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**Between novelty and fashion –  
Risk management and the adoption of computers in retail banking**

**By**

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**Abstract**

This chapter explores developments in researching the adoption of applications of computer technology by retail deposit-accepting financial institutions. Contributions to date suggest an understanding of both technological and business decisions. This is a research agenda informed by developments both in the history of computing and in business and economic history because the analysis of computer applications in business should consider not only how decisions came about but also the expectations of decision makers and the context and stakeholders that helped to shape business decisions. This is a view which aligns with that of Wadhvani and Jones' (2014) "constitutive historicism" or the investigation of how economic actors' perceptions of their own places in historical time shape their strategies.

## **1. Introduction**

Late in 2015, HSBC was host to some 275,000 unfinished retail payment transactions in a single day (Collinson and Bachelor, 2015). This was within a month of the day when 600,000 payments were unfulfilled at the Royal Bank of Scotland and its subsidiaries NatWest, Ulster Bank and Coutts (McAteer, 2015; Sheffield, 2015). Something along the same lines took place almost simultaneously at the Commonwealth Bank in Australia (Mannix, 2015). Upgrades of legacy software were to blame in all cases.

Meanwhile in wholesale markets and also in 2015, a significant reduction in Chinese stock prices was followed by similar moves across the world. These events led international economic commentator Rana Foroohar (2015) to lament about how little had been learned by financial authorities and market participants about computer trading exacerbating a market correction. Foroohar's view was not novel as similar comments had been a regular feature in the media since at least October of 1987, when computer trading emerged as one of the causes behind the so-called "Black Monday" (Morris, 1987).

Foroohar's comments, developments around "Black Monday" and developments in retail banking, show how at the dawn of the twenty-first century applications of computer technology are ubiquitous and a fact of life in banking and finance. Indeed, there is some consensus that the most important forms of change in retail finance since 1970 have been associated with the adoption of computer applications, regulatory innovation and/or new ways to assess (and price) risk (Bátiz-Lazo and Woldensenbet, 2006; Bátiz-Lazo and Wood, 1999, 2003; Williams, 2015). The adoption of information technology (IT) and computer applications in particular plays a crucial role in the strategic expansion of financial institutions. This growth has been reflected in both the size of business and territorial expansion as financial institutions have constructed national and international networks of agents, representative offices, retail branch outlets and full fledged subsidiaries. The process of

adoption of IT began in the mid to late 1950s. Early computer applications in securities trading involved testing whether stock market prices followed a random walk or not; whereas inside financial institutions computers were initially employed around the accounting function (such as payrolls or digitalizing ledgers). Throughout the following decades, banking and finance became one of the main consumers of computer applications across the world.

There is a growing body of systematic studies discussing the impact and use of information technology in business and, particularly, financial institutions in Western Europe and North America from an historical perspective. There are several strands to these contributions, dating from the early introduction of mechanical contraptions and computers (Berkeley, 1949; Booth, 2001; Campbell-Kelly, 1989; Campbell-Kelly, 1992, 1998; Ellis, 1931; Osborn, 1954; Rouse, 1930; Wardley, 2000) to more recent efforts which include, among others, conceptual discussions (Bátiz-Lazo and Wood, 2002; Coombs et al., 1992; Lamoreaux et al., 2003; Langlois, 2003), the deployment of specific devices (Bátiz-Lazo, 2009; McKenney and Fisher, 1993; McKenney et al., 1997) and applications (Haigh, 2001, 2006; Pardo-Guerra, 2011; Stearns, 2011), single company and industry case studies (Bátiz-Lazo and Wardley, 2007; Billings and Booth, 2011; Booth, 2001, 2007; Martin, 2012; Wardley, 2000; Wood and Bátiz-Lazo, 1997) as well as the nature of organizational groups (Billings, 2007; Maixé-Altés, 2014; Scott and Zachariadis, 2014) and specific practices (Poon, 2011).

In spite of these contributions and, indeed, a special issue (Bátiz-Lazo and Boyns, 2004) and an edited book (Bátiz-Lazo et al., 2011), the study from an historical perspective of how computers have changed risk management decisions in financial markets and institutions remains underexplored. Although historians have published on computerization in European and North American financial institutions during the late twentieth century, little has been

documented on similar experiences in Asia, Africa, Oceania and Latin America.<sup>1</sup> As a result, the field is somewhat underrepresented within the overall history of banking (Colvin, 2015). Others such as Frame and White (2009) continue to perpetrate the myth that all innovations in this area have emerged solely from experiences in the United States.

In short, this chapter will focus on how IT applications changed decision-making processes and risk management routines in retail banking. This is important because, first, it focuses not on the devices but on changes in the management of information. Indeed, the glamour and novelty of applications of computer and communications technologies for a while overshadowed research on how organizational processes, procedures and routines changed (or not) following the adoption of mechanical, electromechanical and digital machinery (Cortada, 2011). Information is the fundamental component of the modern corporation (Yates, 1989, 1997, 2005). Yet focusing on innovations associated with information technology will help to articulate an overview of the evolution of both commercial banking and computing as well as the history of their industrial organization. This approach thus enables computing to be viewed as a business history (Cortada, 1996), and banking to be seen as part of the history of computing (Cortada, 2006).

The next section briefly discusses the challenges of researching innovation in banking. The third section offers a broad look at the history of computing in retail banking from the perspective of the business historian. Emphasis is placed on how decisions to adopt general-purpose computing were made. The fourth and final section reflects on the long-term impact of computer technology on banks' risk management whilst offering a tentative way forward.

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<sup>1</sup> Notable exceptions include Bátiz-Lazo and Smith (forthcoming); del Angel (2011); Rishi and Saxena (2004).

## **2. About innovation in banking**

Researching computers in banking and finance from an historical perspective requires developing an understanding of different types of innovation in order to ascertain the nature of technological change. At its most basic, innovation is associated with economic growth and depicted, for instance, as an expansion of the production possibilities frontier or a movement along the long-term average cost curve. Empirical validation, however, is often inconclusive, partly because “innovation” is one of those overused terms in business and economics that has effectively lost meaning.<sup>2</sup> Whether assessing the impact of new regulation, changes in the productivity of individual firms or the development of new skills or instruments to assess risk, studies of financial innovation have been subject to the same constraints. This thus renders any review that aims to summarize research into innovation in financial markets and institutions either totally encompassing or thoroughly incomplete.

In this chapter I have opted for the latter whilst aiming to consider broad trends within established and emerging systematic contributions towards the better understanding of technological innovation as related to the application of computer technology within retail financial markets and the institutions that populate them. Specifically, I will focus on deposit-taking financial institutions with an emphasis on the so-called commercial banks. These are the organizational forms that dominated empirical studies as well as the market for retail deposits in most countries throughout the twentieth century. Of course, this is not an attempt to dismiss other organizational forms that by the end of the twentieth century had populated markets for retail finance including investment banks, savings banks, micro-finance, postal banks, import/export banks, development banks, insurance companies, hire purchase organizations, et cetera.

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<sup>2</sup> For an interesting yet brief critique on the culture of innovation in business and management see Lepore (2015).

A second order of ideas is the duration of technological change in banking. This is a process which can be dated to the origins of retail banking in the late seventeenth century. Since then financial intermediaries working in retail banking markets have undergone a sustained and continuous process of change that has altered their nature, size, structure and behaviour. In the last century or so financial institutions have also been locations of significant technological change – though as the locus of the diffusion of new technology rather than the development of novel machinery. And by their application of waves of new technology, financial intermediaries have adapted to change both in terms of what they do and of how they do it.

Inevitably, the nature of mechanization and the type of technology introduced to achieve "modernity" is a significant part of this chapter. However, this is not a tale of technological determinism. Rather, managers and directors at retail banks endeavoured to assess the costs and benefits associated with the adoption of new technologies and act appropriately given their perceptions of the business environment (Coopey, 1999, 2004). A case in point is the adoption of the cash dispenser in 1967. This was novel and untested technology and one of the few examples where banks rather than engineers promoted its conception and development in Britain and Sweden (Bátiz-Lazo, 2009; Bátiz-Lazo et al., 2014). The innovation was a direct response to and a potential solution for greater unionization and spiralling labour costs. Banks in several other countries (as diverse as the USA, France, Spain, Mexico and Israel) promptly followed suit and explored the potential of this device, albeit cautiously by deploying individual or at most a couple of dozen units. Throughout the 1970s the devices evolved as they sought to replicate different forms of transactions otherwise undertaken by a human bank teller. Banks in several countries persevered and continued to invest in this technology as it was until the mid- to late 1980s

when “it came of age” and proprietary networks grew to thousands of units each (Harper and Bátiz-Lazo, 2013).<sup>3</sup>

Of course, managers’ assessments altered significantly as the economic, social, political and cultural landscape was transformed by a number of factors. These included: the much expanded role of the state as shown by the adoption of British-made ICL by the Post Office and Trustee Savings Banks as a result not of a cost/benefit analysis but of the British government’s belated policy attempts to develop an indigenous computer industry (Bátiz-Lazo et al., 2014; Billings and Booth, 2011); the impact of war as innovations for the military found their way into business, such as IBM translating knowledge developed through intercontinental ballistic missiles into the business applications of computers (Cortada, 2006); changing perceptions of gender as up to the 1970s women were limited to secretarial and repetitive, labour-intensive jobs (Booth, 2008; Wardley, 2006); and the development of a large managerial class and its increased professionalism (more below). Although new technology underpins these developments, these additional themes also play a role in this story.

Mechanization and later on computerization took place on the back of long-established systems of control in the form of an adherence to closely specified practices and protocols. These clearly specified and supervised routines (and accounting systems) determined the organization and nature of day-to-day business in head offices and retail bank branches.

An illustration of the transformation of these processes relevant to the theme of this edited book is how computer applications changed the location of and responsibilities for assessing the credit worthiness of individual customers. For most of the twentieth century this was the remit of the manager of the retail branch, who decided on advances to individual customers (or equally importantly, filtered requests to head office). Achieving the status of

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<sup>3</sup> The ATM Industry Association expected there to be three million ATMs across the globe by the end of 2015 and the total number of global cash withdrawals from ATMs to rise to above 8.6 billion per year (Morrison, 2014).



manager of a retail branch carried great responsibility and offered financial and social rewards, because the manager had important standing within his community (Bátiz-Lazo and Wood, 2000). The managers were all men, recruited as school leavers (aged 16). They rose through the ranks by proving themselves trustworthy, disciplined and cautious (Seltzer, 2004). When assessing credit worthiness the usual criteria were not the individual's cash flow or history of liquid balances (i.e. the ability to repay) as much as the nature of the collateral, history at the branch, social standing and reputation. Eligibility thus required a relationship with the manager and access to a current account which, to begin with, was mostly the remit of the well off and middle-class men. There was, of course, a degree of "credit rationing".<sup>4</sup>

Things were to change, at least in part as a result of retailers developing numerical credit scoring (Poon, 2009, 2011). Retail banks adopted this system much later, already in computerized form and controlled from head office. This brief example thus illustrates that the result of this and other forms of computerization was to upset the organizational setting built in the decades prior to World War II by introducing central offices that would replace retail branches as the bank's value creation units (Ackrill and Hannah, 2001; Bátiz-Lazo, 2009).

### **3. From ledger to laser beam**

A process involving great changes in the equipping of bank offices began in the late nineteenth century and heightened during the first two decades of the twentieth century. New technology, embodied in telephones, typewriters, pneumatic communication tubes, photographic records, steel filing cabinets, paper clips and electric lighting became more common (see Table 9.1). One such innovation saw the adoption of the adding machine which

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<sup>4</sup> In their seminar article, Stiglitz and Weiss (1981) define "credit rationing" as an excess demand for loans where individuals of the same credit standing have been denied an advance either randomly (i.e. an internal deficiency of the bank) or as a result of "redlining". Redlining was originally coined in the USA to describe the practice of denying services, either directly or through selectively raising prices, to residents of certain areas based on the racial or ethnic makeup of those areas.

could undertake many of the essential but routine operations of basic arithmetic that characterized the overwhelming majority of operations undertaken in banks and other bureaucratic organizations (Wootton and Kemmerer, 2007). Communication between the specialists managing the bank's accounting function and vendors of mechanical accounting devices (such as NCR, IBM and Burroughs) was important (Cortada, 1993). Their interaction cemented long-lasting relationships that would later see accountants<sup>5</sup> spearheading the introduction of computer equipment into some banks as the vendors of mechanical accounting diversified into general-application computer equipment (Bátiz-Lazo and Wardley, 2007).

**<TABLE 1 ABOUT HERE>**

Electromechanical tabulators were a second group of important devices (Heide, 1994, 2008, 2009). The adoption of these required a special set of skills for their operation which included, among others, a group of people (usually pools of women) transferring handwritten information to punch cards, as well as a group of specialists (usually men) that could reprogram the device for different applications by physically rearranging the wiring (Bátiz-Lazo and Wardley, 2007; Booth, 2008; Wardley, 2006). The latter group would often form the kernel of the operations and methods departments inside commercial banks (Booth, 2004, 2007), and, like accountants, would be responsible for advising on the adoption of general-purpose computing.

As is implied above, the directors of commercial banks in the 1950s and 1960s relied on middle managers in accounting and operations and methods departments to make decisions about the adoption of general-purpose computers. But more often than not they had

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<sup>5</sup> The trajectory of accountants inside retail financial institutions remains largely uncharted. They certainly do not seem to have achieved the same level of influence as their counterparts in manufacturing (Matthews et al., 1998).

little idea of what was involved in the use of computers. Nonetheless senior managers were willing to invest and explore this technology (Martin, 2011, 2012). A case in point is that of Sir John Anthony Holt Saunders (1917-2002), chief executive of HSBC between 1962 and 1972.<sup>6</sup> Saunders came to regard computerization as vital for the future of the bank after a visit to the United States in the mid-1960s. Saunders returned to Hong Kong convinced of the need to keep up with US banks. In 1964 he set up a Methods & Research (M&R) unit to study the use of computer technologies and assigned the task of supervising computerization to Norman Howard Talbot Bennett (born 1921). As head of the M&R team Bennett negotiated the bank's first contract for a computer with IBM in December 1965. A key point here is that British-born Bennett had left the United Kingdom and joined HSBC in 1946, well before the British banking industry began introducing electronic computers in the late 1950s. Bennett had, therefore, been isolated from these developments and knew little more than Saunders about computers.<sup>7</sup> Neither did Bennett possess knowledge of any of the disciplines (such as engineering, maths or physics) that would typically gravitate to electronic computing.

This was symptomatic. Immersed in the logic of an internal labour market<sup>8</sup>, bank directors would appoint “bankers” to learn about computing while mistrusting “engineers”. As mentioned, this was partly a reflection of the inertia of the systems and procedures related to control, although a lack of knowledge about computers in general also played a part. But keeping up with technological change was demanding and by the early 1970s directors increasingly relied on external consultants (Bátiz-Lazo and Wardley, 2007; Kipping and Westerhuis, 2014). At the same time, and as was the case in Swedish savings banks, some

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<sup>6</sup> Unless otherwise stated the remainder of this paragraph borrows freely from Bátiz-Lazo and Smith (forthcoming).

<sup>7</sup> HSBC was not totally blind in the navigation of its first adoption as key appointments on Bennett's team were British expatriates who had firsthand programming experience with computers (Bátiz-Lazo and Smith, forthcoming).

<sup>8</sup> Internal labour markets required the implementation of career structures and, most important of all, the designation of power and authority within a retail branch network (Seltzer, 2004; Wardley, 2000).

young managers embraced the technological change agenda early on and eventually moved up to positions of responsibility where they could implement ideas which in the past were seen as far-fetched (Bátiz-Lazo et al., 2014).

There is reason to believe that, at least in the Swedish case, young managers really believed in the new methods. Throughout the 1950s these young managers were under the leadership of Sven G Svensson, director of Sparfrämjandet, who also organized annual conferences in Saltsjöbaden (near Stockholm) to facilitate the meeting of like-minded young managers (Bátiz-Lazo et al., 2014; Thodenius et al., 2011). They were united by the idea that the savings banks had to adjust to social change. Furthermore, they believed that savings banks should meet the challenge of commercial banks not by demanding protection from the state but by introducing better services. Many of the ideas that came out of the conferences at Saltsjöbaden were implemented during the 1960s and 1970s as the attendants reached influential positions within the savings banks. As a result the Swedish savings banks evolved from small-scale savings institutions to ‘modern’ business-oriented banks.

It is up to further empirical research to determine whether this type of experience was unique to Sweden and, of even more interest, how changes in attitudes towards computer applications permeated banking organizations as the twentieth century came to a close. The fact remains, however, that a chasm was to open inside banking organizations. In the course of the last three decades of the twentieth century banks increasingly relied on applications of IT for more than gaining greater efficiency in everyday business, and “engineers” and “bankers” fought for control of the organization (Fincham et al., 1994). This arm wrestling prevailed until “hybrids” or people that could be trusted and also thoroughly “speak” the language of both banking and engineering rose through the ranks and came to dominate banking organizations in the late 1990s (Bátiz-Lazo and Wood, 1999, 2003).

#### **4. In summary: Bankers, risk and IT**

This chapter has focused on the role of technicians and computer specialists in the introduction of computerization in banking. It has discussed how financial institutions in general and retail deposit-accepting banks in particular, adopted mechanical, electromechanical and then digital devices. Initially the aim was to gain greater efficiency in operations. But at the same time the introduction of these labour-saving devices brought about changes (perhaps Tayloristic in nature) within the banking organization where customer-facing staff lost their skill set.

Evidence of this is the manager of the retail bank branch losing social standing within his immediate community. Algorithms inside computers rather than managers of retail bank branches would make ultimate decisions about loans and other types of advances. This was not a linear process. Technology changed but so did bankers and the society around them. In the long term is hard to distinguish cause from effect as these factors were intimately intertwined. For instance, banks' active recruitment of female university graduates rather than male school leavers is yet another sign of change in banks' practices and in society.

In any case, new practices and new technologies brought about new challenges such as keeping up with technological change and the creation of new communities of practice that would bid for the ultimate control of the banking organization. Thus a legacy of technological change in the late twentieth century was the computer technicians and computer engineers influencing and shaping banks' risk management techniques. Initially they were seen as a separate and distinctive group. But the jury is still out as to whether the early twenty-first century saw a new breed of banker-technician (such as John Reed at Citibank) or whether key computer applications remain the remit of a handful of people (ergo, there is no deep understanding of computer systems by senior managers).

This chapter has emphasized retail markets and the adoption of hardware. The latter is relatively easy to follow given the large capital investment and lifespan involved. There is still much to be learned about smaller devices (such as mini- and personal computers) and, as noted by Gandy (2013), the role of software in shaping practices, procedures and recruitment.

Meanwhile, and with notable exceptions (Kyrtsis, 2010; Pardo-Guerra, 2011; Scott and Zachariadis, 2012, 2014), there is a dearth of studies of the computerization of wholesale financial markets from an historical perspective. This is in sharp contrast to the attention that the sociology of finance has given to these markets and institutions (McKenzie, 2005; Millo and McKenzie, 2009; Pardo-Guerra, 2010). Broadly speaking, this field argues that computer networks are built to replicate social connections rather than to influence or be shaped by those practices. Whether economic and business historians share this view is yet to be seen. But this literature certainly offers a place to initiate a conversation. There is also a body of literature around the history of computers and computing that often touches on banking applications, published in outlets such as *IEEE Annals in the History of Computing*, *History & Technology*, and *Technology and Culture*. And there is of course the work of information system academics and their various outlets, who also regularly deal with issues within financial service organizations.

Finally, and given the large lacuna in this area, it is hard at the start of the twenty-first century to ascertain the extent to which computers took over risk management from human beings or human beings imposed themselves to shape technological change. Hopefully this chapter will enthrall others who will help to shed light on this question.

## References

- Ackrill, M., Hannah, L., 2001. *Barclays: The Business of Banking 1690-1996*. Cambridge University Press, Cambridge.
- Bátiz-Lazo, B., 2009. Emergence and Evolution of ATM networks in the UK, 1967-2000. *Business History* 51, 1-27.
- Bátiz-Lazo, B., Boyns, T., 2004. The business and financial history of automation and technological change in 20<sup>th</sup> century banking. *Accounting Business and Financial History Journal* 14, 225-232.
- Bátiz-Lazo, B., Karlsson, T., Thodenius, B., 2014. The Origins of the Cashless Society: Cash Dispensers, Direct to Account Payments and the Development of On-line Real-time Networks, c. 1965-1985. *Essays in Economic and Business History* 32, 100-137.

- Bátiz-Lazo, B., Maixé-Altés, J.C., Thomes, P., 2011. Technological Innovation in Retail Finance: International Historical Perspectives. Routledge, London and New York.
- Bátiz-Lazo, B., Smith, A., forthcoming. The Changing Industrial Organization of Epistemic Communities During Hong Kong's Progression Towards a Cashless Society (1960s-2000s). IEEE Annals in the History of Computing.
- Bátiz-Lazo, B., Wardley, P., 2007. Banking on Change: Information Systems and Technologies in UK High Street Banking, 1919-1969. *Financial History Review* 14, 177-205.
- Bátiz-Lazo, B., Woldensenbet, K., 2006. Product and Process Innovations in Banking. *International Journal of Financial Services Management* 1, 400-421.
- Bátiz-Lazo, B., Wood, D., 1999. Management of Core Capabilities in Mexican and European Banks. *International Journal of Service Industry Management (Special issue on Service Management in Latin America)* 10, 430-448.
- Bátiz-Lazo, B., Wood, D., 2000. Effects of Regulatory Change on European Banks: A Case Study on the Strategy and Stock Market Performance of Lloyds Bank 1980-1993. *Journal of European Financial Services* 4, 31-63.
- Bátiz-Lazo, B., Wood, D., 2002. An Historical Appraisal of Information Technology in Commercial Banking. *Electronic Markets - The International Journal of Electronic Commerce & Business Media* 12, 192-205.
- Bátiz-Lazo, B., Wood, D., 2003. Strategy, Competition and Diversification in European and Mexican Banking. *International Journal of Bank Marketing* 21, 2002-2016.
- Berkeley, E.C., 1949. *Giant Brains or Machines That Think*. John Wiley & Sons, New York.
- Billings, M., 2007. Corporate Treasury in International Business History, Business and Economic History On-Line. The Business History Conference.



- Billings, M., Booth, A.E., 2011. Techno-Nationalism, the Post Office and the Creation of Britain's National Giro. In: Bátiz-Lazo, B., Maixé-Altés, J.C., Thomes, P. (Eds.), *Technological Innovation in Retail Finance: International Historical Perspectives*. Routledge, London, pp. 155-172.
- Booth, A.E., 2001. British Retail Banks, 1955-70: A Case of 'Americanisation'? In: Kipping, M., Tiratsoo, N. (Eds.), *Americanisation in Twentieth Century Europe: Business, Culture, Politics*. Université Charles de Gaulle, Lille, pp. 309-323.
- Booth, A.E., 2004. Technical Change in Branch Banking at the Midland Bank, 1945-75. *Accounting, Business and Financial History* 14, 277-300.
- Booth, A.E., 2007. *The Management of Technical Change: Automation in the U.K. and U.S.A. since 1950*. Palgrave, Basingstoke.
- Booth, A.E., 2008. Technological Change and Gender in the Labour Policies of British Retail Banks, 1945-70. In: Melling, J., Booth, A.E. (Eds.), *Managing the Modern Workplace: Productivity, Politics and Workplace Culture in Postwar Britain*. Ashgate, Aldershot, pp. 101-124.
- Campbell-Kelly, M., 1989. *ICL - A Business & Technical History*. Clarendon Press, Oxford.
- Campbell-Kelly, M., 1992. Large-scale data processing in the Prudential, 1850-1930. *Accounting, Business and Financial History* 2, 117-139.
- Campbell-Kelly, M., 1998. Data Processing and Technological Change: The Post Office Savings Bank, 1861-1930. *Technology & Culture* 39, 1-32.
- Collinson, P., Bachelor, L., 2015. HSBC to process 275,000 delayed payments overnight. *The Guardian*, London (August 28, 2015).
- Colvin, C., 2015. *The Past, Present and Future of Banking History*, Queen's University Centre for Economic History. The Queen's University of Belfast, Belfast.

- Coombs, R., Knights, D., Willmott, H., 1992. Culture, Control and Competition: Towards a Conceptual Framework for the Study of Information in Organizations. *Organization Studies* 13, 51-72.
- Coopey, R., 1999. Management and the Introduction of Computing in British Industry, 1945-70. *Contemporary British History* 13, 59-71.
- Coopey, R., 2004. A Passing Technology: The Automated Teller Machine. In: Lyth, P., Trischler, H. (Eds.), *Wiring Prometheus: Globalisation, History and Technology*. Aarhus University Press, Aarhus, pp. 175-192.
- Cortada, J.W., 1993. *Before the Computer: IBM, NCR, Burroughs, and Remington Rand and the industry they created, 1856-1956*. Princeton University Press, Princeton, NJ.
- Cortada, J.W., 1996. *Information Technology as Business History: Issues in the History and Management of Computers*. Praeger Publishers, Westport, CT.
- Cortada, J.W., 2006. *The Digital Hand, Vol. 2*. Oxford University Press, New York.
- Cortada, J.W., 2011. *Information and the Modern Corporation*. The MIT Press, Cambridge, MA.
- Del Angel, G., 2011. Computerization of commercial banks and the building of an automated payments system in Mexico, 1965-1990. In: Bátiz-Lazo, B., Maixé-Altés, J.C., Thomes, P. (Eds.), *Technological Innovation in Retail Finance: International Historical Perspectives*. Routledge, London, pp. 92-117.
- Ellis, F.J., 1931. New Lamps for Old: Part I. *The Spread Eagle* 6, 404-407.
- Fincham, R., Fleck, J., Procter, R., Scarbrough, H., Tierney, M., Williams, R., 1994. *Expertise and Innovation: Information technology strategies in the financial services sector*. Oxford University Press, Oxford.
- Foroohar, R., 2015. A Market Rout Carries Echoes of the 2008 Crash. What hasn't Been Fixed?, *Time*. Time Magazine, New York, NY, 7-8.

- Frame, W.S., White, L.J., 2009. Technological Change, Financial Innovation, and Diffusion in Banking. Federal Reserve Bank of Atlanta, Atlanta, GA.
- Gandy, A., 2013. Book Review: Technological Innovation in Retail Finance. *Economic History Review* 66, 1227-1228.
- Haigh, T., 2001. The Chromium-Plated Tabulator: Institutionalizing an Electronic Revolution, 1954-1958. *IEEE Annals of the History of Computing* 23, 75-104.
- Haigh, T., 2006. 'A Veritable Bucket of Facts': Origins of the Data Base Management System, 1960-1980. *ACM SIGMOD Record* 35, 73-88.
- Harper, T.M., Bátiz-Lazo, B., 2013. Cash Box: The Invention and Globalization of the ATM. NetWorld Media Group and ATM Industry Association, Louisville, KY.
- Heide, L., 1994. Punched-card and computer applications in Denmark 1911–1970. *History and Technology* 11, 77-99.
- Heide, L., 2008. Punched cards for professional European offices: revisiting the dynamics of information technology diffusion from the United States to Europe, 1889-1918. *History and Technology* 24, 307-320.
- Heide, L., 2009. Punched-Card Systems and the Early Information Explosion, 1880-1945. The Johns Hopkins University Press, Baltimore, MD.
- Kipping, M., Westerhuis, G., 2014. The Managerialization of Banking: From Blueprint to Reality. *Management & Organizational History* 9, 374-393.
- Knight, L., 2013. A dark magic: The rise of the robot traders. British Broadcasting Corporation, London.
- Kyrtsis, A.A., 2010. Financial Markets and Organizational Technologies: System Architectures, Practices and Risks in the Era of Deregulation. Palgrave-Macmillan, Basingstoke.

- Lamoreaux, N.R., Raff, D.M.G., Termin, P., 2003. Beyond Markets and Hierarchies: Towards a New Synthesis of American Business History. *American Historical Review* 108, 404-433.
- Langlois, R.N., 2003. The vanishing hand: the changing dynamics of industrial capitalism. *Industrial and Corporate Change* 12, 351-385.
- Lepore, J., 2015. *The Disruption Machine: What the gospel of innovation gets wrong*. The New Yorker, New York.
- Maixé-Altés, J.C., 2014. ICT the Nordic Way and European Savings Banks. In: Universidad A Coruña, (Ed. MPRA / Ideas.RePEc.org). A Coruña, Munich.
- Mannix, L., 2015. Customers stranded at supermarkets, servos as CommBank hit by tech outages. *Sydney Morning Herald*, Sydney (September 11, 2015).
- Martin, I., 2011. Britain's First Computer Centre for Banking: What did this Building Do? In: Bátiz-Lazo, B., Maixé-Altés, J. C., Thomes, P. (Eds.), *Technological Innovation in Retail Finance: International Historical Perspectives*. Routledge, London, pp. 37-70.
- Martin, I., 2012. Too Far Ahead of its Time: Barclays, Burroughs and Real-Time Banking. *IEEE Annals of the History of Computing* 34, 2-16.
- Matthews, D., Anderson, M., Edwards, J.R., 1998. *The Priesthood of Industry: The Rise of the Professional Accountant in British Management*. Oxford University Press, Oxford.
- McAteer, O., 2015. NatWest, RBS, Coutts and Ulster Bank customer payments are 'missing' after technical glitch. *Metro*, London (June 17, 2015).
- McKenney, J.L., Fisher, A.W., 1993. Manufacturing the ERMA Banking System: Lessons from History. *IEEE Annals of the History of Computing* 15, 7-26.
- McKenney, J.L., Mason, R.O., Copeland, D.G., 1997. Bank of America: The Crest and Trough of Technological Leadership. *MIS Quarterly* 21, 321-354.

- McKenzie, D., 2005. *An Engine, not a Camera: How Financial Models Shape Markets*. MIT Press, Cambridge, MA.
- Millo, Y., McKenzie, D., 2009. The usefulness of inaccurate models: Towards an understanding of the emergence of financial risk management. *Accounting, Organizations and Society* 34, 638-653.
- Morris, B., 1987. Probe into Computer Trade. *The Times*, London (October 22, 1987).
- Morrison, D., 2014. 3 Million ATMs Worldwide By 2015: ATM Association. *Credit Union Times*.
- Osborn, R.F., 1954. GE and UNIVAC: Harnessing the High-Speed Computer. *Harvard Business Review* 32, 99-107.
- Pardo-Guerra, J.P., 2010. Creating flows of interpersonal bits: the automation of the London Stock Exchange, c.1955-1990. *Economy & Society* 39, 84-109.
- Pardo-Guerra, J.P., 2011. The Automated House: The Digitalization of the London Stock Exchange, 1955-1990. In: Bátiz-Lazo, B., Maixé-Altés, J.C., Thomes, P. (Eds.), *Technological Innovation in Retail Finance: International Historical Perspectives*. Routledge, London and New York, pp. 197-220.
- Poon, M., 2009. From new deal institutions to capital markets: Commercial consumer risk scores and the making of subprime mortgage finance. *Accounting, Organizations and Society* 34, 654-674.
- Poon, M., 2011. Historicizing Consumer Credit Risk Calculation: The Fair Isaac Process of Commercial Scorecard Manufacture, 1957–circa 1980. In: Bátiz-Lazo, B., Maixé-Altés, J.C., Thomes, P. (Eds.), *Technological Innovation in Retail Finance: International Historical Perspectives*. Routledge, London, pp. 221-245.
- Rishi, M., Saxena, S., 2004. Technological innovations in the Indian banking industry: the late bloomer. *Accounting, Business and Financial History* 14, 339-353.

- Rouse, H.L., *Mechanisation in the Banks*. Journal of the Institute of Bankers. Meetings of the British Bankers' Association and the Committee of London Clearing Banks, London, 1930.
- Scott, S.V., Zachariadis, M., 2012. *Origins and Development of SWIFT, 1973–2009*. *Business History* 52, 462-483.
- Scott, S.V., Zachariadis, M., 2014. *The Society for Worldwide Interbank Financial Telecommunication (SWIFT): Cooperative governance for network innovation, standards, and community*. Routledge, London.
- Seltzer, A., 2004. *Internal Labour Markets in the Australian Banking Industry: Their Nature Prior to the Second World War and Their Recent Decline*. *Accounting Business and Financial History* 14, 237-256.
- Sheffield, H., 2015. *RBS completes 600,000 delayed payments three days after they were due*. *The Independent*, London (June 19, 2015).
- Stearns, D.L., 2011. *Electronic Value Exchange: Origins of the VISA Electronic Payment System*. Springer, London.
- Stiglitz, J.E., Weiss, A., 1981. *Credit rationing in markets with imperfect information*. *American Economic Review* 71, 393-410.
- Thodenius, B., Bátiz-Lazo, B., Karlsson, T., 2011. *The history of the Swedish ATM – Sparfrämjandet and Metior*. In: Impagliazzo, J., Lundin, P., Wangler, B. (Eds.), *History of Nordic Computing 3: Revised Selected Papers*. Springer, Berlin.
- Wadhvani, R.D., Jones, G., 2014. *Schumpeter's Plea: Historical Reasoning in Entrepreneurship Theory and Research*. In: Bucheli, M., Wadhvani, R.D. (Eds.), *Organizations in Time: History, Theory and Methods*. Oxford University Press, Oxford, pp. 192-216.

- Wardley, P., 2000. The Commercial Banking Industry and its Part in the Emergence and Consolidation of the Corporate Economy in Britain before 1940. *Journal of Industrial History* 3, 71-97.
- Wardley, P., 2011. Women, Mechanization and Cost-Savings in Twentieth Century British Banks and other Financial Institutions. In: Richardson, M., Nicholls, P. (Eds.), *A Business and Labour History of Britain. Case studies of Britain in the Nineteenth and Twentieth Centuries*. Palgrave Macmillan, Houndmills, Basingstoke, pp. 32-59.
- Williams, J., 2015. Electronic Banking. In: Cooper, C. L. (Ed.), *The Blackwell Encyclopaedia of Management – Vol. IV Finance (3rd ed)*. Blackwell Publishing, Oxford.
- Wood, D., Bátiz-Lazo, B., 1997. Corporate Strategy, Centralization and Outsourcing in Banking: Case Studies on Paper Payments Processing. *International Association of Management Journal* 9, 33-57.
- Wootton, C.W., Kemmerer, B.E., 2007. The Emergence of Mechanical Accounting in the U.S., 1880-1930. *The Accounting Historians Journal* 34, 91-124.
- Yates, J., 1989. *Control through Communcation: The Rise of System in American Management*. The John Hopkins University Press, Baltimore and London.
- Yates, J., 1997. Early Interactions Between the Life Insurance and Computer Industries: The Prudential's Edmund C. Berkeley. *IEEE Annals of the History of Computing* 19.
- Yates, J., 2005. *Structuring the Information Age*. The Johns Hopkins University Press, Baltimore.

<b>Table 1: The Use of Technology in the Organisation</b>					
	<b><u>Early Adoption</u></b> <b>(1770-1915)</b>	<b><u>Early Mechanisation</u></b> <b>(1916-1955)</b>	<b><u>Specific Application</u></b> <b>(1956-1971)</b>	<b><u>Emergence</u></b> <b>(1967-1982)</b>	<b><u>Diffusion</u></b> <b>(1983-2005)</b>
<b>Innovation in Service Offering</b>	<ul style="list-style-type: none"> <li>• Reduce inter-market price differentials.</li> </ul>		<ul style="list-style-type: none"> <li>• Conversion from branch to bank relationships</li> <li>• Automated bank statements</li> <li>• Cheque guarantee &amp; credit cards</li> </ul>	<ul style="list-style-type: none"> <li>• Growth of cross border payment.</li> <li>• Widespread adoption of ATM.</li> <li>• Bank of the 'masses'.</li> <li>• New external forms to price risk (Eurobonds, options)</li> </ul>	<ul style="list-style-type: none"> <li>• Supply of non-payment products like insurance, mortgages and pensions.</li> </ul>
<b>Operational Function Innovation</b>	<ul style="list-style-type: none"> <li>• Internal forms to price risk (Joint stock &amp; permanent BS)</li> <li>• Explore economies of scale (Amalgamation)</li> </ul>	<ul style="list-style-type: none"> <li>• Increased co-ordination between head office and branches.</li> <li>• Facilitate specific tasks (eg accounting and payroll)</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce cost of labour intensive activities (i.e. clearing system)</li> <li>• Demise of internal labour market</li> </ul>	<ul style="list-style-type: none"> <li>• Automation of branch accounting.</li> <li>• Real time control begins.</li> </ul>	<ul style="list-style-type: none"> <li>• Growth of alternative distribution channels, such as phone, e-banking and EFTPOS.</li> </ul>

Source: Bátiz-Lazo and Wood (2002), Bátiz-Lazo and Wardley (2007) and author



