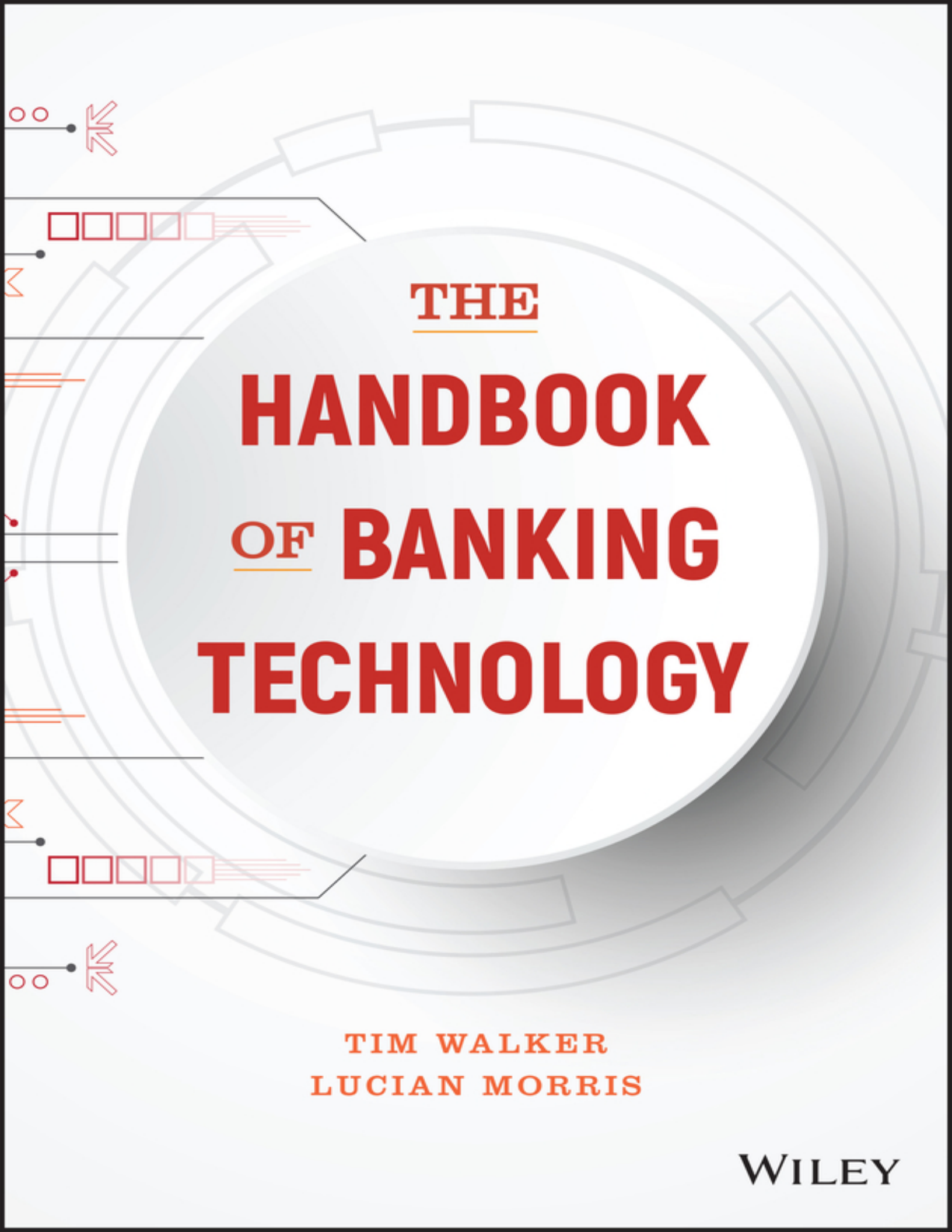

THE HANDBOOK OF BANKING TECHNOLOGY

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WILEY

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To Debbie, Tom, Holly and Emily.

– TJW

To Jo, Cameron and Amelie.

– LAM

Preface

Our goal in writing this book is to bring about a better understanding of the complex world of technology in banking. Of course, there are many books covering just about every aspect of technology, from mainframe computers to cloud computing and from the first programming languages such as COBOL to the latest such as Go. However, books that cover how technology is used in the banking industry are rare to non-existent, which means that those working in the industry have had to rely on documentation supplied by vendors, training courses, the Internet and, of course, by talking with their colleagues in the technology function. Throughout our careers working for many different types of banking and payment businesses, from one of the smallest with a single branch to the largest international banks and various start-ups along the way, we found documentation supplied by vendors, with some notable exceptions, is often incomplete or superficial, only available after attending a training course or only aimed at developers. Attending training courses is often expensive in terms of both money and time and Internet resources can be patchy, of variable quality and sometimes just wrong. One of the reasons we decided to write this book was to fill this gap.

This book is therefore targeted at all readers with an interest in banking and technology, not just technologists. It provides an introduction to the history of banking and an analysis of the current technology landscape that supports the major functions of modern banks, and looks at the opportunities and risks posed by the digital era that we are in. To read this book you do not have to be deeply technical, nor focused only on technology. Instead the book

aims to provide all readers with a common understanding of the opportunities and challenges related to technology that all banking businesses must address.

Of course, if you are an executive or manager in the banking industry who wishes to improve your understanding of the technology used in the industry, this book is particularly relevant. It should also provide a good introduction for those who are embarking on a career in technology in the banking industry or who have changed roles in a banking technology function and need to familiarise themselves with the technology used in their new area. It's also useful for those looking to launch a new bank or fintech start-up, even if only to illustrate how technology should not be implemented!

We cover retail and commercial banking, which includes bank accounts, secured and unsecured lending, payments, and payment cards, across all the channels from branches to mobile banking that are in common use, and all of the functions that you'd expect to find in a modern bank, from operations and finance to marketing. We have focused on the technology behind basic bank accounts, payments, and customer interaction and been less detailed about the platforms that support specialised banking products. We don't cover investment banking, investment management, asset management or insurance, which would probably require books in their own right. We have drawn on our experience in the banking sector in Europe, the Middle East, and North America, although readers will quickly understand that we tend to draw most deeply on our experience in the UK, where we have spent most of our careers.

Of course, banking businesses are often complex and the technology they use is also complex, wide-ranging and anything from five or more decades old to right up to date.

Our aim is to provide an overview of the technology in use so that if you are a manager or executive outside the technology function you should be able to have more informed conversations with your colleagues in the technology function, and if you are in the technology function you should better understand the wider context of the work you are doing or managing. If you need to get more technical, you can consult the references and further reading lists that we provide.

As we are covering technology in the banking industry, we often tend to use the term *bank* when in reality what we have written applies to businesses that provide banking services and which may not, strictly speaking, be banks. If we were to follow the UK's banking regulators, an organisation can only be called a bank if it is licensed to take deposits. For example, credit card issuers and lenders that do not take deposits are not banks but they do provide banking services, and many aspects of what we have written in this book are also relevant to them. Given that payments are integral to banking, we have devoted a chapter each to card payments and to interbank payments.

Acknowledgements

We started thinking about and then writing this book several years ago. However, progress was patchy as work and family life (including Lucian's cycling accidents and the death of Tim's teenage son from leukaemia) took priority. By the start of 2020 we had written less than a third of the final manuscript. However, we decided to take advantage of the lockdown due to the Covid-19 pandemic to focus on completing the book. Our families sustained us while we beavered away, for which we say a huge thank you.

Although we worked together previously, this exercise has taught us that co-authoring a book can be challenging but

is ultimately rewarding. Reviewing each other's writing made us realise we had different writing styles and points of view on various topics, and that sometimes what one or the other of us had written was just plain wrong. At times we have even been a little short with each other. However, we were always able to discuss and resolve these differences with equanimity while also still striving for quality and completeness. If there are mistakes in this book, we accept joint responsibility.

Finally, the last two chapters are relatively opinionated. The reader is perfectly entitled to disagree with what we have written.

CHAPTER 1
Introduction

1.1 Banking and the Rise of Technology

The banking industry, in many varied forms, has verifiably been in existence for at least four millennia. Beginning as a simple money and commodity management activity that supported early merchants and royalty, banking has gradually evolved into today's model: a complex, highly connected network of businesses that spans the globe. While it can appear that the development of the banking industry has generally taken place at a rather sedate pace, in reality banks have been established, grown and consolidated into ever larger organisations seemingly non-stop for centuries.

The advent of computers and, later, the Internet have had a dramatic impact on how banking has been conducted in recent times and ended the long-standing trend of opening more and more branches across the globe. Banks have changed their products and services, developed credit and debit cards, introduced computers to improve efficiency, built multi-channel digital banking platforms and, in many geographies, significantly reduced their high street footprint. They are moving from being brick-and-mortar businesses to what seems often to be purely digital utilities. However, the emergence of digital-only propositions may allow new businesses to develop with a much lower cost to serve, better products and services and more convenient customer access. A *digital-first* world of banking, it is argued, would not only replace the legacy brick-and-mortar

world, but has the potential to deliver business models that will out-compete the incumbents, businesses that have grown huge, cumbersome and complacent. Visionaries and digital advocates in the financial services market argue that incumbent banks are, like the dinosaurs, plodding slowly but surely towards their inexorable extinction. On the other hand, large incumbents have the advantage of huge economies of scale and existing customer bases, meaning they pay less for deposits and make more money from each of their existing customers. Although there is evidence to show that the costs of complex, legacy technology are higher than modern technology, the massive scale of incumbent banks may mean that this cost can be borne for long enough for these banks to modernise their technology estates. Thus, the stage is set for a struggle between the old and the new.

The outcome of this struggle is far from a foregone conclusion and, in fact, the history of banks and banking institutions implies that the bigger ones eventually acquire the smaller ones – for more than a century the total number of banks in developed markets has been declining and this trend continues even up to the present.

Some observers have predicted that the shift to digital will sideline incumbent organisations in a different way, akin to what happened in the mobile telecommunications industry, where huge and highly profitable new businesses offering a new paradigm – the smartphone – were built. The mobile network providers no longer have access to the bulk of the revenue in this industry and are purely utilities with varying levels of profitability and return on capital in different markets around the world. Could incumbent banks just become utilities providing vanilla banking products with the customer relationships intermediated by new organisations with better technology? In practice, many digital new entrants are offering just the same

banking products as incumbents, with a better mobile app, and this doesn't feel like a paradigm shift like the smartphone was. Also, it appears likely that only some incumbents will manufacture products for others and the rest will resist being intermediated unless forced by regulators, such as in the EU, where the Payment Services Directive 2 (PSD2) has resulted in banks having to offer an open banking interface for use by third-party service providers.

There is a third point of view: that to even present the current situation as incumbents versus new entrants and fintech start-ups, or old versus new, may not even be an appropriate or accurate representation of the true picture.

Where many analysts and commentators originally expected conflict (as early as 1994 Bill Gates famously made his big bank dinosaur speech),[1] it is now becoming clear that the relationship between new and old will be much more nuanced, with start-ups as likely to cooperate with incumbents as they are to compete.

So, we believe that the predictions of apocalypse for the incumbents within the banking industry are far from certain. While the digital agenda is creating opportunities for new entrants and does pose a risk to incumbent organisations, the rise of innovative fintech solutions and business models also provides many opportunities for established entities. There is no doubt that a significant amount of work, both forward-looking and in remediation, must be carried out in order for the incumbents to remain competitive and position them to seize these new opportunities, but their size and scale offers stability, established market access, lower unit costs and the income to fund the required changes – all key attributes that the new entrants and fintech start-ups typically lack. Over the last seven decades the established banks have proven

themselves more than capable of adjusting to, and adopting, new technologies (computers, ATMs and Internet banking, to name a few) and any suggestion that a new wave of technologies means certain destruction for them may therefore be premature or even wrong. Not only do they have a proven history of adaptation, but many also have the balance sheets to buy themselves out of trouble should they need to, either through investing in joint ventures with up-and-coming start-ups or through outright acquisition of potential competitors.

Incumbent organisations may well struggle to adapt and there will inevitably be some organisations that will fall by the roadside (which usually means being acquired), but any significant change in market conditions typically results in casualties among the established order in that market. To survive and prosper, the leadership of a bank needs to recognise that it is a fundamentally digital business and that having a sufficient understanding of technology, its uses and sources of competitive advantage is essential.

1.2 The Challenges of Technology in Large Banks

There are several typical challenges that a bank's leadership faces relating to technology. For example, the leadership will have to decide whether its bank can persist in using legacy banking platforms. In order to meet the demands of the new digital economy our incumbent banking organisations require substantial changes within their organisations, and not just in the technology itself. Bank leadership teams need to acknowledge that the banking business is essentially becoming one of technology. Banks are now, at their core, digital businesses, and the leadership team must accept that and ensure that it has the skills at the top of the bank to manage a technology

organisation. One of the reasons we wrote this book is to help to raise the level of understanding of technology among bank management.

Many of the platforms and systems that sit at the core of banking businesses are legacy environments, containing dated software and hardware, that have been built up over many years. Stories continue to circulate about the age of some of these systems. For example, the UK newspaper *The Telegraph*, as recently as December 2016, published an article claiming that some banking platforms in the UK still run on pounds, shillings and pence,[2] the UK's currency before decimalisation in 1971. We do not know whether this story is really true or not, but it was certainly an urban myth that occasionally surfaced in our conversations across the industry during our careers. While the latest developments may have been carried out in modern software development languages, the core of these platforms is still legacy and is often complex and poorly understood and therefore prone to going wrong when changes are made. Not only are these platforms getting on in age, but so are many of the developers who understand them. Such systems are often blamed for the seemingly high cost base of technology, the shortcomings of various products offered by the bank, and the lack of flexibility to introduce new products and services. On the other hand, re-platforming is expensive and full of risk – we are aware of several banks around the world that spent huge sums replacing their core banking platforms, and some, such as TSB in the UK,[3] that ran into highly public difficulties.

In parallel with maintaining legacy banking platforms, it would appear that many banks have struggled to maintain appropriate controls over the ongoing development of their technology estates. Of course, there are many reasons for the huge diversity in technology estates, which include business-led decision-making with technology

standardisation low on the list of priorities, ongoing developments in technology with consequent dead ends and obsolescence, and accumulation of technology variety through mergers and acquisitions. Consequently, modern banking technology estates are complex and often poorly understood, even by the technology functions that run them. Some estates are so large that even tracking the hardware and software within them can be a significant task and many large modern banks struggle to do even this effectively, let alone calculate the input costs for each service that they supply and for which they charge the business units that consume them. Of course, there are usually no easy solutions to the problems posed by this complexity and we are often reminded of the supposedly Irish response to a request by a lost traveller about how to get somewhere which goes *I wouldn't start from here if I were you*.

Banks' technology functions can be as complex and politically charged as any other function in a large business. In large international banks the internal technology organisations are often huge, containing tens of thousands of workers distributed across dozens of sites, and are dependent upon a diverse supplier ecosystem. The structure of these organisations varies from bank to bank and over any given period, often oscillating between business-aligned and technology-driven structures (as discussed in Chapter 9). When business alignment is the primary driver, individual technology functions align with business units and while this may provide greater control to the business units, it can also result in technology functions that associate more with their business unit than with the CIO's office. This can lead to political in-fighting and huge inefficiencies, such as duplication of roles, technologies and third-party relationships within the broader organisation as similar capabilities are established

and technologies built to support the same general need. The alternative model, with alignment to technical horizontals, can deliver much greater technological competence, reduced potential for business-driven in-fighting and lower costs, but does so at the risk of alienating the business units when they cannot get the service they believe they need to support the ongoing running and development of their business. When this happens, we have seen business units develop their own in-house technology functions, resulting in additional technology costs, duplication of roles and systems and a lack of consistency across the technology estate, in much the same way as the business-aligned model.

On top of the challenges associated with managing an international technology organisation, the current low public regard for banking,[4] namely that it is a staid industry, full of untrustworthy middle-aged men in suits with outdated views on technology,[5] makes it harder to recruit graduates and technology professionals that can bring the much needed skills and mindset the industry needs to fully grasp the opportunities presented by the digital world. Also, the ambitious perceive they can have more impact and make more money elsewhere. The talent that is clearly needed in technology departments within incumbent banks is being drawn to the more dynamic environments of technology-centric companies such as Apple, Facebook and Google and the fintech companies that the incumbent banks fear.

Finally, the scale of technology functions, and the complexity and scale of the technology itself, present challenges for the processes used to manage and govern them. These processes often represent legacy practices that are engrained in the culture and mindset of the technology function. Changing these established ways of working requires a supreme effort and a determined

executive team. Despite recent high-profile technology failures, or perhaps even because of them, internal technology functions are often conservative by nature and married to legacy processes and ways of working that are proven, despite being inefficient. In order to adjust to the threats and opportunities posed by the digital agenda, the technology functions will first need to address their legacy operating models and adjust to new ways of working.

1.3 Navigating This Book

In Chapter 2 we provide a review of the history of banking and a snapshot of the current state of the banking industry. This chapter is not essential reading, but it provides context for the rest of the book.

Chapter 3 provides a technology primer, building up a picture of the technology required to support a simple bank that provides bank accounts, credit cards and an Internet banking channel. It includes an overview of core banking platforms, databases, mainframe technology (which is still prevalent in large banks), how platforms are made highly available and how different platforms are integrated, including both service-oriented architecture and microservices. It finishes with a review of data analysis, touching on data warehouses, data marts and data lakes. Less technical readers may not wish to read all the sections in this chapter.

The remaining chapters are sequenced broadly according to the model of a bank we show in Figure 1.1. At the top, it shows the customer segments the bank serves – in this case retail customers, commercial customers (i.e. small and medium-sized enterprises) and corporate customers (i.e. large enterprises). Of course, some banks may use finer segmentation such as underbanked, mass retail and premier retail in place of a single retail segment. The

largest banks are likely to have a wholesale segment, which includes the very largest corporations and other banks as their clients. Normally, each segment will have a corresponding business unit inside the bank with a member of the executive team heading it up and marketing, product management, relationship management and sales staff in the unit.

The customers and potential customers of the bank engage with it through various channels, as shown in alphabetical order in the second layer of Figure 1.1. Note that these channels may technically overlap – for example, emails are usually sent over the Internet, but both are regarded as distinct channels by our bank. Similarly, telephone calls may be made using standard telephone lines, from mobile phones or over the Internet. However, every bank needs to consider if and how it will deal with such a channel. Some channels will have corresponding business units, such as the chat, email, telephone and video channels which would be handled by the bank's contact centre(s). We cover the Internet channel in Chapter 3 and then the other channels in Chapter 4.

The business units that correspond to the first two layers of this model are occasionally called the *front office* of the bank.

The categories of products that the bank offers are shown in the third layer down in Figure 1.1. These are ordered so that the products with more relevance to commercial and corporate customers are to the right-hand side. Retail transaction banking covers retail current accounts and deposit accounts and retail lending encompasses both unsecured lending and lending secured on assets other than property (e.g. vehicle loans). Commercial finance includes asset-based lending, asset finance, leasing and sales finance such as invoice factoring and discounting.

Transaction banking is the provision of bank accounts and services such as cash management to commercial and corporate customers. Syndicated lending is the participation in and organisation of loans underwritten by multiple lenders to corporate customers. For each product type there will sometimes be a corresponding business unit within the bank, particularly for credit cards (which, along with other payment cards, we cover in Chapter 6) and in some cases the product type will be owned and managed by the corresponding business segment. Many banks offer insurance products to their customers, but we do not cover these in this book. Some banks also offer specialist products based on derivatives to corporate clients to manage interest rate and foreign exchange rate risks, which we would class as investment banking products and so we do not cover them.

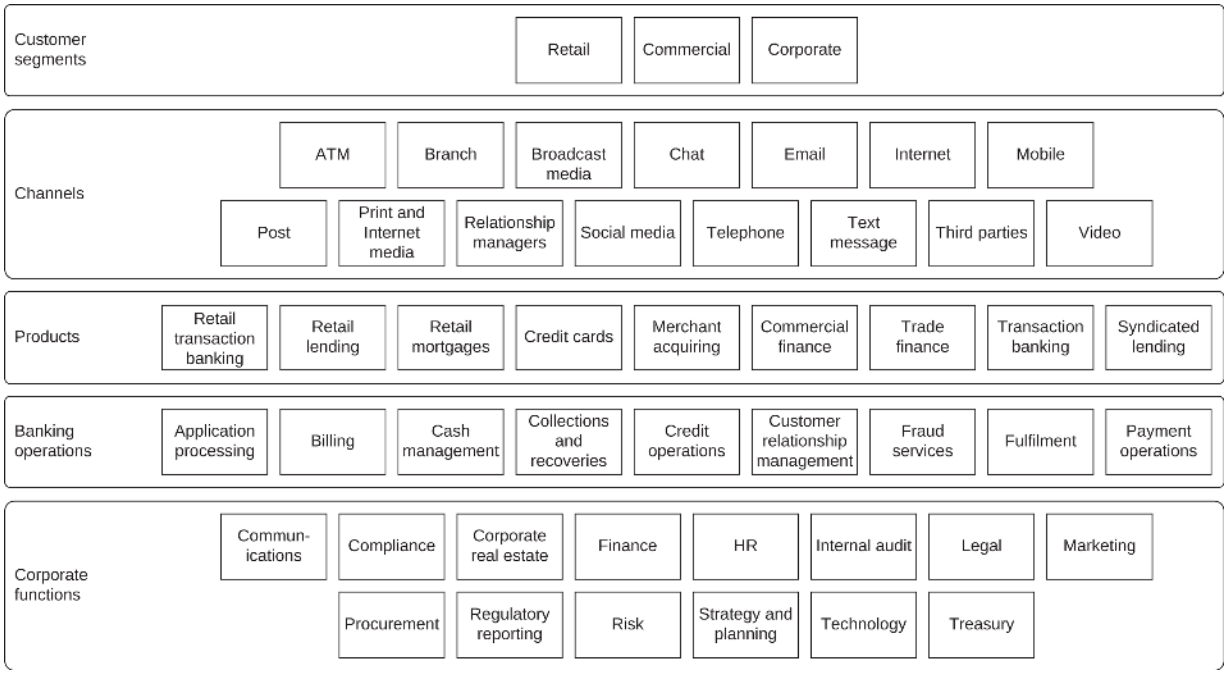

FIGURE 1.1 Operating model of a bank.

The products typically draw on some of the banking operations services shown alphabetically in the fourth layer of Figure 1.1, which are sometimes said to comprise the

middle office. For example, application processing covers the processing of applications for products by new and existing customers, billing covers the billing of customers (typically more complex for larger corporate customers) and credit operations covers deciding whether to lend to a customer and at what interest rate. We cover these services in Chapter 5.

Finally, the lowest layer in Figure 1.1 shows the range of corporate functions a bank may have, i.e. the internal organisational units of the bank (apart from the customer-facing business units aligned with the customer segments in the first layer of the model). Many of these would be described as being in the *back office*, although this varies from bank to bank. In larger banks all the functions shown may exist, whereas in smaller banks some may be combined. For example, communications and marketing are often a single team and finance often includes regulatory reporting and treasury. We cover these functions in Chapter 8, apart from technology, which is the subject of Chapter 9.

Note that, although we have used the classification of front, middle and back office in this section, there are no standard definitions of what is included in each category and many banks do not use this terminology. Some banks use the classification of distribution (broadly equivalent to the sales functions in the front office plus marketing), manufacturing or production (covering the various products manufactured or produced by the bank and the servicing of them) and corporate services (equivalent to the back office). We will tend to avoid these classifications in the rest of the book.

1.4 References