. These are typically not-for-profit organisations run on behalf of their members. Credit card systems are similar. In many countries, these institutions are largely self-regulating. Oversight is provided by the central bank, mainly as a safeguard against systemic risk rather than abuse of market power.

4.4 The regulation of price structures for new electronic media

TCE and payments industries all face heavy up-front investment costs. Regular update costs also occur for security and technological reasons. In the case of a public good proper such as broadcasting and entertainment, the marginal cost of provision to new subscribers is negligible. In the case of super-

public goods such as phone systems, negative capacity externality effects are outweighed by the positive network externality. This is also a feature of electronic and other security dealing platforms.[4]

These industries combat the inertial effect by neutralising the consumer's participation cost. They do this by providing consumer equipment such as games consoles, digital television decoders and mobile phones well below cost. They then try to recoup these costs via subscriptions, rentals and high user costs.[5]

As I have argued, security considerations in electronic payments markets seem to favour a debit-based payment system, since this offers limited liability to the holder. It also extends the system to those who are not deemed to be creditworthy. This means putting up cash in advance, typically in a zero interest balance, with a high cost-of-carry opportunity cost. Allowing providers to offer interest on positive balances may help to overcome this problem.

This discussion leads me to suggest that, subject to basic considerations of solvency, newcomers should be allowed a degree of freedom in their pricing strategies. Attempts to constrain their marketing strategies by restricting cross-subsidisation or imposing interest rate ceilings could well frustrate development.[6]

5. Conclusion

As the scale and scope of the internet increases, the drawbacks of the credit and debit card networks will become increasingly apparent to their users. At the same time, technological developments should reduce the cost and enhance the security and convenience of dedicated digital media. If this happens, uptake and acceptance could increase, overcoming the network handicap and turning it into an advantage.

Like many financial systems, payment systems are largely self-regulating. Oversight is provided by the supervisory authorities in order to safeguard system stability. However, in recent years, many commentators (notably Cruikshank (2000) and Ginguly and Milne (2001)) have called for the regulation of payment systems by the competition authorities. I have argued that the payments market exhibits some very worrying features, resembling a natural monopoly with a low elasticity of demand. The lack of innovation is particularly worrying, a classic telltale sign of an uncompetitive system. I am surprised that this area has not attracted the attention of the competition authorities before.

The analysis of this paper suggests several ways in which the regulator could foster the development of digital money. There is a clear need to ensure open markets, minimise the effect of switching costs, and police the pricing structures of both new and old transaction media. There may be a trade-off here with financial stability but, in my view, this is a risk we have to take in order to encourage innovation.

Intelligent supervision of payments markets could do much to promote the development of digital money. However, in view of the obstacles presented by the industrial structure, this may not be enough. It may take a grand policy initiative to get a new payment system off the ground. Ultimately, money is a super-public good and, if the market fails to do this, the state may have to provide digital money in the same way as it does notes and coin

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[4] These are arguably different from payment and TCE systems because the initial investment costs are relatively small. Consumer resistance and security concerns have proved less of a problem than in the case of payment systems.

[5] Although theoretically this is a disequilibrium phenomenon, consumer resistance to membership costs means that it tends to prevail for a long time.

[6] The draft European Union Directive on electronic money proposes a high level of regulation. In particular, it suggests that interest payments on credit balances should be banned. Such a rule would clearly prevent promoters exploiting a key advantage of e-cash over physical cash.

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The financial progress of pure-play internet banks

Robert DeYoung[1]

1. Introduction

The internet has become a major distribution channel for US banks. Most internet banks use a "clicks and mortar" banking model, which deploys transactional websites in conjunction with traditional bricks and mortar branches. Only a handful of banks use a stand-alone, "internet-only" banking model in which websites are the sole delivery channel.

To date, most internet-only banks have struggled for profitability. These difficulties contrast with relatively recent predictions that they would come to dominate traditional branching banks. According to the standard internet-only business model, low overhead expenses and access to larger geographic markets should allow internet-only banks to offer better prices (higher deposit rates, lower loan rates) than branching banks, grow faster than branching banks, and still earn normal profits. However, in practice the number of physical branch locations is growing, not shrinking. US commercial bank branches increased by about 10,000 during the 1990s, even as the number of US commercial banks declined by about 4,000.

But this emerging conventional wisdom - that the internet-only banking model is not viable - may be premature. As internet-only banks age, they accumulate experience with this new business model which may allow them to run it more efficiently in the future. Moreover, as internet-only banks grow larger, they may generate scale economies in excess of those available to traditional banks that use less capital-intensive production and distribution technologies. If these effects are substantial, internet-only banks may be able to close the performance gap with traditional banks.

2. Literature on experience effects and scale effects

"Experience" can be an important determinant of cost and production efficiency. Experience is usually measured by accumulated production volume over time, starting from the initial unit produced. Holding production technology and firm size constant, as a firm accumulates experience using the technology, its unit costs will fall. Gemawat (1985) reviews this concept.

Experience effects have not been extensively measured in banking. But a handful of studies have measured the rates at which the financial performance of newly chartered, or de novo, banks improves over time. For example, DeYoung and Hasan (1998) found that the typical de novo bank takes about nine years to become as profitable as an established bank, and that over half of this improvement occurs during the first three years. Under certain conditions, time paths like these can be interpreted as implicit experience curves, because they use the passage of time to indirectly measure the accumulation of experience.

Most internet-only banks are de novo banks. Both Sullivan (2000) and Furst et al (2000) found that newly chartered internet banks earn lower profits than newly chartered non-internet banks. However, these studies based their results on data that contained mostly clicks and mortar internet banks. DeYoung (2001a) studied six internet-only banks chartered between 1997 and 1999, and found that the average one-year-old internet-only bank earned significantly lower profits than the average one-year-old traditional bank, primarily due to low business volumes and high non-interest expenses.

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There is a rich literature on commercial bank scale economies that has been surveyed a number of times elsewhere (eg Evanoff and Israilevich (1991), Berger et al (1993), Berger et al (1999)). Currently, there is a debate in this literature over whether the very largest banks enjoy increasing returns to scale. However, this debate is irrelevant for this study, because the newly chartered banks examined here are substantially smaller than the minimum efficient scale estimates in any contemporary study.

3. My current research and this paper

This paper summarises a number of results from my research in progress on internet-only bank performance (see DeYoung (2001a,b,c)). I propose that three separate experience processes may be operating at new internet-only banks.

The first of these processes is the maturity experience effect. As a new bank ages and its employees and managers accumulate general banking experience, the maturity effect transforms this experience into improved financial performance. This transformation could occur through improvements in numerous aspects of financial performance, such as cost control, risk management, marketing, or pricing policies. Note that this process is common to all newly chartered banks, regardless of their distribution strategy.

The second of these processes is the technology experience effect. This process is specific to banks that are using a new and non-standard technology, such as the internet-only business model. As these new banks age and their employees, managers and perhaps even their customers accumulate experience with the new technology, the technology effect transforms this experience into improved financial performance. Note that these technology-based experiences are in addition to the general banking experience that drives the maturity experience effect.

The third of these processes is the technology-specific scale effect. This process is also specific to banks that are using a new and non-standard technology. As these banks grow larger, the technology-specific scale effect transforms increased size into improved financial performance, primarily through reductions in unit costs. Note that these technology-based scale economies are in addition to any scale economies derived from the standard production technology used by traditional banks.

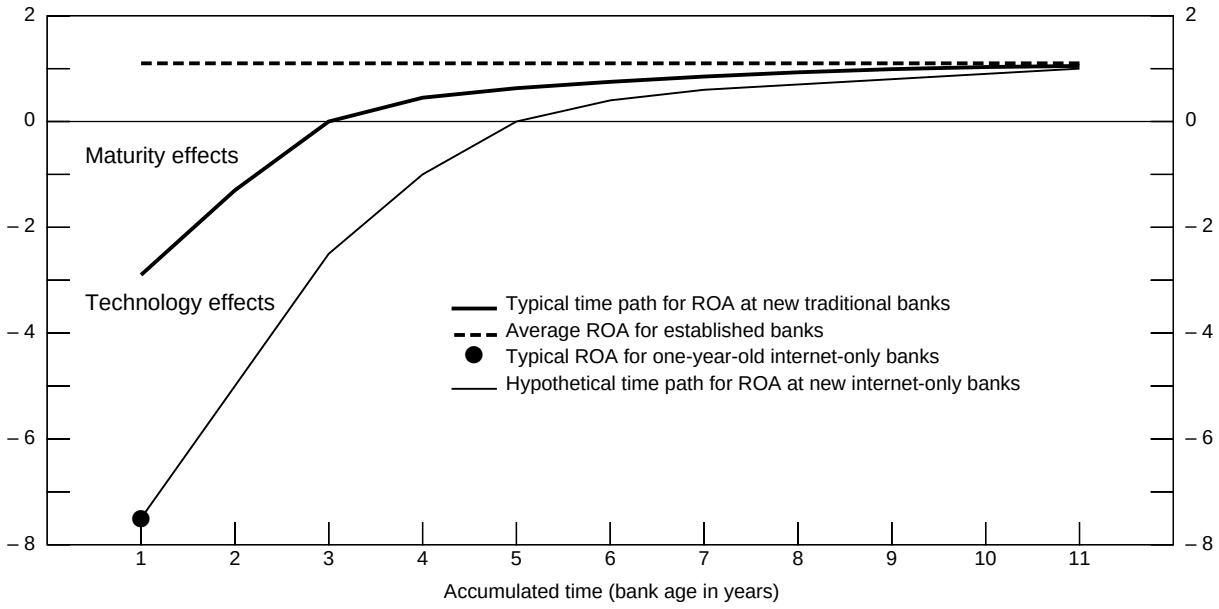
If only maturity-based effects exist, financial performance at new internet-only banks will improve at the same rate as traditional start-up banks over time, preserving the current performance gap. But if technology-based effects exist, financial performance at new internet-only banks could improve faster than at traditional start-up banks, narrowing or perhaps closing the performance gap.

These three propositions are illustrated in Figure 1, where accumulated time (bank age) on the horizontal axis indirectly measures accumulated experience. It shows the return on assets (ROA) for the typical de novo bank gradually approaching mature bank ROA levels over time. The diminishing gap between these two lines is driven by the maturity experience effect, as accumulated age and experience (in addition to increased scale) are transformed into improved financial performance. This general relationship is based on previously documented performance patterns of de novo commercial banks (DeYoung, (1999)).

The black dot at Age=1 illustrates that internet-only banks are typically much less profitable than traditional banks at this age. The line running through the black dot - just one of many possible hypothetical time paths for the ROA of internet-only banks - assumes that internet-only ROA will improve quickly over time. The diminishing gap between these two time paths is driven by the technology experience effect and the technology-specific scale effect, as accumulated age, experience and increased scale are transformed into improved financial performance. My current research tests whether this gap is actually closing over time as suggested in the figure.

Graph 1

Time paths for ROA at newly chartered banks



4. Sample selection and data

I compare the performance of two samples of banks: newly chartered internet-only institutions and newly chartered traditional institutions.

To be included in the internet-only sample, banks had to meet four conditions. First, these institutions could not operate any full-service branch locations, and their primary contact with their customers had to be over the internet. Second, the institution had to begin its operations using a new charter in 1997, 1998, 1999 or 2000. (This condition was relaxed in the case of two charter conversions where it was clear from the data that the enterprise was starting afresh with a new, internet-only strategy and spillover effects from the pre-existing bank were minimal). Third, the institution had to provide a full range of basic banking services, including taking insured deposits, offering chequing accounts and making loans. Fourth, the institution had to hold less than $100 million in assets at end of its first full quarter of operation.

This resulted in a sample of 10 internet-only banks: Bank of Internet USA, ClarityBank.com, Ebank, First Internet Bank of Indiana, G & L Bank, Lighthouse Bank, NetBank, Nexity Bank, Principal Bank and The Bancorp.com Bank. (Note that “trade name” internet banks were excluded from consideration. Trade name banks use the internet-only business model but do not hold separate bank charters and do not file separate financial statements like traditional banks. WingspanBank.com, which is owned and operated by Bank One, is a well known example).

The appropriate performance benchmark for new internet-only banks is the financial performance of other newly chartered banks, not the financial performance of established banks. The benchmark performance sample contains all newly chartered traditional (ie not internet-only) banks in urban geographic markets that met the second, third and fourth conditions listed above. Rural banks were excluded because they service agriculture-driven local economies, and as a result produce product mixes quite different from those of internet-only banks.

The combined data set is an unbalanced panel of 3,700 quarterly observations of 579 banks over a 15-quarter window from 1997 Q2 to 2000 Q4. Start-up quarters are excluded, because banks typically operate for less than 90 days during them. The data panel is unbalanced because newly chartered institutions started up at different times during the 15-quarter window, because a small number of the newly chartered traditional banks were acquired during the sample period, and because I observe the financial performance of the sample banks for the first nine full quarters of their lives. The last condition is imposed because only two of the internet-only banks were more than nine quarters old at the end of the sample period. As I am measuring performance time paths in this research, I must

make sure that the right-hand ends of any estimated time paths are not determined by only a few banks.

5. Regression framework

I use multivariate regression analysis to compare the financial performance of the new internet-only banks to the financial performance of the new traditional banks. The regression framework includes two types of analysis. A static analysis tests for cross-sectional differences in the performance of the two sets of banks over the entire 1997-2000 period. A dynamic analysis tests for differences in the intertemporal performance of the two sets of banks as they grow older and larger. Various measures of financial performance are regressed on the age of the banks, the size of the banks, an intercept shift dummy for internet-only banks, various interaction terms and a vector of control variables. In all, 18 different measures of financial performance are used as dependent variables in separate regressions. The base regression specification is:

$$Performance_{i,t} = \alpha + \beta_1 * lnAge_{i,t} + \beta_2 * lnAssets_{i,t} + \beta_3 * Internet\ Bank_i + \beta_4 * Internet\ Bank_i * lnAge_{i,t}$$
$$+ \beta_5 * Internet\ Bank_i * lnAssets_{i,t} + \beta_6 * State\ Job\ Growth_i + \beta_7 * MBHC_i + \beta_8 * \%C\&I_{i,t}$$
$$+ \beta_9 * \%RealEstate_{i,t} + \beta_{10} * Thrift_i + \beta_{11} * OCC_i + \beta_{12} * Year\ Dummies_t + \beta_{13} * Quarter\ Dummies_t + e_{i,t} \quad (1)$$

where *i* indexes bank-level observations and *t* indexes time.

The dependent variable *Performance* takes on 18 different definitions of financial performance (ROA, ROE, etc). $lnAge_{i,t}$ is the natural log of the age (in calendar quarters) of bank *i* in quarter *t*, which is a proxy for accumulated production experience. $lnAssets_{i,t}$ is the natural log of bank assets for bank *i* in quarter *t*. This variable controls for differences in accumulated experience not accurately captured by *Age*, and it also provides a test for the effects of increased scale on bank performance. $Internet\ Bank_i$ is a dummy variable equal to 1 for internet-only banks.

I estimate several versions of equation (1). First, I estimate the equation with the restrictions $\beta_4 = \beta_5 = 0$. In this specification, if β_3 is significantly different from zero, then the financial performance of the internet-only banks is either better or worse (depending on the sign of β_3) than the financial performance of the traditional banks, at the means of the data. These restrictions assume a single performance time path for all banks, ie that all newly chartered banks benefit from an identical maturity experience effect, and that newly chartered internet-only banks do not benefit from any additional technology-based experience or scale effects.

Second, I estimate equation (1) only with the restriction $\beta_5 = 0$. This allows separate maturity-based and technology-based experience effects for internet-only banks. In this specification, if β_4 is significantly different from zero, then new internet-only banks have a different performance time path than new traditional banks, holding scale constant.

Third, I estimate equation (1) only with the restriction $\beta_4 = 0$. This allows separate maturity-based and technology-based scale effects for internet-only banks. In this specification, if β_5 is significantly different from zero, then new internet-only banks have a different scale economy paths than new traditional banks, holding experience constant.

Obviously, *Age* and *Assets* are strongly positively correlated over time for newly chartered banks. Hence, given the small number of observations for internet-only banks, it is statistically difficult to separate technology-based experience effects from technology-based scale effects in the same regression equation (ie a regression that restricts neither β_4 nor β_5 to be zero). See DeYoung (2001c) for a detailed discussion of this issue and for results of regression tests that include neither restriction.

The remainder of the right-hand variables are control variables. $State\ Job\ Growth_i$ is the percentage change in total employment in the home state of bank *i* over the sample period. (The nationwide average for this variable is assigned to internet-only banks). $MBHC_i$ is a dummy variable equal to 1 if bank *i* is an affiliate in a multi-bank holding company. $\%C\&I_{i,t}$ and $\%RealEstate_{i,t}$ are the percentages of bank *i*'s loan portfolio invested, respectively, in commercial and industrial loans and real estate loans at time *t*. $Thrift_i$ is a dummy variable equal to 1 if bank *i* holds a thrift charter, and OCC_i is a dummy variable equal to 1 if bank *i* holds a national bank charter. *Year Dummies* and *Quarter Dummies* are included to control for cyclical and seasonal influences on bank performance not captured by the other control variables. $e_{i,t}$ is a disturbance term distributed randomly with zero mean.

6. Results

The static analysis is largely consistent with results of earlier studies - on average, newly chartered internet-only banks perform poorly relative to newly chartered traditional banks. However, the dynamic analysis suggests that financial performance improves more quickly over time at the internet-only start-ups than at the traditional start-ups, and the evidence is consistent with both technology-based experience effects and technology-specific scale effects. Selected results from the regression tests are displayed in Table 1. For more complete results, see DeYoung (2001c). The regression results reflect the average financial performance of the internet-only banks and thrifts included in the data set, and are not meant to imply that any single one of these 10 institutions performed well or poorly during the sample period.

The key results from the static analysis are shown in the first column of figures. Profitability, as measured by ROA and ROE, is statistically and substantially lower at the typical one-year-old internet-only bank than at the typical one-year-old traditional bank - on average, internet-only ROA was lower by about 300 basis points, and internet-only ROE was lower by almost 1,100 basis points.

The regressions offer strong evidence that newly chartered internet-only banks tend to hold substantially higher levels of equity capital, tend to have greater difficulty generating deposit accounts, and tend to incur higher non-interest expenses relative to newly chartered traditional banks. On average, the equity/assets ratio was higher by 10% of assets at the internet-only banks. The deposits-to-assets ratio was lower by 7% of assets at the internet-only banks. The non-interest expense-to-assets ratio was 2% of assets higher at the internet-only banks, with the other non-interest expense ratio accounting for three quarters of the difference. There is weak statistical evidence that new internet-only banks grow faster, pay higher wages and have trouble generating loans and non-interest income compared with new traditional banks.

The second and third columns of figures display the key results from the dynamic analysis. These tests suggest that the financial performance gap between newly chartered internet-only banks and newly chartered traditional banks narrows - but does not necessarily close completely - as these banks pass through the first two years of their lives.

The performance time paths of new internet-only banks and new traditional banks diverge from each other for a handful of performance measures. This divergence is measured by the interaction coefficient β_4. ROA at the typical one-year-old internet-only bank increased faster than at the typical one-year-old traditional bank, consistent with the hypothesis that technology experience effects are helping to close the performance gap between these two sets of banks. The driving force behind this improvement appears to be rapid declines in non-interest expenses, especially in the “other non-interest expenses” category. The total non-interest expenses/assets ratio and the other non-interest expenses/assets ratio both declined more sharply at the internet-only banks over time. Equity/assets ratios declined more slowly at internet-only banks than at traditional banks, reflecting second capital offerings at internet-only banks and explaining why the regressions find technology experience effects for ROA but not for ROE.

For the rest of the financial performance measures (ROE, interest margins, premises expenses, labour expenses, employment/assets, wages, loans to assets, deposits to assets, non-performing loans, non-interest income, physical overheads, asset growth, deposit interest rates and loan interest rates), the internet-only banks progressed at about the same rate over time as the traditional banks. The internet-only banks progressed more slowly than the traditional banks in only one aspect of financial performance, the deposits/assets ratio, suggesting that the internet distribution channel is more efficient at attracting loan customers than attracting core depositors.

The scale effects at the internet-only banks also diverge from scale effects at the traditional banks in a number of performance areas. This divergence is measured by the interaction coefficient β_5. ROA increases more rapidly with bank size at the internet-only banks than at the traditional banks, and total non-interest expenses decline more rapidly with bank size at the internet-only banks than at the traditional banks. The decline in non-interest expenses largely reflects scale-related reductions in labour expenses and other non-interest expenses.

Table 1

Regression analysis

Dependent variable	Static analysis[1]		Dynamic analysis[2]	
	β_3		β_4	β_5
Return on assets	– 0.0310*** (0.0040)		0.0094* (0.0053)	0.0078** (0.0035)
Return on equity	– 0.1096*** (0.0220)		– 0.0123 (0.0291)	– 0.0008 (0.0194)
Interest margin/assets	0.0002 (0.0018)		0.0004 (0.0023)	– 0.0005 (0.0015)
Equity/assets	0.1034*** (0.0137)		0.0334* (0.0181)	0.0126 (0.0121)
Non-interest expenses/assets	0.0214*** (0.0066)		– 0.0158* (0.0087)	– 0.0148** (0.0058)
Premises expenses/assets	0.0015 (0.0011)		– 0.0008 (0.0014)	– 0.0013 (0.0009)
Labour expenses/assets	0.0045 (0.0035)		– 0.0047 (0.0046)	– 0.0084*** (0.0031)
Full-time employees/$ million of assets	0.0478 (0.0507)		– 0.0129 (0.0371)	– 0.0550 (0.0447)
Wage (salary and benefits)/full-time employee	0.0083*** (0.0027)		0.0022 (0.0036)	– 0.0014 (0.0024)
Other non-interest expense/assets	0.0154*** (0.0030)		– 0.0104** (0.0040)	– 0.0053** (0.0026)
Deposits/assets	– 0.0700*** (0.0163)		– 0.0417* (0.0215)	– 0.0381*** (0.0143)
Loans/assets	– 0.0636** (0.0253)		– 0.0208 (0.0334)	– 0.0331 (0.0222)
Non-performing loans/loans	0.0000 (0.0011)		0.0000 (0.0015)	– 0.0006 (0.0009)
Non-interest income/assets	–0.0151*** (0.0036)		– 0.0012 (0.0048)	– 0.0022 (0.0032)
Physical overheads/assets	– 0.0056 (0.0044)		0.0088 (0.0058)	0.0100** (0.0039)
Asset growth rate (annual)	0.7524** (0.3012)		0.0886 (0.4047)	..
Deposit interest rate	– 0.0006 (0.0015)		0.0026 (0.0019)	0.0031** (0.0013)
Loan interest rate	– 0.0082 (0.0054)		0.0068 (0.0072)	0.0031 (0.0048)

[1] Estimates of β_3 in regressions that restrict $\beta_4 = \beta_5 = 0$. [2] Estimates of β_4 with β_5 restricted to 0 and of β_5 with β_4 restricted to 0 respectively.

***,** and * indicate significance at the 1%, 5% and 10% level respectively.

Not all of the technology-specific scale effects are beneficial for new internet-only banks. Deposits/assets increase less rapidly with bank size, physical overhead to assets decline less rapidly with bank size, and deposit interest rates increase more rapidly with bank size at the internet-only banks. For the remainder of the financial performance measures, the effect of increased scale on internet-only bank performance was similar to the effect of increased scale on traditional bank performance.

7. Conclusion

Most banks that use the internet-only business model are struggling for profitability, and emerging conventional wisdom states that internet-only banking is a failed business model. But this may be premature. As internet-only banks age, they accumulate experience which may allow them to operate more efficiently in the future, and as they grow larger they may generate scale-based savings not available to traditional banks that use less capital-intensive production and distribution technologies. If the experience-based technology effects and/or the scale-based technology effects are large enough, the performance gap between internet-only banks and traditional banks could narrow in the future.

On the one hand, this study finds results that are largely consistent with the conventional wisdom. On average, internet-only banks have been substantially less profitable than traditional banks. They have generated lower business volumes than traditional bank start-ups, and any savings generated by lower physical overheads appear to be offset by other types of non-interest expenditure. But on the other hand, this study also finds that profitability ratios and non-interest expenses ratios improve more quickly over time at the internet-only start-ups than at the traditional start-ups, perhaps propelled by both technology experience effects and technology-specific scale effects.

If these trends continue into the future, the internet-only banking model could eventually prove to be a viable business model, despite its generally poor financial performance to date. However, the findings in this study are very preliminary. The data suggest that, after two full years of existence, the average newly chartered internet-only bank still lags the performance of the average newly chartered traditional bank. Furthermore, the data set used here contains just 10 banks over the first nine quarters of their life cycles, too little information over too short a period to draw definitive conclusions.

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Technology and e-finance in Japan

Motoshige Itoh[1]

1. Introduction

Rapid progress in information and communication technology (ICT) is an important factor changing the financial sector in many countries. Although its effects are visible in many industries, for several reasons they are particularly strong in finance. Financial services are intangible; progress in ICT has drastically reduced the cost of providing them and is a driving force for structural change in conjunction with globalisation and deregulation.

This paper studies recent developments in Japan and examines the underlying economic reasons. It examines two of the most notable areas where e-finance is posing a challenge to incumbents; e-broking and e-banking. It concentrates on theoretical considerations as these services are in their infancy and data are scarce.

An important feature of e-finance in Japan is the active entry of new firms in addition to e-services being offered by existing financial firms. This active entry reflects differences in the cost structure and corporate organisation between e-banks and traditional banks. The new entrants have resulted in the e-finance industry encompassing a wide variety of participants, from traditional financial companies to manufacturing firms and retail stores, from large corporations to small venture capitalists, and from indigenous firms to subsidiaries of overseas firms. This diverse participation may play an important role in reshuffling the structure of the entire financial services industry. It may lead to some "unbundling", where integrated financial services under a single financial supermarket are spread to a range of specialised providers. It may also cause a fusion between financial institutions, retailers, internet information services and the like. Economies of scope between e-finance and other services may encourage further entry of firms from other sectors.

2. Low-cost operation and structural change: e-broking

Low operating costs are an important influence on both the performance of e-finance providers and the structure of the finance industry. A good example is the rapid expansion in internet-based securities broking ("e-broking") in Japan in recent years. Not only large incumbent securities houses but also new firms are attracting a lot of broking business on the internet and achieving significant market share. The traditional brokerage industry in Japan was heavily regulated. Incumbent firms charged high fees for their labour-intensive activity. Deregulation of brokerage fees provided good opportunities for e-brokers to expand as they were able to offer very low fees. When brokerage fees are large, it requires a large price movement before a trade becomes profitable, even for a canny investor who correctly predicts the direction. Large price fluctuations are by their nature uncommon. By contrast, when fees are small, profits can be made from much smaller, and more common, price fluctuations, allowing more frequent participation of retail customers.

E-brokers enabled small investors to enter the market. Not only did they charge lower fees, the e-brokers were willing to deal in smaller quantities and at more convenient times (more than two-thirds of their transactions occur after 5 pm). While traditional brokers only provided research and information to their large customers, e-brokers use the internet to give small investors access to a similar range of information.

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Some e-broking firms encouraged small investors to take stakes in them. For example, when a Japanese e-broker, Monex, made its IPO, it made the minimum purchase size very small. Whereas usually the minimum size is very high due to regulations (¥12 million, about €110,000), Monex found a way to split the shares so that the minimum purchase size was under €500. It then used its internet site to market its stock, which it allocated to small investors by a computerised lottery. This was the first time many small investors participated in an IPO.

While incumbent brokerage firms can offer e-broking services, these would risk "cannibalising" their traditional retail business. It is worth noting, however, that the increasing use of e-broking does not necessarily imply high profits for the e-brokers. Competition is squeezing fees and the huge investment needed in sophisticated systems may make it hard for them to achieve high profit margins.

3. Economies of scope in e-banking: the entry of retailers

Many e-banks have recently been established in Japan. As with e-brokers, many entrants from other industries are offering e-banking services and e-banks offer a similar low-cost 24-hour service. Low costs, including both fees and time, are particularly important as customers access banks more frequently than securities markets. There are various kinds of e-banking services; transactions accounts with low fees, savings deposits offering higher interest and loans charging lower interest. This section only discusses e-banking by retailers.

E-banking must be backed up by some branch services for activities such as easy access to cash. This is especially important in Japan, where the amount of cash per capita is among the highest in the world (Table 1). Retail stores are well placed to provide a counter for such basic banking transactions. One of the interesting features of e-banking offered by retailers is that they may be able to offer 100% reserve deposits (ie the corresponding bank assets are all safe and liquid) as they do not make loans.

Table 1

Currency per capita (end-2000)

	Currency (€ equivalent)
Japan	4,571
Switzerland	3,460
United States	2,095
Hong Kong	1,855
Germany	1,734
Netherlands	1,181
Australia	837
France	835
Finland	644

Source: International Monetary Fund (2001).

Japan's largest retail group, Ito-Yokado, established its e-banking arm in October 2001. It owns Seven-Eleven Japan, a chain of around 10,000 very small convenience stores open 24 hours every day with a highly sophisticated information network based on point-of-sale data but low-paid staff. Seven-Eleven, which is already the largest retail chain in terms of sales and profits, is expanding its branch network further. Offering basic banking services such as cashing and transfers not only provides an additional source of revenue for each outlet but the customer data captured at the point of sale can be used to support other retail activities.[2] The use of a smartcard at stores, allied with a

[2] An example of such synergy is that Seven-Eleven operates an internet book store. The books can be delivered to customers' homes but more than 90% of customers prefer to pick them up at a local store.

loyalty scheme and internet access to e-banking, allows the creation of a detailed databank on each customer's transaction patterns and financial position, which can be used for targeted marketing by Ito-Yokado itself or, subject to meeting privacy requirements, sold to other firms.

4. Unbundling of banking business and e-finance

Commercial banks dominate the Japanese financial system. Bank deposits and postal savings accounts together account for about 60% of financial assets held by the household and corporate sector. Commercial banks perform many functions such as deposit-taking, lending, consulting and research. Deregulation and the development of information networks are eroding banks' franchise value in favour of a network of specialised financial institutions which are forming a new financial system.

One lesson from the bursting of the bubble economy was that a financial system centred on commercial banks cannot spread financial risks effectively. Fierce international competition also promotes this reform as traditional full-service banks cannot maintain their profitability.

Progress in ICT promotes this unbundling in the financial system, as it does with the industrial structure in other sectors. Easy and low-cost access to the financial market through e-banking fits well with this decentralised market model.

5. E-finance and private money

The use of ICT for various financial services paves the way for new forms of private money. Hayek (1976) presented an intriguing discussion of the possibilities for competition among private monies and its effect on the performance of the economy.[3] Section 3 above mentioned the importance of a possible 100% reserve bank. Such a bank should not be subject to bank runs as its deposits would be totally backed by safe assets. Alternatively these new financial institutions could be structured as a unit trust, which again would not be subject to runs. This could imply a different style of supervision and regulation than for conventional banks.

Retail stores may issue a smartcard to customers that can be used as e-money. Customers can accumulate value in this card by transfer from their e-bank account and then spend it in retail stores. A possible analogy with these new monies created by private firms is gift coupons issued by retail stores. There is no link between this type of "new money" and the monetary base.

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[3] For a review of modern discussions of e-money, see the paper by Hawkins in this volume.

Reflections on the regulatory approach to e-finance

María J Nieto[1]

1. Introduction

In the last 20 years, the financial services industry has witnessed dramatic changes, largely driven by globalisation, deregulation and consolidation. Technological advances helped make globalisation and consolidation feasible and encouraged deregulation. More recently, IT has accelerated the process, reinforcing some of these trends, particularly globalisation and deregulation, as well as facilitating the development of e-finance.

In the first part of this paper, attention will be focused on the interaction between the recent trends that have been shaping the way financial services are provided worldwide and the advent of IT. The second part focuses on the regulatory challenges posed by IT to financial services. First, we discuss why regulation of financial markets continues to be necessary in spite of the changes in the financial structure brought about by technology, and what sort of approach to regulation is better suited to this new environment, particularly in consumer and investor protection and promotion of competition. Secondly, we discuss in more detail the challenges posed for the traditional regulatory approach to reducing systemic risk. Thirdly, we comment on a supervisory model that seems to fit better an ever more complex financial structure.

2. Recent trends in financial services and the impact of IT

Among the different trends shaping the provision of financial services in the world, this presentation concentrates on those that, in our view, pose the greatest challenges for policy-making: globalisation, deregulation and consolidation. These trends are interrelated and often mutually reinforcing eg globalisation and deregulation; deregulation and consolidation; consolidation and globalisation. The recent technological revolution is adding an additional dimension of complexity, reinforcing some of the trends shaping the financial system structure.

2.1 Globalisation

Financial markets have grown ever more integrated in the recent past. The liberalisation of the capital account and the deregulation of financial markets have contributed significantly to this phenomenon in the industrial countries. Communication technologies have made an important contribution by dramatically increasing the ability to move information both in terms of volume and speed, making capital account restrictions more difficult to re-establish. IT allows vast quantities of financial information to be available anywhere, anytime. For example, one of the fundamental attractions of internet banking is the capacity to address a materially larger customer base in geographically remote markets without incurring the expense of building and maintaining a branch network.

The finance industry is particularly affected because the information business is one of the fundamental services provided by financial intermediaries. IT increases competition in financial services by making it much easier for foreign competitors to penetrate local markets and renders the process of price formation more transparent. At the same time, the greater interconnection and

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transparency of markets could make asset prices and financial flows more volatile because market participants are able to react immediately to any new information.

As a by-product of the ubiquity in the provision of financial services brought about by the improved communication technologies, there is an internationalisation of products and attitudes, leading to global institutions with a worldwide customer base for which it is increasingly irrelevant where the customer and the institution reside. The Nasdaq stock market is an example of an all-electronic communication network which deals with several stock exchanges around the world (Osaka Securities Exchange, Deutsche Börse, London Stock Exchange, Hong Kong Stock Exchange and Australian Stock Exchange).

2.2 Deregulation

In the past, financial activity was heavily regulated. Regulation governed both qualitative and quantitative aspects of financial intermediaries' activities. This meant the administrative determination of prices charged for financial services (ie interest rate ceilings) and the types of service offered (ie restrictions on banks and insurance companies' asset management activities), barriers to entry (ie limitations on the activity of foreign banks) as well as geographic restrictions (ie limitations on the opening of branches). Financial regulators', and particularly banking regulators', main aim is and has always been minimising systemic risk by providing government guarantees and addressing the moral hazards arising from them. Systemic risks are much less significant in investment and insurance firms.

Deregulation in the financial sector aimed at increasing competition and integrating financial markets while preserving financial stability. The basic objective was to achieve welfare gains from greater competition. The integration aspects of deregulation aimed at globalising the financial activity and breaking the historical segmentation between financial intermediaries. Both consequences of deregulation have been reinforced by the application of IT to financial services. In parallel to these developments, regulators' attention has increasingly focused on consumer and investor protection and competition, although, in the particular case of banking, minimising systemic risk has remained their priority.

The consumer and investor protection regulations are aimed at minimising adverse selection by the users of financial services by solving the asymmetric information problem. To this end, the regulator requires that information provided by financial intermediaries be reliable and complete. Closely related to this type of regulation is competition policy, aimed at ensuring that financial intermediaries do not abuse the market power they have gained from their ability to supply services at lower cost thanks to economies of scale. The second part of the paper deals in more detail with this justification for regulating financial intermediaries in the light of the advent of new technologies.

2.3 Consolidation

Two regulatory developments have contributed to consolidation in the financial sector. First, regulators removed entry barriers to the local markets (eg the single market programme in the European Union, the Riegle-Neal Act in the United States), favouring mergers both across and within borders. Second, regulatory barriers separating the activities of the different financial intermediaries (banking, insurance and securities activities) have been blurred, favouring mergers across sectors (eg the Gramm-Leach-Bliley Act permits banks to affiliate with securities firms and insurance companies in the United States).

Factors affecting consolidation may vary across financial services. Banks, in particular, have been subject to strong competition from capital markets, particularly for their larger clients, in both their assets (eg commercial paper, corporate bonds) and liabilities (eg mutual funds). These disintermediation forces have obliged banks to increase their capital base via mergers and acquisitions in order to achieve economies of scale in the medium-size loan market, where the larger banks have potential competitive advantages. However, a consensus exists that a plethora of financial services (eg lending to small firms, brokerage services, trading systems) have witnessed a reduction in their economies of scale and an increase in competition due to the availability of IT.

Securities markets have also been largely affected by the development of IT that allows securities trading and capital raising activities to migrate to global financial centres. The result has been consolidation of trading systems as well as certain middle and back office functions.

More competition forces financial intermediaries to minimise costs and innovate. In the traditional borrowing-lending business, for example, the reduction in lending margins has created incentives to take more risks by developing more sophisticated products which render obsolete the traditional barriers between different financial products (banking, securities and insurance). Furthermore, technology is tearing down barriers to entry based on physical presence (eg bank branches) while simultaneously creating others based on the first mover advantage and network externalities. The latter is caused by providers of financial services creating standards widely used by the market participants.

3. Why financial market regulation is still necessary in the wake of technological advances but regulators face new challenges

The justification for government involvement in the financial system is unlikely to change, even as the structure of financial intermediation changes as a consequence of technological advances. The driving forces behind government intervention in the form of regulation are still there: consumer protection; promotion of competition; and protection of the stability and soundness of the financial system. However, the accelerating pace of technological progress reinforces some existing trends in the financial sector (eg globalisation, deregulation), raising questions about whether the traditional approach to financial sector regulation is adequate.

One of the objectives of financial regulation is *consumer and investor protection*, which aims to achieve equity in the distribution of information. At the macro level, transparency rules impose the correct dissemination of information and equal treatment among market players. Transparent and reliable advertising by financial intermediaries has traditionally been the focus of this type of regulation. At the micro level, regulation aims at non-discrimination in relations between intermediaries and consumers. Business rules are a good example of this aspect of consumer and investor protection regulation.

Regulators have strongly advocated broader disclosure in recent years. The underlying rationale is that disclosure allows counterparty surveillance and makes markets more efficient "in the sense that they embody the knowledge that market participants have".[2] In this way, regulators have begun to rely more on disclosure and market forces as a disciplinary mechanism for financial institutions. The application of IT to the financial services sector has been largely responsible for the increase in transparency. As a consequence, the balance of power between customer and financial intermediary has been tilted more in favour of the consumer, thanks to the improvement in the quantity and quality of information. In this fashion, IT has reduced the two traditional problems associated with the lack of information: adverse selection in decision-making and moral hazard once the financial transaction takes place. In this context, regulators need to focus on increasing information quality and facilitating private access to that information.

However, applying IT requires a greater emphasis on other areas of consumer protection more related to the micro aspects of the financial intermediary/consumer relationship. The immediate challenges faced by the financial regulator are threefold: security and data privacy, the global character of the provision of e-finance services and the entrance of non-regulated new intermediaries.

Security of transactions and data privacy is increasingly a matter of concern for regulators worldwide. In response, banking regulators of the G10 countries have agreed on principles aimed at addressing the risks related to the privacy of customer information, non-repudiation and accountability for e-banking transactions as well as the establishment of a comprehensive security control process. In addition, the ubiquitous character of the provision of financial services via the internet demands a different approach to the supervision framework for cross-border financial activities. In the case of banking, for example, the approaches developed for the traditional banks do not appear to work well for internet-only banks. In order to meet this new challenge, G10 regulators are discussing guidelines for coordinating the supervision of internationally active internet-only e-banks. Last but not least, the emergence of unregulated non-traditional financial service providers (eg aggregators and non-bank

[2] Greenspan (2000).

payment systems) may pose new challenges for regulators on the consumer protection front. Against this background, not only market discipline via increased transparency, but also consumer education are becoming effective tools of consumer protection.

Closely related to the regulatory objective of customer and investor protection is the objective of *promoting competition* linked with the general objective of efficiency. This requires rules for controlling the structure of competition in the markets aimed at avoiding abuse of dominant positions and excess concentration. Financial services are mostly (and more efficiently) provided by large firms that, thanks to their size, achieve economies of scale. Despite the potential for consumers to be exploited, competition policy has not traditionally been the concern of financial regulators. Furthermore, the promotion of competition has been, to a certain extent, in conflict with solvency requirements (eg restrictions on the structure of ownership or activities, minimum initial capital requirements) and only some areas of financial activity (eg self-regulating organisations) are subject to competition rules. Nevertheless, regulators have recently introduced elements of competition in banks' solvency requirements. A good example is the current revision of banks' minimum capital requirements (New Capital Accord) that allows for greater competition via enhanced risk management techniques. This is expected to yield more competitive pricing initiatives.

Technological advances that allow for cheaper delivery channels seem to be reducing economies of scale in the provision of certain financial activities such as lending to small firms, brokerage services and trading systems. At the same time, technology is making it possible to break the traditional chain of value creation by allowing the production and distribution of financial products to be separated into different businesses. From this point of view, dominant positions, excess concentration and vertical integration might increasingly be less of a concern for the competition regulator, particularly in an ever larger global financial market. However, two caveats need to be made. First, high setup costs for technology in some instances and possible network externalities may promote increasing scale of operation and further consolidation. Second, while vertical integration may decrease as technology encourages financial service providers to "unbundle" their chain of value creation, it is also likely to increase reliance on third-party service providers. Regulatory concern would then switch from large vertically integrated financial intermediaries to the market structure of third-party service providers - many of which are more difficult for financial regulators to oversee.

Furthermore, IT has reduced barriers to entry, facilitating entry by non-financial entities and, as a consequence, an increase in competition, particularly in services traditionally provided by banks (eg aggregators) and brokerage firms (eg alternative trading systems). Although the results of increased competition in the global marketplace have been good - lower commissions - globalisation and reduction of entry barriers raise the problem of market definition for the regulator. Here, as in the case of consumer protection, an international approach to the promotion of competition that ensures a level playing field increasingly demands coordination of regulators and supervisors worldwide.

Furthermore, from the competition viewpoint, IT raises an additional challenge, posed by providers of financial services that create standards widely used by market participants. By creating standards that lead to a dominant share of the market, financial service providers may abuse their market power (eg mobile payment standards developed through the cooperation of banks and telecommunication companies). This phenomenon is termed "network externalities". Financial markets involving high network externalities include payment and trading systems and exchanges.

A primary objective of financial market regulation is *macroeconomic stability*. Here it is appropriate to distinguish between banks and other financial intermediaries in regulatory terms because of the differences in risk profiles and systemic impact. The justification for regulations on safety and soundness of banks is twofold: First, to provide government guarantees (explicit or implicit) to the holders of liabilities issued by this type of financial intermediaries as well as lender of last resort facilities to the banks. Second, to address the moral hazards that arise from those guarantees.

The desirability of the safety net stems from the conviction that banks are different from other types of institutions. The special character of banks lies in the host of services they provide that are essential to the proper functioning of the economy: access to the payment system; access to liquidity; provision of information about borrowers; intermediation between savers and investors; diversification of risks and acting as a conduit for the above-mentioned government guarantees. The divergence between the private and social costs of bank failure explains ex post government intervention in the form of a safety net. If depositors lose confidence in the safety of a bank's portfolio, they may wish to withdraw their funds, forcing the bank to liquidate its assets. A danger of contagion arises, where the loss of confidence in one bank spreads throughout the system. Investors unable to distinguish between a

localised problem and a system-wide problem may wish to withdraw funds from perfectly sound banks and, as a consequence, a large-scale bank failure may follow if banks cannot liquidate sufficient funds to meet the run on their deposits. In these circumstances, the safety net aims to safeguard customers (deposit insurance) and financial institutions (lender of last resort) from the consequences of actions beyond their control. Another rationale for government intervention relates to the important role banks play in creating money. Monetary policy operates to a large extent through banks so that the solvency of the banking system is important for a properly functioning monetary policy.

The existence of the safety net may, in turn, cause distortions as a result of the elimination of market discipline and increase incentives to take more risk, posing a moral hazard problem. This justifies ex ante government intervention in the form of prudential regulation (eg minimum capital requirements, limits on the concentration of credits) and supervision of financial institutions (eg on-site and off-site) in order to secure the stability of the financial intermediaries that may pose a systemic problem, and to minimise the impact of those distortions.

Although the traditional issues raised by the safety net remain with the use of new technologies in financial services, there is little doubt that technological progress has made banks "less special". Technology allows non-banks to provide payment functions without directly involving a depository institution (eg balances on stored value cards and in mobile payment systems),[3] calling the banks' exclusive role in the payment system into question. The advent of IT opens the possibility of having payment settlements outside the central bank.[4] Some authors refer to the threat to monetary policy from the electronic revolution stemming from the "decoupling" of the operations of the central bank from the markets in which financial claims are created.[5] Furthermore, substitutes have emerged for deposits (eg mutual funds, brokerage houses) and lending products (eg bonds and commercial paper), reducing the importance of banks and increasing the importance of securities markets as financial intermediaries. At the same time, advances in IT also raise questions concerning the provision of information about borrowers as a typical bank service. In light of this less special role of banks, Claessens et al (2000) argue that regulations on the safety net and soundness of banks need to be revised. Although most regulators would consider this approach controversial, to say the least, based on the difficulties that non-banks have in providing large amounts of liquidity at short notice,[6] many would agree on the need to revise the traditional approach (or at least certain aspects) to macro and micro financial stability.

Regarding the safety net, the regulator faces challenges mainly on three fronts. First, technology is allowing the separation of payment and credit services, potentially reducing the banks' role in the payment system. As a consequence, ex post government intervention to avoid the danger of contagion may not be effective in preventing a systemic problem. Systemic risk can emanate from any financial (or other) participant sufficiently large in size and scope to affect the system as a whole. Second, new deposit substitutes by non-banks may give rise to confusion on the extent of the safety net. In addition, the extension of the safety net to cover these deposits may further increase the moral hazard problem associated with deposit guarantees. Finally, the use of unregulated outsourced technological infrastructures that are shared by a number of banks in an ever more complex relationship raises increasing concerns about systemic risk. All these issues are increasingly capturing the attention of regulators worldwide.

In parallel, prudential regulation and supervision are also facing challenges of their own. Traditionally, regulators have relied on well understood categories of financial intermediaries (banks, insurers and securities firms), requiring market participants to comply with legally defined views of the marketplace. Technology is rendering these traditional categories obsolete and facilitating the entry of non-traditional financial intermediaries into the financial arena. Regulators' response to these developments ought to be technologically neutral and should not deter innovation ensuring that

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[3] Telephone companies' mobile payment systems can easily be used to direct payments to the user's telephone bill, thereby removing banks from the customer relationship.

[4] King (1999).

[5] Friedman (2000) See Hawkins in this volume for a summary of these debates.

[6] Corrigan (2000).

consumers are not deprived of its benefits while, at the same time, securing the soundness of the financial system.

Challenges to the regulatory approach to e-finance

Regulatory objectives	Traditionally	e-finance environment
Consumer and investor protection	Transparency rules	IT increases transparency. Regulators focus on: • Information quality
	Business rules (eg non-discrimination)	• Access to information • Consumer and investor education
		Entry of non-traditional financial service providers
		Security and data privacy
		Cross-border activity without physical presence
Promotion of competition	Competition often in conflict with solvency requirements	Solvency requirements yield to more competitive pricing initiatives
		Concentration to the extent IT does not reduce scale economies
	Competition authority objectives: avoiding dominant positions, excess concentration	Market definition
		Market structures of unregulated third-party providers
		Dominant positions based on network externalities
Financial stability	Banks have systemic impact, hence are "special"	Banks are "less special" • Disintermediation
Safety net		• Non-exclusive role in payment systems • Deposit substitutes
Regulation and supervision	Minimising systemic risk by providing government guarantees	Systemic risk can emanate from any financial (or other) participant sufficiently large to affect the system as a whole
	Minimising moral hazard	Systemic risk is potentially higher: unregulated outsourced technological infrastructures shared by a number of banks
	Well understood categories of financial intermediaries (FIs)	Traditional categories of FIs obsolete and entry of non-traditional FIs
		Unregulated outsourced technological infrastructure may endanger solvency
	Ability to enforce national standards	Borderless e-finance activities
		Need to secure technological neutrality and desirable market innovation

Moreover, national regulations no longer fit a global marketplace making the reliance on national standards, and the ability to enforce them, increasingly difficult. In this context, we are witnessing increasing harmonisation of standards (eg IAIS, Core Principles for Effective Banking Supervision) as well as a more internationally coordinated approach to prudential regulation and supervision. At the same time, market surveillance, as a mechanism of market discipline, is becoming increasingly important (eg Pillar 3 of the New Basel Capital Accord focuses on the need for greater transparency and disclosure by banks).

In light of the evolution of the role of financial intermediaries, various authors[7] argue that the *monitoring of compliance with prudential regulation* needs to be revised. Financial conglomerates and

[7] Di Giorgo et al (2000) and Claessens et al (2000).

groups operating in a variety of different business sectors in a highly integrated global market demand a supervisory model based on objectives or finalities, as opposed to the traditional arrangement based on the type of financial intermediary (institutional approach). According to this, the three objectives of supervision - stability, transparency and competition - would be entrusted to three distinct authorities designed to oversee the entire financial market regardless of the legal form of the intermediaries and the functions they perform. For example, market stability and solvency of each intermediary, whether bank, security firm or insurance company, would be the responsibility of one authority. The most attractive aspect of this approach is that it provides uniform regulation for different subjects engaged in the same activities, thus avoiding regulatory arbitrage between financial intermediaries. Although conflicts between different objectives are the same as the institutional approach, conflict resolution is more transparent in the supervisory model based on objectives. The negative aspect is that it may produce a certain multiplication of controls or, vice versa, a deficit of controls may occur whenever the exact areas of responsibility are not clearly identifiable in specific cases. No financial supervisory arrangement in the world fits this approach as yet. The single regulator supervisory model shares some features, such as the unified view of financial intermediaries, although the conflict between objectives remains within the institution and its resolution might not be transparent to the public. Still, the global nature of financial activity adds one more dimension of complexity to this institutional arrangement, demanding ever greater coordination among regulators worldwide.

4. Conclusion

While the structure of financial intermediation continues to change as a consequence of technological advances, the justification for government involvement in the form of regulation is unlikely to change: consumer protection; promotion of competition; and protection of the stability and soundness of the financial system. However, the accelerating pace of technological advances raises questions about whether the traditional approach to financial sector regulation is adequate.

The transparency brought about by the incorporation of IT into financial services assists regulators aiming at *consumer and investor protection* to the extent that it helps to solve the asymmetric information problem. The regulators' role needs to focus on improving the quality of information and facilitating private access to it. At the same time, new challenges arise from the security of transactions and data privacy, the cross-border provision of e-finance services and the emergence of non-traditional financial service providers. In this context, not only market discipline via increased transparency, but also consumer education are becoming effective tools of consumer protection.

Promoting competition in financial services has been the responsibility of competition rather than financial regulators. Technological advances and globalisation could make dominant positions, excess concentration - to the extent that economies of scale are reduced - and vertical integration less of a concern for competition authorities. However, financial regulators' concerns may increase to the extent that the breaking of the traditional chain of value creation takes place in favour of unregulated third-party providers - many of whom are more difficult to oversee. At the same time, globalisation and the reduction of entry barriers made possible by technology raise the problem of market definition. Meanwhile, new forms of abuse of market power in the form of network externalities are increasingly a matter of concern for regulators.

The differences in risk appetite and systemic impact between the different financial intermediaries - systemic risks are more important in banks - justify a different approach to the pursuit of macroeconomic stability. Although the traditional issues raised by the safety net are unchanged by new technologies, there is little doubt that technological progress has made banks "less special". In particular, banks are not the sole participants in the payment system, nor do they enjoy the exclusivity of being financial intermediaries (disintermediation via capital markets) nor are they the sole providers of information about borrowers. These developments demand a revision (at least of certain aspects) of the traditional approach to the pursuit of *financial stability*. Regarding the safety net, ex post government intervention to avoid the danger of contagion may not be effective in preventing a system-wide problem given the increasing participation of non-banks. In addition, new deposit substitutes by non-banks may give rise to confusion over the extent of the safety net. All of this is taking place against a background of increasing concerns over systemic risk stemming from the use of outsourced, often unregulated, technological infrastructures shared by a number of banks in an ever more complex relationship.

Regarding prudential regulation and supervision, technology is rendering obsolete the traditional categories of financial intermediaries while facilitating the entry of non-traditional financial intermediaries. In this context, the regulator should balance the need for "ex ante" government intervention aimed at securing the stability of financial intermediaries - particularly those posing a systemic risk - and minimising moral hazard while, at the same time, securing technological neutrality and desirable market innovation.

This more flexible approach to regulation seems to demand a *supervisory model* based on objectives or finalities (stability, transparency and competition), as opposed to the traditional institutional arrangement based on the type of financial intermediary. The most attractive aspect of this approach is that it provides uniform regulation for different institutions engaged in the same activities, thus avoiding regulatory arbitrage between supervisors.

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Electronic finance and monetary policy

John Hawkins[1]

1. Introduction

The rapid spread of the internet and some aspects of e-finance[2] are changing the financial system in ways that are hard to predict. This has potential ramifications for monetary policy all through the process of its operation.[3] Effects may be felt on the central bank's ability to operate monetary policy, the connection between interest rates it controls and key market rates, how these rates affect the real economy and inflation, and the feedback from real economy data to policy setting. This paper discusses these effects in turn. Many of them will probably only be manifest in the medium- to long-term but given the rapid development of the internet some could occur surprisingly soon. While e-finance also has important implications for financial stability, bank supervision, consumer protection, security and law enforcement, these are outside the scope of this note.[4]

2. Monetary policy operating procedures

Implementing monetary policy involves the central bank's role as operator of the inter-bank settlement market and the monopoly supplier of liquidity to it. Other entities could affect financial markets by operating on a sufficiently large scale, but only the central bank can do so by operating on a small scale. The central bank can generally determine the interest rate prevailing in the inter-bank market to an adequate degree of precision; for example, the average deviation between the federal funds overnight rate and its target over the past year has been only 7 basis points. Monetary policy will be effective to the extent that this interest rate affects other interest rates and so ultimately output and inflation.[5]

Often the central bank does not even need to operate in the market; it can merely announce its desired rate ('open mouth operations') and the rate in the market will move there. It is able to do this only because the market knows that the central bank has the *ability* to act to move the rate to its desired level. The danger posed by e-finance is that, in Friedman's (1999) analogy, the central bank may become "an army with only a signal corps" lacking the means to impose its will. The relevant questions are therefore whether either the central bank's settlement market ceases to operate and/or whether the link between interest rates in it and those pertinent to the rest of the economy are severed.

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[1] This paper has benefited from discussions with numerous colleagues at the Bank for International Settlements and Professors Benjamin Friedman and Charles Goodhart. Opinions expressed are those of the author and not necessarily shared by the the BIS.

[2] 'E-finance' has been defined in different ways. Here it is used rather broadly to mean the provision of financial services over the internet or other electronic media. This includes money, banking, payments, trading, broking, insurance etc.

[3] Useful references on this topic include Freedman (2000), Friedman (1999, 2000), Goodhart (2000), King (1999) and Woodford (2000).

[4] Some of these issues are discussed in Sato et al (2001) and Turner (2001).

[5] This contrasts with the textbook idea of the 'money multiplier', which posits that the central bank can control its liabilities, the 'money base' and this has a stable relationship to the money supply and hence nominal spending and inflation. The money base predominantly consists of banknotes issued by the central bank (it also includes deposits of banks with the central bank, and possibly coins and other items). In this view the effect of e-money replacing banknotes would be very serious; the money base and so the money supply would contract, triggering a recession.

2.1 What if e-finance causes central bank balance sheets to shrink?

There are two main types of e-money. Firstly, there is 'e-cash', which includes electronic purses and multi-purpose stored value (smart) cards[6], such as Mondex and Proton. Secondly, there is 'cybermoney' (sometimes called 'network money'), prepaid software products that can be used for payments or transfers on the internet, such as the failed Digicash. It is worth noting, however, that payments for most internet purchases - and these are still less than 1% of retail sales in most countries - are made using the conventional credit card network. E-cash is more likely to substitute for notes and coin (and so is discussed in this section), while cybermoney is more likely to substitute for bank deposits (and so is discussed in the subsequent section).

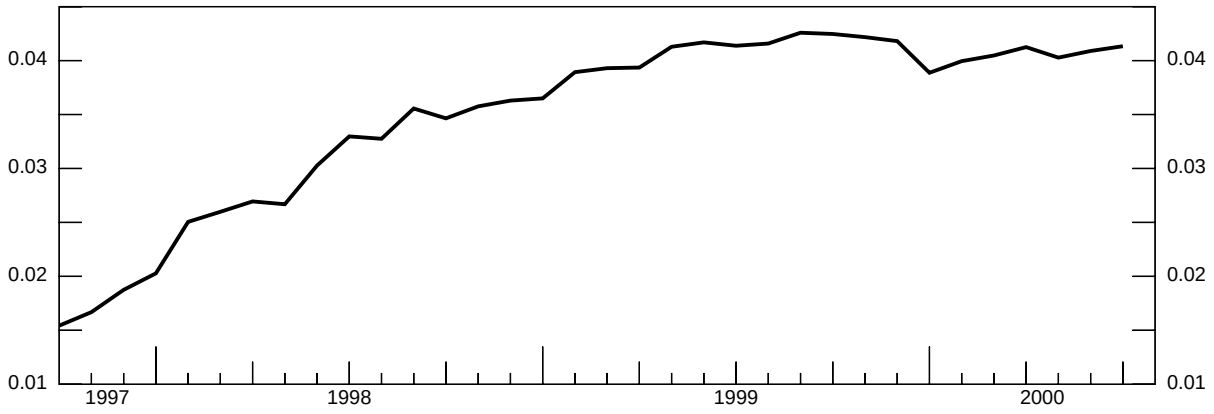
Any displacement of notes and coins is happening very slowly. Indeed the ratio of notes and coin to GDP has actually risen in some countries. It is possible that this overall stability disguises two offsetting trends: a very gradual displacement of low-denomination notes and coins by e-cash, but a greater use of high-denomination notes for various forms of bad behaviour or as a store of value offshore. E-cash is typically used only for small-value transactions. If it only displaces coins and low-value notes, this would not have much effect on the total *value* of notes and coin outstanding, as this is dominated by large denomination notes.

The ECB's data for the euro area show e-cash outstanding is only €140 million, less than 0.1% of notes and coin on issue, and its spread has been slowing. (Graph 1) This is consistent with anecdotal reports that many 'electronic purse' projects have been disappointing and have not progressed beyond the trial stage.[7]

Graph 1

Electronic money in the euro area

As a percentage of notes and coins



[6] As distinct from credit cards, debit cards, ATM cards etc, which do not have any intrinsic value themselves but allow customers to transfer funds between bank accounts, and single-purpose payment cards which are essentially an acknowledgement of a pre-payment.

[7] The most successful ventures have been those based on a popular single-use stored-value card. The majority government-owned Octopus card in Hong Kong is a contactless reloadable card used to pay for trips on the underground railway and bus networks. There are now more cards on issue than residents in Hong Kong and the card's use has gradually been extended to kiosks within rail stations and drink vending machines. It is now used for 1-2% of household expenditures. Another possible manner in which a card could quickly achieve a large market share would be if governments that require their citizens to hold identity cards had electronic chips in these cards which could be given an additional payment function.

It is now generally thought that the spread of e-cash will continue to be quite gradual, although some new forms seem better designed, such as being contactless.[8] There are good reasons why notes and coins may continue to be preferred. They are familiar and simple to use, and clearly anonymous. They are legal tender, ensuring widespread acceptability, and government-guaranteed. They can be readily respent by the recipient. The resource costs of their use are generally not borne by the user. Furthermore, the attractiveness of the present raft of e-cash schemes is limited by their lack of interoperability. It would be technically possible for e-cash to pay interest, which would obviously increase its attractiveness, but so far no forms do. The period between the introduction of the euro and its manifestation in notes and coins represents a missed opportunity for e-cash issuers. In the same way that currently various payments instruments (coins, notes, cheques, giros, credit cards, direct debits etc) co-exist, specialising in different uses, it is likely that e-cash and banknotes will co-exist for a long period.

Looking a long way ahead, there are possible concerns about the widespread issue of e-cash by private non-banks. It might erode the benefits of a currency as a single unit of account. If over time some types of e-cash were thought more creditworthy or acceptable than others, they may then trade at different values. Then a good might be priced at 100 BankA e-dollars but 105 BankB e-dollars. This might be avoided by requiring all e-cash to be redeemable in conventional money[9] and/or requiring issuers to be licensed and supervised.

Some writers fear that excessive issue (or worse still counterfeiting) of e-cash could give rise to inflationary pressures. Another risk is that were a prominent e-cash system to fail, it could shatter consumer confidence in many other electronic schemes. If by this time such schemes dominate the payments system, this could be highly disruptive to the economy. In this way, a prominent e-cash scheme could become too big to be allowed to fail and so implicitly government-guaranteed.

For central banks, wider usage of e-cash could eventually reduce seigniorage (ie issuing an interest-free liability to buy interest-earning assets). Seigniorage is currently a multiple of central banks' operating expenses but, in the very long run, it may be less. This may force central banks to rely on government grants to fund their operations, with implications for (perceived) central bank independence.

There are three possible responses central banks could make to this challenge.

- persuade governments to impose taxes or reserve requirements on private issuers of e-cash to generate revenue for the central bank.
- become issuers of e-cash themselves.[10]
- increase other revenue such as charges for services rendered or build up their capital to the point where the yield on it was sufficient to fund their expenses.

As well as the effect on seigniorage, if displacement by e-cash means the issue of banknotes is much reduced, the central bank's balance sheet will be much smaller. Circumstances might then arise where the central bank finds it more difficult to implement operations on a sufficiently large scale. (The other major central bank liability in many countries is banks' required reserves. If e-money displaces banks' current deposits to a large extent, this could also reduce the central bank's balance sheet.) From time to time, the central bank needs to sell a large amount of assets to sterilise the effects of large purchases in the foreign exchange markets or to offset the effect of large-scale emergency liquidity assistance to a bank. It may be difficult to do this if it lacked sufficient assets on its balance sheet to sell. Possible solutions to this problem are the central bank expanding its balance sheet by issuing

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[8] Even in a survey of issuers of e-cash, only a third expected it would totally replace notes and coins (and most of these thought it would take over ten years) and a fifth thought it would not replace it at all. Credit cards have been available for over a quarter of a century but have still not replaced cash or cheques.

[9] This may be necessary for e-cash to become widely acceptable. Paper money initially gained acceptance by promising convertibility into precious metals. In Europe redeemability is required by legislation.

[10] The authorities in Singapore plan to issue e-cash with legal tender status by 2008. Given that central bank e-cash would presumably be more trusted and accepted by government agencies it could well become the dominant form. On the other hand, the central bank might be a less technologically innovative issuer. It might also put the central bank in the position of being both the supervisor and a competitor to banks.

central bank bills or inducing the government to deposit with it, or conducting operations using repos or forex swaps. Another alternative in the emergency liquidity assistance case would be for the central bank to guarantee loans made to the troubled bank by other banks rather than make the loan itself.

It is possible that developments in information technology will allow banks to manage their operations in the inter-bank market more efficiently. This could mean that they need to hold smaller amounts on average in their accounts with the central bank. Similarly, some countries require banks to hold on average a set proportion of their deposits in their accounts with the central bank and e-finance could reduce the magnitude of bank deposits to which such ratios apply. However, as illustrated by the fact that a number of central banks (Australia, Belgium, Canada, Hong Kong, Mexico, New Zealand, Sweden, UK), operate monetary policy with no required reserves, it is *marginal changes* in the settlement balances than are relevant for monetary policy operating procedures rather than the levels.

2.2 What if banks no longer settle at the central bank?

Another possible risk to current monetary policy operating procedures is the possibility of banks switching to their own electronic settlement system not involving the central bank. This is technologically feasible. There have been cases where one private bank has provided settlement services for other private banks (eg HSBC in Hong Kong prior to December 1996). In some countries only the larger banks settle directly using central bank funds and smaller banks settle across accounts at one of the larger banks. There are already a number of large private sector bank networks which conceivably could develop in this direction. One possibility is that global banks might decide to settle all transactions between each other in just one place rather than using national central banks.

However, there are a number of reasons why banks may continue to settle on the books of the national central bank. The first is that it may be compulsory, as in Australia and Canada. The second is that the central bank is almost universally regarded as the safest counterparty. The third is that banks may not want a rival organisation to gain more information about their operations. Fourthly, staying with the current system avoids adjustment costs. Finally, the provision by the central bank of routine intra-day or overnight credit and the possibility of providing emergency liquidity assistance provide a further attraction. Even if these reasons did not prove enough, governments could require that transactions with them (tax payments, pensions, government employees' salaries, purchases etc) are settled on the central bank's books.

3. Central bank operations and the broader financial market

But even if the inter-bank settlement market continues to exist, it may become less relevant to the broader economy.[11] If the bulk of citizens hold their wealth, borrow funds and effect payments through other types of institutions, then influencing the inter-bank market may not give much leverage over broader macroeconomic conditions. Could e-money not just erode the demand for notes and coin but also erode the demand for bank products?

If, as had been the case in many countries in the 1960s and 1970s (due to heavy regulation of banks), the banks lose business to domestic non-bank, but bank-like, financial intermediaries such as building societies, thrifts, finance companies, merchant banks etc, then the central bank can try to bring these intermediaries within its purview. It could then require them to settle with the central bank. Similarly, the central bank could try to ensure that all new institutions based in the domestic economy offering banking services through the internet are licensed as a bank and meet prudential rules. However, this may lead to further new institutions being established outside the regulatory net. This risks what Friedman (1999) calls "a regulatory race … the central banks might well lose." Moreover, this response would be much more difficult if domestic residents are banking with e-banks (or using the internet to bank with traditional banks) in a foreign jurisdiction.

[11] The comment that banking is necessary but not necessarily banks has been attributed to Bill Gates.

3.1 What if alternative currencies are used for payments?

Another possibility, albeit probably much further in the future, is that some non-banks may set up rival currencies with their own payment and settlement systems. King (1999) has argued that "the key to any such developments is the ability of computers to communicate in real time to permit instantaneous verification of the creditworthiness of counterparties, thereby enabling private sector real time gross settlement to occur with finality." Then "the successors to Bill Gates would have put the successors to Alan Greenspan out of business". Such a development would resemble historic periods of "free banking".

One way such a rival network may emerge is the growth of cybermoney, which might be issued by telecommunication or IT companies. While early attempts at marketing cybermoney have not been very successful, there are reasons why demand for it may grow. Many internet content providers expected to fund themselves by selling advertising space on their sites. This has proved much harder to do than expected, as the market becomes saturated and consumers increasingly ignore such advertisments. These content providers are likely to switch to charging users a small amount to access some information, read an article or listen to a song. These micropayments are uneconomic if the credit card network has to be used but could be well-suited to cybermoney.

The potential demand for cybermoney has also been increased by the greater number of person-to-person payments induced by online auctions, such as those conducted using eBay. Payments mechanisms such as PayPal have been established to facilitate these payments, but so far they are not interoperable and rely on the credit card system for settlement. In principle, a "money" can be issued by any kind of entity that can convince people to hold it. The difference with cybermoney is that it has a ready use which might encourage people to hold it, and well-known companies such as telecoms and information technology firms with both the technical capacity to develop it and sufficient public trust to encourage customers to hold it. Eventually cybermoney could be used to pay for transactions that did not originate on the internet. Generally, cybermoney is initially purchased in exchange for conventional money. However, this is not necessary; some accrue as 'rewards' for purchases from a particular company but can be spent on the web. A private cybermoney may not be able to claim a lower default-risk than the national currency but it could market itself as less vulnerable to inflation. However it will be hard for a private currency to be convertible into a widely useful commodity (like salt, wheat or cattle used to be).

At present the size of cybermoney is believed to be tiny. Berentsen (1998) suggests that cybermoney balances will never be very large as the same improvements in technology that facilitate its use for payments also facilitate transfers from interest-bearing accounts to it. Rather than hold large amounts of cybermoney, customers will buy some online only when they want to make a large payment.

Perhaps the more likely rival to the domestic currency and settlement with the domestic central bank is not a new private cybermoney but rather existing national currencies of other countries which e-finance may make easier to use for domestic transactions. In a sense, the dollar, euro, yen, sterling and Swiss franc may become competing brands, not just in the third world but within their own territory. There are already instances of 'xenocurrencies' playing a large role in economies; the dollar in Latin America, the euro in eastern Europe, the Hong Kong dollar in Macao and southern China, and the baht in Cambodia. There may be lessons from their experience if e-finance brings this phenomenon into advanced economies as well.

There has been a recent surge of interest in the question of whether monetary policy could operate even in this brave new world. Goodhart (2000) has argued that the monetary authorities could still influence monetary conditions, as being backed by the government's power to levy taxes, they are uniquely able to intervene in financial markets (if necessary, buying or selling some private e-money) regardless of concerns about its profitability. In this way the central bank could still move interest rates up and down.

The question that then arises though is how large such purchases might need to be. If the central bank demonstrates a few times that it able and willing to make sufficiently large purchases and sales to affect the market interest rate, in future its announcements may move interest rates, much as is currently the case. However, this argument still requires the central bank to make these interventions a few times to establish its credibility. Given the size of financial markets, the size of such purchases could be very large relative to the balance sheets of central banks or the size of transactions they have typically made in the past to influence financial conditions.

4. Effects on the transmission mechanism

The growing use of internet technology will affect the transmission mechanism in a myriad of ways, through influences on financial institutions, trading in financial markets and changes in the behaviour of the real economy. Assessing how quickly these changes will occur and the size (or even sign) of the net impact is very difficult. But this problem should not be overstated. Central bankers have been coping with significant and hard-to-predict changes in the nature of the transmission mechanism (whether induced by technological change, financial deregulation, currency unification or division, or even the move from a planned to market economy) for the last three decades and will continue to do so.

In general, the application of internet technology to the real economy could be thought most likely to accelerate the impact of monetary policy. For example, the use of information technology to economise on inventories ("just-in-time" procedures) and track sales more closely means that a reduction in sales will reflect more quickly in changes in output and prices. The more rapid spread of information via the internet should enable agents to react more promptly.

By contrast, it is possible that some e-finance developments will attenuate, or at least slow, the impact of a monetary policy tightening. The development of e-finance is completing markets, and removing frictions. Monetary policy will therefore have to operate more by changing relative rates of return rather than quantities and this process may be weaker and slower. For example, previously constrained firms may be able to access a wider range of potential lenders, which could weaken the credit channel of monetary policy. If hedging against exchange rate and interest rate fluctuations becomes easier and cheaper, this could reduce the responsiveness of activity and prices to changes in interest rates.

On the other hand, the spread of e-broking in retail markets may increase the importance of wealth effects in the monetary transmission mechanism. It has markedly reduced transactions costs, which has been a factor in encouraging more small investors to invest directly in equity markets. This may mean that reductions in equity prices resulting from a tightening in monetary policy would have much larger effects than were observed after the 1987 stock market crash.

The transmission mechanism may also be influenced by the impact of e-finance on competition between financial institutions. For example, it had been suggested that virtual banks operating without physical branches would make such large savings on operating costs that they would be able to offer more attractive interest rates than established banks. However, it now appears that savings on branch operating costs are offset by the much higher marketing expenses they incur (see the paper by DeYoung in this volume). More importance is now being accorded to network effects and economies of scale which may in time lead to increased consolidation in the finance industry, possibly making the market in the longer term less competitive and responsive.

Another institutional change arising from the development of e-finance is the emergence of new entities. These include vertical portals (which compare offers from rival banks), smart agents (which go one step further and automatically transfer funds to the bank offering the best deal) and aggregators (which consolidate information about a consumer's various bank accounts). These might all be expected to reduce information and transactions costs and so reduce lags in the monetary transmission mechanism.

The move from floor- or telephone-based trading to e-trading in financial markets allows fundamental changes to the market microstructure. Architectural features such as access, and the extent of transparency and anonymity, are now a matter of choice rather than being dictated by physical limitations. E-trading could have implications for the liquidity and volatility of financial markets. At least in the short term, a proliferation of new trading platforms in some currently centralised markets may be reducing the liquidity in each individual platform. However, in many formerly OTC markets such as for foreign exchange and bonds, e-trading is exerting a centralising effect. While e-trading may reduce the profitability of designated market-making, causing firms to scale back this activity, it is arguable how much designated market makers contribute to maintaining liquidity. As e-trading is reducing the cost of trading, it is likely to lead to increased market participation, which should increase liquidity.[12] A report

[12] The impact may depend on the nature of the additional participants. Markets are increasingly dominated by institutional investors seeking slightly better returns than their rivals. As the managers of these funds are often evaluated by a comparison of their short-term performance with their peers, they tend to behave like a herd, rushing in and out of markets

by the Committee on the Global Financial System (2001) found no firm evidence that liquidity had suffered from the introduction of electronic trading.

5. Effects on data used in setting monetary policy

As distinct from the technical ability to operate policy by moving instruments, e-finance may complicate the task of setting these instruments by affecting the data analysed by central banks. For example, if e-money eventually displaces a significant amount of banknotes, then monetary base and M1 growth rates will be misleadingly low if e-money is not included. Furthermore, offshore e-banks may attract a significant share of deposits and provide a significant share of loans, or e-finance may enable more financing to occur through securities markets rather than banks. In this case, broader monetary and credit aggregates may be similarly misleading. The entry of non-financial institutions outside current data collections into financial activity may cause further distortions.

Central banks who place weight on such indicators in their monetary policy deliberations may need to start planning data collections on e-money and incorporate it into their measures. Since 1998, the European Central Bank has included e-money issued by banks as overnight deposits and therefore as a component of the monetary aggregates. However, it is not clear that a monetary aggregate that included a sizeable component of e-money would bear the same relationship to economic activity as one based on current forms of money. For example, if e-money were to contribute to a more efficient payment system, it could boost the velocity of circulation of monetary aggregates. The analysis would be further complicated to the extent that e-money was interest-bearing or substituting for components of the money supply that pay interest.

The wider use of internet banking may mean that a significant proportion of liquidity available to domestic residents is held with banks physically located in foreign countries. If the domestic authorities are to know the extent of this, it may be necessary to ask foreign countries to request information from their banks on non-resident deposits and for central banks then to exchange such information, perhaps by building on the existing BIS international banking statistics.

Macroeconomic data used by but not compiled by the central bank will be affected by e-commerce more generally. Sales are increasingly being made over the internet (and in the case of software, music etc the product delivered over the internet). These are likely to be missed from the traditional surveys of retail stores by statisticians. This could lead to inflation being overstated if internet purchases are cheaper. Even if the prices are the same, the volume of private consumption may be understated. Policymakers could then set policy too loose if they mistakenly interpret the apparent fall in consumption as a drop in domestic demand.

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together. By reducing the costs of transacting, e-trading may just add to the number of investors jamming the exits. Herding investors may hit limits simultaneously, causing them all to sell at once, leading to further sharp price falls. In this way a vicious circle may arise, amplifying price volatility. However, encouraging more participants may also mean there are more contrarian investors able to buy at lows and sustain temporary losses if needs be, which will act to stabilise prices.

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Glossary

John Hawkins[1]

The literature on e-finance has spawned a lot of technical terms. These are the meanings assigned to terms in the papers in this volume. Other documents may use some terms in other ways.

Terms in *italics* denote a cross reference.

Access	The possibility to participate in a market.
Adverse selection bias	Problem of an insurer being unable to assess risk and therefore pricing inappropriately and so attracting excessive numbers of poor risks.
Aggregator	*Internet*-based facility allowing customers to view information about (and perhaps shift funds between) their accounts from several financial institutions on a single screen eg Yodlee. Also known as "screen scraper".
Akerlof's lemons model	Analysis of *adverse selection bias* by George Akerlof, originally published in August 1970 issue of the Quarterly Journal of Economics.
Algorithm (order execution)	Rules to determine the method by which orders are matched.
AMEX	A major US equity market, organised as a floor-based *order book*.
Analogue	Information that is continuously variable (cf *digital*).
Anonymity	Non-disclosure of identities of counterparties (pre-trade or post-trade).
Architecture (market)	Broadly, key features of market structure such as participation arrangements, venues, trading *protocols*.
Asymmetric information	See *Information asymmetry*.
ATS	Alternative trading system; a non-traditional market for trading securities, particularly one which matches buy and sell orders automatically without the intervention of a human *broker* or *market-maker*.
BCBS	Basel Committee on Banking Supervision. A committee established by the G10 central banks with secretariat support from the BIS.
Bertrand competition	A model of duopoly pricing in which price equals average cost.
Bid-ask spread	Difference between the buying and selling price.
Block trade	Large, potentially market-moving trades, which may be exempt from an exchange's usual disclosure rules.
Broker	Firm which operates in a market on behalf of other participants to arrange transactions without being a party to the transactions itself (cf *dealer*).
Bundle matching	An *algorithm* that matches orders for securities in bundles and provides *price discovery*.

[1] Thanks are due to Helen Allen, Lihui Lin, Jochen Metzger and Tom Minic for helpful comments. The glossary draws on Committee on Payment and Settlement Systems, *A glossary of terms used in payments and settlement systems*, January 2001, and Committee on the Global Financial System, *The implications of electronic trading in financial markets*, January 2001 (both available at www.bis.org), and E Banks, *e-Finance: the Electronic revolution*, John Wiley & Sons, 2001.

Call market	An order-driven market where orders are processed at discrete points in time, being matched by a particular *algorithm*. (Referred to as *crossing system* where prices are matched at the price in another market.)
Cherry-picker	Firm only competing in the most profitable areas of a business rather than providing a range of services.
Clearing	The process of transmitting, reconciling and sometimes confirming instructions to transfer instruments prior to *settlement*.
Clicks-and-mortar	Bank which operates through both the *internet* and physical branches, also known as "hybrid operation" or "surf and turf" (cf *virtual bank*).
Consolidation of trading	Bringing together aspects of the trading process (*order routing*, *execution*) into a smaller number of markets (cf *fragmentation of trading*).
Contestable market	Market where potential competitors can readily enter (and exit) and compete effectively with existing firms.
Continuous market	Market that trades on an ongoing basis (cf *call market* or periodic market).
Counterparty credit risk	The risk that the market participant on the other side of a transaction will default.
Crossing system	System matching buy and sell orders at a price determined in another market, eg POSIT. Such systems play no part in *price discovery*. Also known as "price-taking systems". (See *call market*). (See pages 44-5).
Cryptography	The application of mathematical theory to develop techniques that can be applied to data to ensure goals such as confidentiality, data integrity and/or authentication.
Cybermoney	*E-money* that is transferred via telecommunications networks such as the *internet*.
DDOS	Distributed denial of service. An attack where hackers overload a website with spurious messages so that others cannot access it. (See page 22).
Dealer	Firm whose primary business is entering into transactions on both sides of wholesale financial markets and seeking profits by taking risks in these markets (cf *broker*).
Dealer market	Market where orders for *execution* pass to an intermediary (*dealer*) who executes them from their inventory.
Debit card	Card enabling the holder's purchases to be directly charged to an account at a deposit-taking institution.
Delivery-versus-payment (DVP)	A mechanism in a *settlement* system ensuring that the final transfer of one asset (eg a purchase) occurs simultaneously with, and only with, the transfer of another asset (eg a payment).
Demutualisation	Process of exchanges converting from a cooperative organisation owned by member *dealers* and *brokers* to a profit-oriented company.
Derivative	A financial contract whose value depends on the value of one or more underlying reference assets, rates or indices.
Digital	A method of representing data via discrete, well-defined samples (cf *analogue*).
Digital certificate	The electronic equivalent of the handwritten signature and unique to the holder. It verifies identity and address and can be used to validate digital cheques and other payment instructions (cf *digital signature* and *smartcard*).

Digital cheque	An internet-based payment system, eg *PayPal*.
Digital divide	Situation where only the affluent and IT-literate have easy access to the financial system.
Digital money	See *cybermoney*.
Digital signature	A string of data generated by *cryptography* attached to a message to ensure its authenticity and protect the recipient against repudiation by the sender.
Direct debit	Pre-authorised deduction from a payer's bank account initiated by the payee.
Dot com	New, often speculative, companies based on *internet* applications.
E-banking	Banking operations conducted using the *internet*.
eBay	A prominent *internet*-based auction system.
EBG	Electronic Banking Group; a group of experts established by the *BCBS*.
E-broking	The processing of orders for purchase and sale of share sent to *brokers* from customers using the *internet*.
EBS	Electronic broking services. *Electronic trading* system for trading foreign exchange.
E-cash	Multi-purpose *SVCs* and *smartcards* eg *Mondex*.
ECB	European Central Bank.
ECNs	Electronic Communication Network, a class of *ATS* used for US equities, notably those listed on *Nasdaq*, eg Instinet, Island. (Sometimes used more broadly as a synonym for *ATS*).
E-commerce	Sale of goods and services carried out over the *internet* or other public networks.
Economies of scale	Situation where unit costs drop as volume increases.
E-finance	Electronic finance. The provision of financial services over the *internet* or other public electronic media. This includes money, banking, payments, trading, broking, insurance etc. Also known as "digital finance". Subset of *e-commerce*.
Efficient market	Market where prices balance underlying supply and demand and adjust as smoothly as possible to embody all available information, without discontinuities or excessive volatility unrelated to fundamentals.
EFT	Electronic funds transfer. A standard mechanism for electronically transmitting funds between two parties.
E-insurance	Insurance operations conducted using the *internet*.
Electronic order routing	Delivery of orders to *execution* system.
Electronic trading	Use of electronic means for transforming orders into trades.
E-money	Money stored electronically in a device such as a *smartcard* or *SVC*, or as *cybermoney*.
EMU	Economic and Monetary Union, within the European Union.
Encryption	The use of *cryptography* to encode text to prevent unauthorised observation.
Eurex	A Swiss/German electronic derivatives exchange offering trading, *clearing* and *settlement* on one platform.

EuroMTS	A trading platform for euro-denominated government bond benchmarks of nine euro area countries.
Execution	Turning matched orders or trade proposals into actual trades.
Explicit trading costs	Costs such as market access fees, commissions, tax, *clearing* and *settlement* costs and staff and *IT* overheads (cf *implicit trading costs*). (See page 42).
Extranet	Linked network of *intranets* or part of a company's *intranet* that is extended to users outside the company. They may be used to share securely part of a business's information or operations with suppliers, vendors, partners or customers.
Financial portal	A financial institution of the future that develops proprietary indices focusing on individual needs and providing customers with financial instruments based on these indices. The business model resembles that of internet portals such as AOL and Yahoo!
First mover advantage	Possible ability of first entrant to a market to achieve a dominant position eg by setting standards or through establishing a dominant brand name. (See page 38).
Fragmentation of trading	Division of some aspects of the trading process (*order routing*, *execution*) between different markets (cf *consolidation*).
Giro transfer	A credit transfer system.
Governance	Rules covering the operation of a market and its participants.
GSM	Global standard for mobile communications.
Hotelling model	Model of duopolistic competition.
IAIS	International Association of Insurance Supervisors.
IBAN	International Bank Account Number.
Iceberg order	An order (partially) invisible on the order book.
ICT	Information and communication technology.
Implicit trading costs	The *bid-ask spread* and impact on market price of a trade (cf *explicit trading costs*). (See page 43).
Indication of interest (IoI)	An investor's stated, but non-binding, desire to purchase securities at a given price.
Information asymmetry	Tendency for some market participants (eg banks, *brokers*) to be better informed than others (eg customers).
Infrastructure	Features required for a market to operate, such as communication devices, software and equipment for *execution*, *clearing* and *settlement* procedures.
Internet	An open worldwide communication infrastructure consisting of interconnected computer networks and allowing access to remote information and the exchange of information between computers.
Intranet	An *internet*-like system only operating within a single organisation.
IPO	Initial Public Offering; the initial sale of shares in a new company.
IT	Information technology.
LIFFE	London International Financial Futures Exchange.
Liquidity	Characteristic of a market where transactions do not markedly move prices. Liquid markets usually have low *bid-ask spreads* and high volume.

Limit order	Order to buy a specified quantity up to a maximum price, or sell subject to a minimum price (cf *market order*)
Market impact cost	Cost of a trade resulting from an order moving the price against a *trader*. Such costs are smaller in a market with high *liquidity*.
Market-maker	*Dealer* obliged to quote buy and sell prices in return for certain privileges within a market.
Market order	Order to buy (or sell) a specified quantity at the prevailing price (cf *limit order*).
M-commerce	Sale of goods and services carried out using mobile phones, particularly if they are also used to make payment.
Micropayment	A small payment (sometimes taken as under US$ 10, sometimes meaning not more than a few cents) which would be uneconomical to process through traditional payment media.
Microstructure (market)	Literature analysing specific institutions, exchanges and trading rules, especially their role in *price discovery*.
Mondex	A type of *smartcard* designed for consumer purchases.
Money base	Monetary liabilities of the central bank. Sometimes called "high-powered money".
Monex	A Japanese e-*broker*.
Moral hazard	Problem of insurance leading to the insured engaging in riskier behaviour.
Nasdaq	*OTC* market for US equities specialising in high-tech stocks.
Network effect, network externalities	Tendency for liquid markets to attract further liquidity as market participants want to trade where others are already actively trading. Sometimes referred to as "demand side *economies of scale*". (See page 38).
Network money	See *cybermoney*.
Network puzzle	Observation that despite pressures for *consolidation*, many markets are subject to *fragmentation*.
NYSE	New York Stock Exchange.
Opacity	Opposite of *transparency*.
Open network	System design based on publicly available and standardised software, enabling easy interlinkage (cf *proprietary system*).
Order book	A market where prices are determined by an order execution algorithm from participants sending firm buy and sell orders (cf *quote-driven* or *dealer* market).
Order routing	Delivery of messages from end users to the *execution* system.
OTC	Over the counter. Bilateral transactions not conducted on a formal exchange.
Outsourcing	The practice of a firm contracting a non-core activity to a third party.
Pareto improvement	A change that makes at least one person better off but nobody worse off.
PayPal	A type of *digital cheque*.
Positive feedback	Situation whereby a market with high *liquidity* attracts more participants, all participants benefit from the additional liquidity, making the *network* more attractive to others, and so on.

Prepayment card	A card on which value is stored for which the holder has paid the issuer in advance.
Price discovery	Determination of prices in a market (cf *crossing system*).
Pricing engines	Systems that automatically generate prices.
Proprietary system	System that can only be used with a specific market or *dealer* (cf *open network*).
Protocol	A set of rules governing trading, eg the types of orders allowed (*market order*, *limit order*, stop-loss, off-market, etc), minimum tick size, rules to halt trading, special rules for openings and closings.
Public good	Commodity or service available to everyone in an area, regardless of their willingness to pay, and where one person's consumption does not diminish that of others. Classic examples include defence and street lighting.
Public key infrastructure	The system of technology, rules and institutions to use *cryptography* to ensure data confidentiality. Elements include certification authorities issuing *digital certificates* and use of different keys for encryption and decryption.
Pure-play internet bank	See *virtual bank*.
Quality (market)	Broadly, market performance across a range of attributes such as *liquidity*, volatility and *resilience*.
Quote-driven	Refers to a market where a class of participants, possibly *market-makers*, post bid and ask quotes, often indicative, with prices being determined through bilateral negotiation.
Regulatory arbitrage	Institutions choosing their preferred (possibly laxest) among alternative regulators.
Relabelling	A financial institution selling another's product under its own name to its customers.
Resilience	Ability of a market to function in an efficient, *liquid* and orderly manner at times of great price uncertainty and market stress.
SEC	Securities and Exchange Commission. A major regulator of financial markets in the United States.
Seigniorage	Profit earned by a central bank by printing money, ie issuing an interest-free liability to buy interest earning assets.
Selection bias	Use of a non-random sampling procedure that does not provide an accurate representation of the population. A class of this is *adverse selection bias.*
Service level agreement (SLA)	A contract between the service provider and receiver that defines the services and service levels and also specifies the guarantees. (See page 22).
Settlement	Completion of a transaction by exchange of instrument and funds.
Shill bidding	The deliberate placing of bids in an auction to raise artificially the price of an item. (See pages 22-3).
Smart agent	A *vertical portal* that not only compares products and services offered by different financial institutions but automatically selects the best offer.
Smartcard	An integrated circuit card with a microprocessor, capable of performing calculations and producing a *digital signature*.

STP	Straight-through-processing: the capture of trade details directly from front office systems to back office. Completes automated processing of *clearing* and *settlement* instructions without the need for re-keying or reformatting data.
SVC	Stored value card. A prepaid card in which the record of funds can be increased as well as decreased. Also called an electronic purse.
SWIFT	Society for Worldwide Interbank Financial Telecommunication. An international messaging system for payment instructions.
TCE	Technology, communication and entertainment industries.
Technology neutral	Approach of supervisors which balances the desire to set regulatory guidelines before market developments go too far against the risk that a heavy-handed regulatory approach may stifle innovation.
Tipping	Tendency for a system provider that has achieved a large market share to move quickly to a (near) monopoly.
Token money	Items such as precious metals and stones that have intrinsic or alternative use value, or objects such as notes and coin that are essentially valueless but generally accepted as media of exchange.
Trader	Employee of *dealer* or end user paid to operate in financial markets.
Transparency	Ability of market participants to observe trade information in a timely fashion. (See page 40).
Tunnelling protocols	Standards governing methods of transferring encapsulated data through private tunnels over public networks.
Upstairs trading	Special arrangement for handling (usually) *block trades*, possibly involving less transparency.
Vertical portal	*Internet*-based, possibly customised, facility allowing customers to compare products and services offered by a range of financial institutions with links to the individual institutions eg CNNfn, Yahoo Finance, Motley Fool.
Virtual bank	A bank operating through the *internet* with no physical branches (cf. *Clicks-and-mortar*).
VPN	Virtual private network. A private data network that uses public networks but maintains security through *tunnelling protocols* and security procedures such as access control and *encryption*. (See page 22).
Xenocurrency	A currency in common use outside its country of issue. Also termed “eurocurrency”.
Y2K issue	Concerns that computer systems would be disrupted by treating 1 January 2000 as 1 January 1900 as old programs only stored the last two digits of years.