Opportunities for Applying Actuarial Techniques in Banking

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This paper has been approved for publication by the Banking Forum (formerly known as the Banking Working Group) and the Scientific Committee of the IAA. The IAA is the worldwide association of professional actuarial associations, with several special interest sections for individual actuaries. The IAA exists to encourage the development of a global profession, acknowledged as technically competent and professionally reliable, which will ensure that the public interest is served.

The purpose of the Banking Forum is to facilitate discussion and knowledge-sharing among Full Member Associations on issues of international relevance for actuaries working in the Banking industry.

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Tel: +1-613-236-0886  Fax: +1-613-236-1386  Email: secretariat@actuaries.org  1203-99 Metcalfe, Ottawa ON K1P 6L7 Canada  www.actuaries.org

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Abstract

This paper discusses opportunities for the application of actuarial techniques in banking practice for actuaries. It has been produced by the Banking Forum of the International Actuarial Association and the contributions come from experienced actuarial practitioners in different jurisdictions.

The paper provides literature and guidance for actuaries working in the banking industry, both as a reference point and for purposes of continuous professional development (CPD). It may also be useful for non-actuaries working in banking risk management, actuaries considering working in banking, and actuarial associations considering an involvement in the domain of banking.

The topics covered are wide-ranging, illustrating the need for high-level analysis, synthesis and application of judgement in solving complex problems in banking using both quantitative and qualitative techniques. Where appropriate, relevant background, including regulatory frameworks, is given to put things into context and to showcase how the skills and expertise of actuaries are relevant, or can be relevant, in the various scenarios.

The paper is a working paper that is expected to be reviewed and updated over time as more techniques relevant to actuaries in banking are developed and/or identified.
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1 INTRODUCTION

1.1 Purpose of the paper

This paper has been produced by the Banking Forum (BF) of the International Actuarial Association (IAA). The paper is intended as additional reading for actuaries and some banking professionals on the application of actuarial techniques in banking. It highlights areas where actuaries are already involved, and areas where they may become involved.

1.2 Context of the paper

The paper has been prepared on the back of developments in recent years where actuaries are increasingly involved in banking in a number of jurisdictions around the world. It therefore considers banking practice for actuaries in different jurisdictions, including South Africa, Australia, North America and the United Kingdom (UK), and it has been prepared in that context.

1.3 Significance of the paper

We believe that the paper fills a gap that no similar paper on actuarial practice in banking has addressed. Other literature that exists includes the study material produced by the Actuarial Society of South Africa (ASSA) for its banking fellowship subject that covers technical aspects in some detail.

The paper provides information for actuaries working in banking towards understanding how actuarial techniques are being applied or may be applied by actuaries in banking work. The paper may also be useful to other professionals working in banking.

1.4 Delimitations of the paper

- While this paper has been produced by a forum of the IAA and published through the IAA, the paper is based on personal views and experience of individual actuaries working in banking. It is recognized that some of the techniques require further research and development over time.
- The paper expresses the views of the BF of the IAA and the individual actuaries who contributed to each section, but does not necessarily express the views of the IAA, or of the organizations for which the individual actuaries work.
- Some of the concepts covered in the paper relate to certain jurisdictions, such as South Africa, the UK and the United States (USA), for illustrative purposes. While the principles are applicable in other jurisdictions, it may well be necessary to take account of the requirements of national regulators as well as those of the Basel Committee on Banking Supervision (BCBS).
- Each section in this paper has been written independently of the other sections to illustrate a specific concept, with no direct link to the other sections. There should, therefore, be no expectation of linkages between sections or natural flow from one section to another, and the sections can be read independently of each other.
2 Opportunities for actuaries in banking

2.1 Introduction

In 2016, the IAA established the BWG, which is making good progress on a number of initiatives, including education and CPD opportunities, to promote the involvement of actuaries in banking across the global actuarial profession.

In addition, the Banking Education Interest Group (BEIG) was formed after a discussion at the IAA meetings in St. Petersburg in May 2016. It was agreed at subsequent meetings in Cape Town in November 2016 that the BEIG should report to both the IAA Education Committee and the BWG. It was also agreed that the primary purpose of the BEIG is to focus on pre- and post- qualification banking education given that banking is an emerging practice area for actuaries.

In view of this, the BEIG and the BWG developed a banking curriculum guide that is expected to be useful as a framework for IAA member associations in developing knowledge for banking practice. The curriculum guide is based on the ASSA banking syllabus. The BWG has produced a number of other documents in furthering its objectives, and this paper is also a product of that work.

2.2 The opportunities

Most methodologies and techniques used to quantify banking risks and to determine product prices are already familiar to actuaries. Many banking methodologies are prescribed in the Basel regulations. The purpose of the banking curriculum guide mentioned earlier is, therefore, not to develop new methodologies for banking, but to explain banking products, terminology and regulation and to identify areas where actuaries could apply techniques with which they are already familiar. In doing this, actuaries could add value by contributing to setting assumptions and assessing sensitivities (rather than relying on a deterministic approach) and by interacting with all relevant areas in the bank (rather than being limited to a particular ‘silo’).

The roles and opportunities for actuaries in banking were outlined in an investigation by the BWG on the role of actuaries in banking in 2017, building on the significant work initially performed by the ASSA in 2009 in its own investigations in this area.

The roles of actuaries in banking typically relate to risk management. This ranges from credit risk, market risk, liquidity risk and operational risk to other business risks. Each of these risks can be broken down further into a breadth of topics. For example, credit risk is a major area of work and can be broken down into loan origination and pricing strategies, monitoring of portfolio trends, provision of capital and reporting. Given actuaries' quantitative abilities and understanding of the financial world, they are able to play a key role in each of these areas.

These roles are not confined to banks but are also available in consulting firms. Consultants are able to act in advisory roles or audit roles. While audit roles often lead to validation of a bank’s model, advisory roles allow actuaries to build up strategies and models with clients (the banks) across the breadth of risk types and topics.

Actuaries employed in the banking sector and risk-consulting field in jurisdictions such as South Africa and Australia are largely employed in the following areas:
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- Credit scorecard development
- Credit risk management and reporting
- Design and pricing of banking products (credit- and non-credit-related)
- Customer and product profitability analysis
- Customer behaviour analytics
- Provision model development
- Balance sheet management; that is, asset–liability mismatching risk management and liquidity risk management
- Pricing and trading of derivative products
- Capital modelling
- Credit, operational (including fraud analytics) and market risk modelling
- Balance sheet management

The relevant skills and knowledge for actuaries in these areas include:

- Quantitative and modelling skills, including asset–liability modelling
- Knowledge of the nature and pricing of financial and derivative products
- Business and regulatory awareness in the banking sector

Given worldwide regulatory pressures in the banking space, actuaries, among other professionals, are sought after to build cutting-edge models to optimize the risk environment and to work on the forefront of policy development.

### 2.3 Banking risks

In a typical bank, the principal risks are credit risk, market risk and operational risk. Actuaries will already be familiar with market risk and operational risk. For credit risk, the terminology may be new to actuaries, but probability of default (PD) is analogous to claim frequency and loss given default (LGD) is analogous to claim severity. Credit risk assessment is analogous to underwriting. For retail loans, credit risk scorecards are analogous to general insurance underwriting criteria. For a cohort of loans, cumulative default rate is analogous to the inverse of survival rate. Other risks in banking include credit concentration risk, interest rate risk in the banking book, and counterparty credit risk associated with transactions in derivatives.

 Provisioning for credit losses is analogous to reserving for claims, and in this area a recent change in accounting standards has been of particular interest to actuaries. Until 2017, the accounting standard for credit losses was International Accounting Standard 39 (IAS 39), which required banks to take losses as they arose. However, as from 1 January 2018, the accounting standard was changed to International Financial Reporting Standard 9 (IFRS 9), which requires banks to hold provisions for expected credit losses (ECLs), in much the same way that insurance companies hold claims reserves. This is an area where the BWG has already held a webinar and where actuaries with experience of claims reserving in general insurance could propose methodologies for use in banking.

In banking, assets include retail and corporate loans made to customers, and investments, while liabilities include retail deposits, wholesale deposits, loan capital and equity capital. Distinct aspects of
banks are the need to consider liquidity and funding risks (as well as capital risks) and to assess the behavioural as well as the contractual terms of loans and deposits. However, the activities of the asset–liability committee in a bank are analogous to asset–liability management in a life insurance company.

The curriculum guide introduces actuaries to a broad range of banking products, across retail, corporate and investment banking, and to a broad range of financial and non-financial risks associated with them. It focuses on the three principal risks of credit risk, market risk and operational risks in addition to looking at liquidity risks, funding risks and balance sheet management.

2.4 Banking strategy

Banking products can be long-term – either as a result of customer behaviour, as for current accounts, deposit accounts and credit cards, or as a result of contractual terms, as for mortgages. However, many banking products are variable-rate, and their pricing may change from time to time. Customer behaviour may also change over the life of these products.

Despite the differences between long-term banking products and life and pension products, product pricing and profitability in banking is normally assessed by using discounted cash flow (DCF) and net present value (NPV) models that are familiar to actuaries. In doing this, one practical difficulty is estimating the behavioural term of banking products. Another practical difficulty is that, while income associated with the products should be clear, a large proportion of costs may be in shared costs; e.g. branch network and online banking, IT, Treasury and central functions. The allocation of shared costs – and capital – to banking products requires analysis and judgement, and is likely to be of interest to actuaries with experience in assessing the pricing and profitability of life and pensions products. Such actuaries could assist in setting assumptions and could assess sensitivities to different assumptions about income, expenses and risks.

Product pricing and profitability can be extended to customer value analysis. This is becoming increasingly important, as new technologies are increasing competition between banks, as a result of both reduced barriers to entry by new banks and online processes that make it easier for customers to switch between banks. New banks are likely to target relatively profitable products and customers. On the other hand, large established banks may be able to make better use of the large amount of information they have about their customers, particularly through current account relationships.

The curriculum guide provides sufficient information about banking products, risks and capital and liquidity requirements for actuaries already familiar with product pricing and profitability in life insurance and pensions to carry out an equivalent role in a bank. In addition, it describes the strategy-setting and implementation process in a bank: working in group strategy might be of particular interest to an actuary who wishes to learn about all aspects of banking, but who does not wish to be confined to its risk department.

2.5 Banking regulation

The Basel regulations for banks are similar to Solvency II for insurance companies in that they both contain three pillars, which deal with (1) minimum capital requirements, (2) the supervisory review process and (3) public disclosures. Another similarity is that, in quantifying their capital requirements, firms may use either the standardized approach (SA) that is specified in the regulations or, subject to
regulatory approval, their own internal models – or a mixture of these approaches. A further similarity is that, as part of their supervisory review process, firms must make regulatory submissions annually: while insurance companies must make a single submission (ORSA – Own Risk and Solvency Assessment), banks must make two submissions, one for capital (ICAAP – Internal Capital Adequacy Assessment Process) and the other for liquidity (ILAAP – Internal Liquidity Adequacy Assessment Process).

Within these regulatory submissions, actuaries may be particularly interested in areas where the assessment is not purely mechanistic, but requires judgement. One area is judging the adequacy of proposed capital requirements. For banks using their own internal models, actuaries may assess if the computed capital requirements are sufficient for their risks. For banks using the SA, assessment may be on whether they should hold more capital and/or liquidity than the minimum amounts required under the Basel regulations, because of their bank-specific risks.

Another area is stress testing, where banks are expected to carry out a range of stress tests – both system-wide and bank-specific – and to make judgements about the size of the capital buffer that they should hold, on top of their capital requirements, for severe adverse scenarios that may emerge.

A third area where judgement is required is in the quantification of banks’ ECLs.

Actuaries, particularly those already familiar with Solvency II, are well placed to do work for banks, either as employees or as consultants, on the quantification of their capital and liquidity requirements, and on their ICAAPs and ILAAPs. The curriculum guide describes methodologies used to quantify banking risks and capital requirements and liquidity requirements. It also explains the evolution of the Basel regulations, regulatory minimum requirements for capital and liquidity, and the expected contents of ICAAPs and ILAAPs.
3  The Actuarial Function

3.1  Solvency II versus Basel II regulations

An obvious similarity between the Solvency II regulations\(^1\) for insurance companies and the Basel regulations for banks is that both contain three pillars, covering (1) the quantification of risks and capital requirements, (2) the supervisory review process and (3) public disclosures to support market discipline.

An obvious difference is that the Solvency II regulations require insurance companies to have an actuarial function, but that there is no requirement for an equivalent function in banks. Banks operate under the ‘three lines of defence’ model, in which revenue-generating business units form the first line of defence, and the second line includes compliance and risk management functions. Internal audit forms the third line.

![The Three Lines of Defense Model](image)

Source: Occasional Paper No 11, BCBS, December 2015, Graph 1\(^2\).

3.2  Solvency II actuarial function

The Solvency II Directive\(^3\) describes the system of governance which an insurance company must follow. It requires insurance companies to have an actuarial function as well as a risk management function, a compliance function and an internal audit function.

The actuarial function must coordinate the calculation of technical provisions, and must ensure that the methodologies and models used and the assumptions made are appropriate. The actuarial function

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must contribute to the risk modelling underlying the calculation of the insurance company’s capital requirements, and to the preparation of its ORSA.

The actuarial function must be carried out by people with appropriate technical skills, and with experience of working under applicable professional and other standards. The actuarial function must be independent and objective, and free from influence by other functions or by the management and board.

### 3.3 Second line of defence in banks

Second-line-of-defence activities are likely to include:

- Validating models used to quantify all types of banking risk
- Reviewing assessments of ECLs
- Reviewing assessments of capital and liquidity adequacy, allowing for stress testing and for management actions that might be taken
- Contributing to the preparation of ICAAP and ILAAP regulatory submissions

### 3.4 Opportunities for actuaries

Insurance actuaries who have had experience of working within an actuarial function and who are interested in banking might consider building on their existing skills and experience by making lateral moves from insurance to banking, such as:

- From insurance model validation to banking model validation
- From assessing reserves for claims to assessing provisions for ECLs
- From working on ORSAs, including stress testing, to working on ICAAPs and ILAAPs, including stress testing

In this paper, the assessment of provisions for ECLs is discussed in Chapter 9 for EU/UK banks and in Chapter 10 for US banks. The preparation of an ICAAP for a UK bank, including stress testing, is discussed in Chapter 4, while stress testing for US banks is discussed in Chapter 11.

Other interesting areas for actuaries moving into banking include credit risk (Chapter 5); retail banking product pricing and profitability (chapters 7 and 8); customer analytics (Chapter 12); operational risk, fraud modelling and cybersecurity analytics (Chapter 13); and systems and technology (Chapter 14).
4 Capital Adequacy Assessment

4.1 Introduction

This section is written from a UK regulatory perspective, although the principles are equally applicable in most Basel-regulations-compliant jurisdictions.

The section is structured as follows:

- Section 4.2 covers the need for understanding and judgement.
- Section 4.3 covers capital requirements, capital buffers and capital adequacy.
- Section 4.4 covers Pillar 1 capital requirements:
  - Minimum capital requirements for credit risk, market risk and operational risk.
- Section 4.5 covers Pillar 2A capital requirements:
  - Additional capital requirements for credit risk, market risk and operational risk; capital requirements for counterparty credit risk, credit concentration risk, interest rate risk in the banking book and pension obligation risk.
- Section 4.6 covers Pillar 2B capital buffers.
  - Regulatory capital buffers; capital buffers determined by stress testing.
- Section 4.7 covers opportunities for actuaries.

4.2 The need for understanding and judgement

For any bank, the assessment of capital requirements and capital buffers, and of capital adequacy, is a central and ongoing task. Two aspects of the assessment make it interesting for actuaries. Firstly, it covers all aspects of the bank's business, and all the risks that it faces. Secondly, much of the assessment is not a purely mechanistic exercise, but requires understanding of the bank's risks and judgement about the amounts of capital that it should hold.

In setting out its expectations for firms undertaking an ICAAP, the UK regulator, the Prudential Regulatory Authority (PRA) – a part of the Bank of England responsible for the prudential regulation and supervision of banks – stated:

A firm must carry out an ICAAP in accordance with the Prudential Regulatory Authority's ICAA rules. These include requirements on the firm to assess on an ongoing basis the amounts, types and distribution of capital that it considers adequate to cover the level and nature of the risks to which it is or might be exposed. The assessment should cover the major sources of risks to the firm's ability to meet its liabilities as they fall due, and should incorporate stress testing and
scenario analysis. If a firm is merely attempting to replicate the PRA’s own methodologies, it will not be carrying out its own assessment in accordance with the ICAA rules. 4

In practice, there is less need for understanding and judgement in the Pillar 1 assessment of capital requirements when banks are using SAs prescribed in the Basel regulations. However, if banks use the internal ratings-based (IRB) approach for credit risk and/or the internal models approach (IMA) for market risk, understanding and judgement is required in building the bank’s own internal models.

In addition, in the Pillar 2 assessment, as part of the supervisory review process banks are expected to show understanding of their risks and make judgements about the amounts of additional capital (on top of their Pillar 1 minimum capital requirements) and capital buffer (on top of their regulatory capital buffers) that they should hold.

4.3 Capital requirements, capital buffers and capital adequacy

In the UK, and in most Basel-compliant jurisdictions, a bank must carry out its own ICAAP once a year (and additionally in the event of a change in circumstances) and must make a submission to the local regulator (broadly comparable to an ORSA for an insurance company) as part of its Supervisory Review and Evaluation Process (SREP). The expected structure of an ICAAP submission is influenced by the structure of the Basel regulations, which, like Solvency II, comprise three pillars:

- Pillar 1: Quantification of capital (and liquidity) requirements
- Pillar 2: Supervisory review process
- Pillar 3: Requirements for public disclosures

Under Pillar 1, banks must quantify their capital requirements for each of credit risk, market risk and operational risk, using methodologies that are prescribed in the Capital Requirements Regulation (CRR), which reflects the Basel regulations and is applicable to all banks. For credit risk, banks are expected to quantify their risk-weighted assets (RWAs) – that is, the sum of loan exposures times appropriate risk weights. For market risk and operational risk, banks are expected to quantify equivalent RWAs. The banks’ Pillar 1 capital requirements are quantified as 8% of their total RWAs. Within the 8%, at least 4.5% must be in the form of Common Equity Tier 1 (CET1) capital.

Under Pillar 2, within the supervisory review process, the PRA distinguishes between Pillar 2A and Pillar 2B:

- Under Pillar 2A, banks must assess their additional capital requirements for risks not captured, or not fully captured, under Pillar 1.
- Under Pillar 2B, banks must quantify the capital buffer which they should hold for possible severe adverse stress scenarios.

A bank’s total capital requirements (TCR) is the total of its Pillar 1 capital requirements plus its Pillar 2A capital requirements.

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A bank must also hold a capital buffer equal to the larger of the capital buffer determined by stress testing and capital buffers that are prescribed in the Basel regulations.

In assessing its capital adequacy, a bank must prepare financial projections for the next five years, under base case conditions and under stress conditions, and must compare the level of its capital throughout the period with its TCR and with the sum of its TCR and capital buffer.

- A bank’s capital must exceed its TCR at all times, including under stress conditions.
- Under base case conditions, a bank’s capital should exceed its TCR and capital buffer at all times.
- Under stress conditions, a bank may dip into its capital buffer, but would be expected to take management actions that lead to its capital being back above its TCR and capital buffer within a reasonable period.

4.4 Pillar 1 capital requirements

4.4.1 Credit risk

To quantify their capital requirements for credit risk, banks may use the SA. Alternatively, for some categories of loans and subject to regulatory approval, banks may use their own internal models to estimate their credit risk under the IRB approach.

**Standardized approach**

The Basel III revised SA for credit risk (which will become effective on 1 January 2023) prescribes risk weights for various categories of loan assets:

- Risk weights ranging from 20% to 150% are applied to corporate exposure depending on credit rating.
- Risk weights of 75% are applied to retail exposures.
- Risk weights ranging from 20% to 70% are applied to residential property exposures, depending on loan-to-value (LTV) ratio.
- Risk weights are generally 50% higher, ranging from 30% to 105% for exposures to income-producing property.

**Internal ratings-based approach**

As an alternative to the SA for credit risk, banks are allowed, subject to regulatory approval, to use the IRB approach to quantify their credit risk. Under this approach, banks are allowed to use their own internal estimates of the PD, LGD and exposure at default (EAD) – and, in some cases, effective maturity (M). Within the IRB approach, there are two levels: Foundation, where only PDs are estimated internally and the other risk components are prescribed; and Advanced, where all three (or four) risk components are estimated internally.

Under the Basel III regulations, banks will have to comply with output floor requirements, which will limit the extent to which banks can benefit from using their own internal models rather than the SA. From 1
January 2023, the total RWAs of banks using their own internal models will have to be at least a required percentage of their total RWAs based on the SA. The output floor will phased in over five years: the required percentage will be 50% from 1 January 2023, will increase by 5% per annum to 70% from 1 January 2027, and will then increase to 72.5% from 1 January 2028.

4.4.2 Market risk

Market risk relates to positions held in banks’ trading books.

To quantify their capital requirements for market risk, banks may use the SA or the IMA.

Revised methodologies to be used under each of the SA and IMA from 1 January 2023 were set out in minimum capital requirements for market risk, which were issued by the BCBS in January 2016 and which replaced the previous regulations for quantifying market risk.

Minimum capital requirements for market risk introduced a number of important changes to the market risk framework:

- The revised SA is more risk-sensitive – and so is more appropriate for use as a fallback measure, or as a base measure in the output floor (see Section 15.6).
- The revised IMA requires a more rigorous model-approval process.
- Banks will have to use expected shortfall (ES) measures of risk under stress – this will help them to overcome the inability of value-at-risk (VaR) models to capture ‘tail risk’.
- Banks will have to allow for a sudden and severe reduction in liquidity across markets, rather than assume that it would be possible to exit or hedge positions within 10 days.

Banks may hold assets in their banking book or in their trading book. Assets in the banking book are regarded as being held to maturity, and do not need to be marked to market. Assets in the trading book must be marked to market. The boundary between banking and trading books has been revised, to reduce the incentive for banks to engage in arbitrage by switching assets between them.

4.4.3 Operational risk

Currently, four approaches to operational risk are permitted:

- The advanced measurement approach (AMA), which is based on banks’ own internal models
- The basic indicator approach (BIA), where the capital requirement for operational risk is 15% of average income over the last three years
- The SA
- The alternative standardized approach (ASA)

From 1 January 2023, banks will have to quantify their capital requirement for operational risk by using a new SA. This new approach allows for two assumptions:

- That banks’ operational risk accelerates with size (measured by total income)
- That banks which have experienced higher operational risk losses in the past are more likely to do so in future
Under this approach, a bank’s operational risk capital is calculated as the product of its Business Indicator Component (BIC) and its Internal Loss Multiplier (ILM). The BIC is quantified by applying percentages increasing from 12% to 18% to buckets of the bank’s total income, measured as the sum of prescribed components. The ILM is a function of the BIC and the Loss Component (LC), which is 15 times the bank’s average historical losses over the preceding 10 years.

4.5 Pillar 2A capital requirements

Under Pillar 2, judgment is necessary because the capital requirements are principles-based.

In January 2015, the PRA in the UK issued a consultation paper, Assessing Capital Adequacy under Pillar 2\(^5\), in which it discussed the need for UK banks to hold capital for risks that are either not captured, or not fully captured, under the CRR in Pillar 1. It identified risks in each of these two categories:

- Risks not captured: The CRR does not require banks to hold capital for counterparty credit risk, credit concentration risk, interest rate risk in the banking book or pension obligation risk.
- Risks not fully captured: For each of credit risk, market risk and operational risk, some banks may need to hold additional capital under Pillar 2A because their own risks are greater than those of the average bank already allowed for under Pillar 1.

For each of these risks, the consultation paper discussed methodologies which banks might use to quantify their Pillar 2A capital requirements. Unlike Pillar 1, the assessment of Pillar 2A capital requirements is not prescriptive – banks are expected to understand their own risks and to make judgements about their capital requirements for these risks. The PRA has subsequently issued updated versions of this paper, the most recent being The PRA’s Methodologies for Setting Pillar 2 Capital, which was published in February 2020\(^6\).

4.5.1 Credit risk

For banks using the IRB approach, if the PRA believes that a bank’s quantification of its Pillar 1 credit risk capital requirements is not adequate because of shortcomings in the bank’s internal models, the PRA will require the bank to address these shortcomings under Pillar 1, rather than to hold additional capital for credit risk under Pillar 2A.

For banks using the SA, the PRA believes that, for some loans, the SA risk weights underestimate the risks. For this reason, banks using the SA must consider whether they should hold capital for additional credit risk under Pillar 2A.

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To inform banks’ judgement, the PRA published a comparison of SA risk weights and average IRB risk weights (excluding ECLs)\(^7\) for various categories of lending. Significant differences include the following:

- For mortgages with LTV ratios up to 80%, SA risk weights are 35%, while average IRB risk weights increase with LTV ratio band from 4.5% to 13.9%.
- For personal loans, the SA risk weight is 75%, while the average IRB risk weight is 77.5% (in a range from 65.9% to 89.2%).
- For UK credit cards, the SA risk weight is 75%, while the average IRB risk weight is 79.6% (in a range from 67.7% to 91.5%).
- For high-grade sovereigns, the SA risk weight is 0%, while the average IRB risk weight is 7.0%.

The PRA is willing to allow banks, in assessing their need to hold additional capital under Pillar 2A for credit risk, to offset overestimates of capital requirements under Pillar 1 in some categories of lending against underestimates of capital requirements in other categories. However, Pillar 2A capital cannot be negative – that is, banks must hold capital for credit risk at least as much as their Pillar 1 requirements according to the Basel regulations.

Consistent with the guidance given by the PRA that banks should not merely replicate the PRA’s own methodologies, the process of quantifying overestimates (e.g. for mortgages) and underestimates (e.g. for UK credit cards) should not be purely mechanistic, based on the risk weights published by the PRA. In particular, individual banks must take account of the riskiness of their own portfolios relative to the average of portfolios held by UK banks.

4.5.2 Market risk

As for credit risk, if the PRA believes that a bank using the IMA approach has underestimated its Pillar 1 capital requirements for market risk, it will ask the bank to amend its internal models, rather than to hold additional capital for market risk under Pillar 2A.

All banks must consider whether they should hold, under Pillar 2A, additional capital for market risks that are not covered, or not adequately covered, under Pillar 1. The PRA highlighted the need to consider illiquid, one-way and concentrated positions (which the PRA refers to collectively as illiquid risks).

In addition, if the PRA identifies shortcomings in a bank’s market risk systems and controls, it may require the bank to hold a capital add-on under Pillar 2A.

4.5.3 Operational risk

For banks using the AMA, the PRA does not expect them to have to hold additional capital under Pillar 2A for operational risk, unless there are outstanding material actions associated with their AMA approval.

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The PRA requires all banks using an SA (whether the BIA, TSA or ASA) to consider whether they should hold capital for additional credit risk under Pillar 2A.

Various types of operational risk loss event that are defined in the CRR include:

- Internal fraud
- External fraud
- Employment practices and workplace safety
- Clients, products and business practices (CPBP)
- Damage to physical assets
- Business disruption and system failures
- Execution, delivery and process management

CPBP is broadly equivalent to conduct risk. Banks may be required to consider separately their need to hold, under Pillar 2A, additional capital for non-conduct operational risk and capital for conduct risk. A bank’s Pillar 2 operational risk capital requirement is the sum of these two elements.

The PRA recognizes that the quantification of operational risk capital requirements represents “a significant challenge” because of fat-tailed loss distributions (reflecting infrequent events with large losses) and limited data, and that these problems are particularly acute for conduct risk. As a result, the PRA says that the determination of Pillar 2A capital requirements for conduct risk is driven mainly by supervisory judgement.

The PRA says that, in setting Pillar 2A capital requirements for non-conduct operational risk, it will take account of the range generated by three loss estimates:

- C1: This is based on a bank’s forecast of its expected non-conduct operational risk losses, extrapolated to estimate the loss at a 1-in-1,000-years confidence level.
- C2: This is based on the average of a bank’s five largest losses by loss event type (excluding CPBP), repeated for each of the last five years, and calibrated at a 1-in-1,000-years confidence level.
- C3: This uses a bank’s scenario assessments (excluding scenarios associated with CPBP).

4.5.4 Counterparty credit risk

Counterparty credit risk is the risk of losses arising from the default of counterparties to transactions in areas such as derivatives, margin lending, securities lending and repurchase/reverse repurchase agreements.

For banks with advanced model permission, any shortcoming in a bank’s quantification of its Pillar 1 capital requirements for counterparty credit risk, or in its management of this risk, will be addressed as part of the model-approval and model-review process, or by model multipliers or capital add-ons under

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Pillar 1. Under Pillar 2A, banks with advanced model permission are expected to focus on risks not covered by internal models, such as concentration risk and settlement risk.

For banks without advanced model permission, under the Pillar 2A assessment process such banks will have to cover key areas that would have to be covered to get advanced model permission, including qualitative requirements, credit concentration risk, IT sufficiency and data quality, settlement risk, collateral management, wrong-way risk, stress testing, model validation and limitations of non-advanced models.

4.5.5 Credit concentration risk

Loan portfolios may be concentrated in single names, industrial sectors and geographic areas:

- Only wholesale loan portfolios need to be considered for single-name and single-sector concentration risk.
- Both wholesale and retail loan portfolios (other than residential mortgages on the SA) must be considered for geographic concentration risk.

To quantify each of these types of credit concentration risk, banks are required to calculate a Herfindahl–Hirshman Index (HHI) measure, based on the sum of the squares of percentages of portfolio RWAs.

4.5.6 Interest rate risk in the banking book

As mentioned in Section 4.4.2, banks typically have a banking book and a trading book (although some small banks may not have a trading book). Assets and liabilities in the trading book have to be marked to market daily. However, assets and liabilities in the banking book are regarded as being held to maturity, or at least for the long term, and are not marked to market. It is therefore necessary for banks to assess their capital requirements for losses that might arise from the impact of changes in interest rates on their banking book assets and liabilities.

Interest rate risk in the banking book may arise from three types of risk:

- Duration risk: There may be a mismatch between the times when assets and liabilities mature (if fixed-rate) or are re-priced (if floating-rate).
- Basis risk: Assets and liabilities may be priced relative to different reference rates, such as bank rate and LIBOR (London Interbank Offer Rate).
- Optionality risk: Customers may choose to repay loans or withdraw deposits before their contractual maturity dates.

To quantify duration risk, and make allowance for optionality risk, banks are expected to allocate their assets and liabilities to time buckets:

- Fixed-rate assets and liabilities should be allocated to time buckets according to their maturities, allowing for customer behaviour in repaying loans or withdrawing deposits before their maturity dates.
• Floating-rate assets and liabilities should be allocated to time buckets according to the dates when they will be re-priced.

Capital requirements for interest rate risk in the banking book are quantified by applying a uniform shift in interest rates.

Banks may not be required by the PRA to hold capital under Pillar 2A for basis risk. However, they will be expected to set limits on their exposure to basis risk for each type of basis risk mismatch, and by setting a limit on the sensitivity of their net interest margin to basis risk.

4.5.7 Pension obligation risk

If a bank’s pension scheme has an accounting deficit, the amount of the deficit must be deducted from its CET1 capital. In assessing their Pillar 2A capital requirements, banks must consider the possible impact of their pension fund going into deficit, or of an existing deficit becoming larger.

In quantifying the appropriate level of their Pillar 2A capital requirements for pension obligation risk, banks are expected to take account of the impact of two stress scenarios that have been prescribed by the PRA.

In considering the impact of these stress scenarios, banks may allow for management actions, provided that they meet three eligibility criteria:

• They should not depend on assumptions about future financial performance.
• They should not depend on assumptions about future agreement by third parties.
• They should be capable of taking effect quickly enough to mitigate the stress.

In addition, banks are expected to have discussed management actions with pension scheme trustees.

4.6 Pillar 2B capital buffer

The Basel regulations require banks to hold three types of capital buffer (the second and third of which may be set at zero):

• All banks must hold a capital conservation buffer amounting to 2.5% of their total RWAs, comprised of CET1 capital – this is intended to reduce the risks that banks might breach their minimum capital requirements. If a bank’s CET1 capital ratio falls below 7% (the total of the minimum required of 4.5% plus the capital conservation buffer of 2.5%), there are progressive restrictions on how much banks can pay out as dividends, share buybacks and discretionary bonus payments.
• In addition, all banks in a jurisdiction may be required to hold a countercyclical buffer of up to 2.5% of their total RWAs, comprised of CET1 capital, as set by national regulators.
• Large banks must also hold a systemic buffer – which, for UK banks, could be up to 3% of their RWAs, comprised of CET1 capital. The amounts of systemic risk buffers are set by national regulators.
In October 2013, the PRA issued a discussion paper, *A Framework for Stress Testing the UK Banking System*\(^9\), in which it discussed how UK banks should quantify the capital buffer they should hold for possible severe adverse stress scenarios. Stress scenarios should include both system-wide scenarios and bank-specific scenarios, designed by individual banks with a view to exploring the risks to which they would be most vulnerable. Bank-specific scenarios are likely to lead to greater losses than system-wide scenarios, because of their focus on individual banks’ areas of vulnerability.

The Bank of England has subsequently published an annual paper\(^10\) in which it has described a baseline economic scenario (BES) and an annual cyclical scenario (ACS). The ACS must be evaluated by a limited number of large banks, and it points to the level of severity that other banks should allow for in the calibration of their stress tests. In the 2018 version of this paper, the ACS allowed for the UK’s gross domestic product (GDP) falling by 4.7%, UK house prices falling by 33%, UK unemployment rising to 9.5% and the UK Bank Rate rising to 4%

As a minimum, UK banks should consider a system-wide stress test (based on or taking note of the ACS), a bank-specific stress test (which could, for example, allow for a significant operational risk loss event) and a combined scenario (with both of these happening at the same time).

In assessing stress scenarios, banks are expected to identify management actions that they would take to mitigate the negative impact of the scenarios on their capital adequacy. These management actions must be realistic and credible. For example, under a market-wide stress scenario, banks might find it hard to raise new capital or to sell subsidiary businesses or loan portfolios. Smaller banks might reduce their capital requirements by reducing their new lending – but, if several large banks were to do this, the limited availability of credit would be likely to compound economic weakness and increase credit losses on existing loans. In their ICAAPs, banks are expected to show the impact of stress scenarios both gross and net of management actions.

It is convenient to present the results of stress tests in a consistent format, showing, for each scenario, forecast total and CET1 capital levels/ratios and forecast Pillar 1 and Pillar 2A capital requirements (and their components) throughout the forecast period, firstly expressed in millions of pounds and secondly as percentages of total RWAs.

Determining the amount of the capital buffer, in the light of the results of the various stress tests, requires judgement. The PRA recognizes that the stress-testing framework is not intended to be a simple ‘pass–fail’ regime, and that the amount of the capital buffer should not be linked mechanistically to the results of the stress-testing exercise.

The PRA recognizes the need to avoid double counting between minimum capital buffers prescribed in the Basel regulations and the capital buffer determined by stress testing:

- If the amount of a bank’s capital buffer determined by stress testing (as a percentage of total RWAs) is less than 2.5% plus its countercyclical buffer, the bank must hold the capital buffers

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\(^9\) [https://www.bankofengland.co.uk/-/media/boe/files/paper/2013/a-framework-for-stress-testing-the-uk-banking-system.pdf?la=en&hash=63A82AB82E02F62432D1DC528FAF78EC910812B6](https://www.bankofengland.co.uk/-/media/boe/files/paper/2013/a-framework-for-stress-testing-the-uk-banking-system.pdf?la=en&hash=63A82AB82E02F62432D1DC528FAF78EC910812B6)

required by the Basel regulations – that is, the capital conservation buffer of 2.5% and its countercyclical buffer.

- If the amount of a bank’s capital buffer determined by stress testing (as a percentage of its total RWAs) is greater than 2.5% plus its countercyclical buffer, the bank must hold the higher amount – that is, it must hold an additional buffer, known as the PRA buffer, on top of the capital conservation buffer of 2.5% and its countercyclical buffer.

These capital buffers must be held on top of any systemic buffer and the bank’s Pillar 1 and Pillar 2A capital requirements.

UK banks must also carry out reverse stress testing, to understand the factors that could render their business model unviable – that is, the factors that could take a bank to the point at which the market loses confidence in it and it is no longer able to carry out its business activities.

4.7 Opportunities for actuaries

As can be seen, the skills and complexities involved in modelling and application of judgment when building internal models and assessing additional capital requirements under Pillars 2A and 2B provide opportunities for actuaries to add value in capital adequacy assessment and balance sheet management of banking institutions in the same way they add value in insurance companies. The principles are similar.
5 CREDIT RISK AND CAPITAL MODELLING IN BANKS

5.1 Basel II and Basel III regulations

Following the banking crisis of 2007–2008, the Basel II regulations were published in December 2010 and revised in June 2011. They introduced a number of important changes to the regulation of banks. In particular, they defined CET1 capital and required banks to hold 4.5% of their RWAs in CET1 capital by 1 January 2015. They required banks to hold a capital conservation buffer amounting to 2.5% of their RWAs, in the form of CET1 capital, by 1 January 2019. They also introduced requirements for liquidity ratios, credit valuation adjustment (CVA) risk, countercyclical buffers and leverage ratios.

Further reforms to the Basel III regulations were published in December 2017. The reforms included revisions to the:

- SA for credit risk
- IRB approach for credit risk
- CVA framework
- Operational risk framework
- Market risk framework

They also introduced requirements for an output floor, under which the RWAs of banks using internal models must be at least 72.5% of their RWAs using the SA.

These reforms to the Basel III regulations will become effective on 1 January 2023 – except for the output floor, which will be phased in between 1 January 2023 and 1 January 2028.

A summary of the evolution of the Basel regulations is set out in the Appendix to this paper.

5.2 Credit risk

The implementation of the revised standards is meant to mitigate future global financial crises, or at least minimize them. One of the biggest areas that will see change is the capital requirements for banks, including for credit risk. Banks hold capital for credit risk to absorb unexpected losses. The unforeseen nature of credit risk makes it interesting for actuaries.

While acknowledging that the current business environment is dominated by large financial institutions, with complex business models and access to sophisticated systems that enable a better and more accurate assessment of the risks incurred, a significant number of institutions operate based on simpler business models, with a scope of application confined by geographic or sectoral factors. In order to reflect this diversity in the business models of institutions, there are two approaches to computing regulatory capital for credit risk: the SA and the internal ratings-based approach (IRB). The SA consists of the simplest options for calculating RWAs and ensures that a simple methodology remains available for a wide range of small and non-internationally-active institutions, where the cost of compliance with more complex standards may not be warranted.

11 https://www.bis.org/publ/bcbs189.pdf
12 https://www.bis.org/bcbs/publ/d424.pdf
The IRB approach designed to address credit risk constitutes a complex framework that allows institutions to model risk and specify risk appetite in a more precise and granular manner than the SA, which consequently should lead to a more accurate calculation of own funds requirements. The extensive flexibility in developing the internal models has consequently been justified in order to allow a high degree of risk sensitivity that is more adapted to institutions’ portfolios. The flexibility of the framework makes it superior as a risk management tool, which should be closely integrated into the risk management practices of the institution.

The underlying premise for the IRB approach is therefore that the differences in risk weights of various exposures should ideally reflect the differences in the underlying risk of those exposures, including the structure of the portfolios, the characteristics of the clients and transactions, as well as the internal risk management and collection processes at the institutions. Given this premise, the model outcome of the IRB approach should ideally lead to similar own-funds requirements across institutions with similar portfolios, and the differences in the models’ output should be justified by the differences in risk profiles.

The implementation of the IRB models has, however, sometimes led to a lack of comparability and substantial divergences across institutions in terms of model outcomes, where not all differences appear to be justified by risk-based drivers. A substantial share of the variation in model outcomes and subsequently RWAs is caused by non-risk-based drivers, such as differences in definitions and modelling choices. This lack of comparability results from the flexibility embedded in the CRR, accompanied by different supervisory practices for assessing the adequacy of internal models and different use of supervisory measures. With the disparity still being a challenge even with the implementation of new standards, actuarial skills can be relevant. Interpretation of standards and assessing the suitability of a bank’s own models over and above building the models will be vital for the standards to achieve what they have been designed to.

### 5.3 Impact of Basel III final reforms

Before implementation of the standards, quantitative impact studies have been conducted, and it is quite apparent that capital levels are going to increase. This brings into the fold several matters that banks should consider – for example, at what point should they start pricing this increase into their costs, especially for long-dated instruments, and will banks still remain profitable if they do this? Given that the final reforms from the BCBS affect different portfolios differently, how should a bank strategically position itself now so that the increased required capital levels do not restrict its ability to support new lending? Where is this cost of holding higher levels of capital going to be allocated? How do these standards take into consideration the economic growth for each nation that is going to implement them – perhaps there should be discussions between the national regulator and the various government departments mandated to grow the economy?

In a recent analysis, by the BCBS in March 2019 (based on June 2018 data)\(^\text{13}\), the below table, from the Basel III Monitoring Report, shows the impact that Basel III will have at initial implementation:

\(^{13}\) [http://bis.org/bcbs/publ/d461.pdf](http://bis.org/bcbs/publ/d461.pdf)
Notably, applying the 2022 (now 2023) minimum total loss-absorbing capacity (TLAC) requirements and the fully phased-in initial Basel III framework, TLAC has a shortfall of €68.0 billion. A more recent publication by the European Banking Authority (EBA)\textsuperscript{14}, using a conservative set of assumptions, shows that full implementation of Basel III will increase the minimum required capital (MRC) of European banks by 24.4% on average, with an aggregate capital shortfall in total capital of about €135.1 billion.

6 Retail Banking Business Models

6.1 Introduction

In this section, we focus on the UK retail banking industry to illustrate principles, although the principles are applicable in other international jurisdictions.

Competition in UK retail banking has been weak, but is likely to be increased by a combination of new technologies, new entrants and regulatory developments. Against this changing background, retail banks will need to have a good understanding of their product pricing and profitability and of the value of their customer relationships. Actuaries can contribute to banking product development and pricing in this changing environment.

6.2 Assessment of profitability

Given the complex pricing structures of some retail banking products, and the need to make judgements about a number of factors, assessment of the profitability of retail banking products is an interesting exercise for actuaries – particularly those already familiar with analysis of the pricing and profitability of long-term life insurance and pensions products.

Within retail banking, current accounts (which have no fixed term) enable banks to establish long-term relationships with their customers and provide opportunities for them to cross-sell other products to their customers. Among personal current accounts (PCAs), the most popular product offers ‘free’ banking – or, more correctly, ‘free-if-in-credit’ banking.

An assessment of the profitability of PCAs is not straightforward. To quantify expected income, it is necessary to make judgements about the future behaviour of customers using the accounts (including their use of overdrafts), the likely term of the accounts and the likely extent of cross-selling. To quantify expected costs, it is necessary to make judgments about the allocation of shared costs (which can be large) and about the determination of funding costs (using funds transfer pricing methodologies).

In a number of other retail banking products, it is normal practice for UK banks to offer better prices for new customers – that is, to use ‘front book’ and ‘back book’ pricing. In deposits, prices are often reduced after one or two years, and may subsequently be reduced further – the UK regulator has estimated that major banks with established PCA businesses and extensive branch networks have retail funding costs that are close to half those of other banks. Credit cards are widely offered on the basis of 0% interest for an initial period, which have been as long as three years. In mortgages, it is normal for lenders to offer low fixed-rate periods followed by reversion to their standard variable rate (SVR). So, in assessing the profitability of these products, a key issue is to make sound judgements about the extent to which groups of customers will stay with their providers despite the move to worse prices after initial periods, or will switch to other providers to obtain their better prices for new customers.

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15 FCA, Strategic Review of Retail Banking Business Models Progress report, June 2018, paragraph 1.13
6.3 UK retail banking structure

UK retail banking is currently dominated by six large incumbents (Barclays, HSBC, Lloyds, RBS, Santander and Nationwide), which together account for 87% of PCAs, 71% of retail deposits, 68% of mortgages, 65% of credit cards and 57% of personal loans\(^\text{16}\). The balance is accounted for by CYBG, TSB and Co-operative Bank, building societies other than Nationwide and a range of new entrant banks, some of which are digital-only. Collectively these latter banks are often referred to as ‘challenger banks’.

In a recent paper on retail banking business models in the UK, the regulator said that 52% of customers with credit cards have one with their PCA provider, and that for personal loans and mortgages the corresponding percentages are 48% and 32% respectively\(^\text{17}\). The corresponding percentage for retail deposits was not given, but it was found that over 80% of large providers’ total balances in easy-access savings accounts are held by customers who also hold a PCA with the same provider\(^\text{18}\).

6.4 Evolution of retail banking business models

In its recent paper on retail banking models, the UK regulator considered how retail banking may evolve in future and set out four scenarios\(^\text{19}\) as illustrations of possible future developments:

- Under one scenario, large volumes of customers, including those who were previously inactive, switch from the incumbent banks to challenger banks.
- Under another scenario, other firms (such as aggregators) take over customer-facing distribution activities, while the incumbent banks concentrate on product ‘manufacturing’.
- Under a third scenario, some consumers switch to alternative providers, while others remain with the incumbent banks, and the incumbent banks seek to recover their lost revenues from their remaining customers.
- Under a fourth scenario, the adoption of new technologies moves slowly and the incumbent banks are able to reduce/reposition their branch networks to meet changing customer needs and to largely maintain their market shares.

The future shape of UK retail banking, and the extent to which it is like any of the four scenarios mentioned above, will be influenced by four factors: new technologies, new entrants, regulatory developments and consumer behaviour. We consider each of these in turn below.

6.4.1 New technologies enabling Open Banking

Open Banking has the potential to transform retail banking. Under Open Banking, customers are able to authorize their bank to transfer information about them to approved third parties, which could be either banks or non-banks, such as aggregators or FinTech companies. Open Banking enables the development of price comparison websites (PCWs) showing prices of alternative products determined

\(^{16}\) FCA, Strategic Review of Retail Banking Business Models Progress report, June 2018, Figure 1.1
\(^{17}\) FCA, Strategic Review of Retail Banking Business Models Progress report, June 2018, paragraph 1.17
\(^{18}\) FCA, The FCA’s response to the CMA’s consultation on its provisional decision to refer personal current accounts and SME banking, September 2014, page 6
\(^{19}\) FCA, Strategic Review of Retail Banking Business Models Progress report, June 2018, Figure 1.2
by individual consumers’ own behaviour, making it much easier for customers to shop around and/or to switch between products and/or providers. As Open Banking extends to other financial products (Open Finance), it will enable the development of personal financial management services covering a range of financial products – as the UK regulator has observed, providers of such services (which could be banks or non-banks) may come to ‘own’ the relationship with the customer, instead of the banks or other firms that manufacture the products\(^{20}\).

### 6.4.2 New banks with low operating costs

After many years during which there were few new banks in the UK, more than 20 new banks have been authorized during the last 10 years, and a number of other firms have submitted applications for authorization. Previous barriers to entry have been reduced in two ways:

- Firstly, the authorization process was made easier, and the UK regulators, the PRA and the Financial Conduct Authority (FCA)\(^ {21}\), established a New Banks Unit to help applicants through the process\(^ {22}\).
- Secondly, more widespread use of online banking means that it is not necessary for a new bank to establish an extensive branch network.

In general, new banks have relatively low operating costs and offer competitive prices. Also, they use modern systems which should make it easy for them to exploit new opportunities such as Open Banking, while the large incumbent banks may be constrained to some extent by their legacy systems. With these advantages, some new banks have grown rapidly, but they remain small relative to the large incumbent banks\(^ {23}\).

### 6.4.3 Regulatory developments encouraging competition

Various changes have been announced or proposed, with a view to encouraging greater competition in the core relationship product, PCAs. With encouragement from HM Treasury, banks providing PCAs agreed to participate in a current account switching service – this should overcome customers’ concerns that PCA switching might be problematic\(^ {24}\). The Competition and Markets Authority (CMA) mandated that customers must be able to use Open Banking to compare alternative PCA products on the basis of their own behaviour\(^ {25}\). More recently, the regulator proposed that firms charging for overdrafts should use only a single interest rate, and that fees other than refused payment fees should be banned – the regulator believed that simplifying prices in this way would make it easier for customers to compare headline prices and would encourage competition between providers\(^ {26}\). In addition, for retail deposits, the regulator has proposed that each bank should set a basic savings rate (BSR) that would apply to all easy-access savings accounts after they have been open for a set period of time\(^ {27}\).

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\(^ {20}\) Open Banking Working Group, *The Open Banking Standard*, March 2016
\(^ {21}\) PRA/FCA, *A review of requirements for firms entering into or expanding in the banking sector*, July 2014
\(^ {23}\) PwC, *Who Are You Calling a ‘Challenger Bank’?* March 2017
\(^ {24}\) HM Treasury, *Regulatory Innovation Plan*, April 2017, paragraph 2.2
\(^ {25}\) CMA, *CMA Points the Way for Open Banking Revolution*, August 2016
\(^ {26}\) FCA, *High-cost Credit Review: Overdrafts*, May 2018
\(^ {27}\) FCA, *Price discrimination in the cash savings market*, July 2018
6.4.4  Consumer behaviour evolving

Use of online banking did not expand as quickly as many people anticipated at the time of the dotcom bubble in 2000 – this allowed the large incumbent banks time to develop their own online banking services, in line with the fourth of the scenarios mentioned above.

Ahead of the launch of Open Banking, it seemed possible that consumers might be reluctant to use it, despite its potential benefits, because of concerns about the security of their personal data and about redress in the event of problems. However, early signs are encouraging, in terms of the numbers of customers using Open Banking and the range of services offered through it. John Glen MP, Economic Secretary to the Treasury and City Minister, said that:

Open Banking has been a huge success in the UK and has made us a world leader in the technology. From better tracking of payments to stop customers getting overdrawn to utilising data to improve access to finance, Open Banking has brought real improvements to the people and businesses using it.\(^\text{28}\)

6.5  Potential involvement of actuaries – data analytics

As retail banking business models evolve, and with availability of big data, actuaries can play a significant role in data analytics in areas such as understanding customer behaviour, designing new products that meet customer needs, pricing those products for risk, and assessing lifetime value of customer relationships. These represent a natural extension of actuaries’ existing skills in assessing the pricing and profitability of retail financial products.

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\(^{28}\) Open Banking, Open Banking adoption surpasses one million customer mark, January 2020
7 Retail Banking Fair Pricing of Products

7.1 Introduction

In this section, the focus is again on the UK, looking at retail banking products to illustrate principles and to discuss where actuaries are already, or can be, involved in the UK or in other international jurisdictions.

In the UK, the fair pricing of financial products is a matter of ongoing interest to the FCA, the CMA and the Treasury Committee. Concern has been expressed about ‘price discrimination’ (charging different prices based on differences in consumers’ price sensitivity) and ‘inertia pricing’ (charging existing customers higher prices than new customers). Fair pricing is an area actuaries are already familiar with, from traditional areas of actuarial practice. Actuarial skills and experience can easily be transferred into banking.

In this section, we consider four UK retail banking markets: current accounts, cash savings, mortgages and credit cards. In each of these markets, the prevailing pricing structure appeals to the tendency of consumers to focus on the short term and on headline prices. PCAs offer ‘free’ banking, easy-access cash savings accounts offer higher interest rates for new customers, mortgages offer low-cost fixed rates for periods of two to five years and credit cards offer 0% rates for up to three years.

However, ‘free’ current account banking for some customers is subsidized by charges paid by overdraft users – particularly by users of unarranged overdrafts. Rates on easy-access cash savings accounts are lower for long-term customers. SVRs on mortgages are higher than introductory rates – and the spread has increased gradually over the last decade. On credit cards, after the 0% introductory period, rates of 20% or more are high relative to prevailing interest rates.

Across the four product markets, the pricing structures lead to cross-subsidies between customer groups – for current accounts, between customers who use overdrafts and those who do not, and, for the other products, between customers who are active switchers and those who are not. In general, vulnerable customers are likely to be among users of overdrafts or less active groups.

The pricing structures may inhibit competition. Their complexity makes it difficult for consumers to compare products from alternative providers. The pricing structures create barriers to entry and give advantages to incumbents with large back books. When cross-subsidies become central to how a market works, as is the case in each of the four markets, it is difficult to see a mechanism whereby market forces can change the position. If a single provider were to offer ‘fairer pricing’ than the market, it would not gain much new business. If all providers were to move to ‘fairer pricing’ at the same time, they might be found guilty of collusion, a criminal offence.

So, in each of these four products, it seems that there is need for some kind of regulatory intervention to encourage a market move to ‘fairer pricing’. Interventions could be demand-side, such as transparency and disclosure measures intended to help consumers make better decisions, or supply-side, intended to restrict how providers design, market, and price products. However, transparency and disclosure measures do not have a good track record of making a significant difference in consumer

29 FCA, Our future Mission, October 2016, page 23
behaviour\textsuperscript{30}, while price interventions may limit competition, create additional barriers to entry and protect the status quo, to the advantage of large incumbents. An additional problem is that, in the event of proposals for interventions intended to reduce cross-subsidies, customers who have hitherto benefited from lower prices on current accounts, mortgages and credit cards, or from higher prices on cash deposits, may complain loudly.

Open Banking and its likely extension to Open Finance has the potential to transform competition in retail banking, by making it much easier for consumers to compare alternative products and to switch between products and/or providers. These developments would reduce the benefit to providers of complex pricing structures and cross-subsidies.

It seems likely that Open Banking will have a significant and positive effect on UK retail banking, even if it takes some time for its full impact to become apparent\textsuperscript{31}. Because of this, any interventions made in the near future should take account of the likely impact of Open Banking.

Section 7.3 gives information about the regulatory background with which actuaries would need to be familiar if they were to be discussing the fair pricing of financial products, helping actuaries to write responses to consultations about the fair pricing of financial products, or doing work for a retail bank, either as an employee or as a consultant.

Section 7.4 considers in turn savings accounts, current accounts, mortgages and credit cards. For each of these, it describes the current market at the time of writing and interventions that the FCA has made, or is now proposing to make. At the end of each product, we assess the current market, or the interventions proposed by the FCA, against the FCA’s objectives.

Section 7.5 identifies matters that would need to be considered in building a model to assess the pricing and profitability of financial products, looking in turn at the methodology to be used and then at each of income, operational costs, credit losses, funding costs and discount rate. Such a model could be used to support judgements about the fairness on pricing of products overall and of product segments likely to be bought by different customer groups, including vulnerable customers.

\section{7.2 Regulatory background}

\subsection{7.2.1 Price discrimination and loyalty pricing}

In the UK, various bodies have expressed concern as to whether the pricing of retail financial products is fair. The FCA has focused on PCAs, where some customers, including some vulnerable customers, pay high charges for unarranged overdrafts, and on cash savings accounts, where prices are often attractive at the outset but deteriorate over time\textsuperscript{32}. The CMA has looked at a range of products, including cash savings and mortgages, where new customers get better prices than existing customers\textsuperscript{33}. The Treasury Committee has asked a number of questions, including whether vulnerable customers pay more for financial services products\textsuperscript{34}.

\textsuperscript{30} FCA, \textit{Our future Mission}, October 2016, page 32
\textsuperscript{31} Open banking, \textit{OBIE Highlights - March 2021}, April 2021
\textsuperscript{32} FCA, \textit{Fair Pricing in Financial Services}, October 2018
\textsuperscript{33} CMA, \textit{Tackling the loyalty penalty}, December 2018
\textsuperscript{34} Treasury Committee, \textit{Consumers’ access to financial services}, May 2019
In October 2018, the FCA issued a discussion paper, *Fair Pricing in Financial Services*[^5]. At the beginning of it, the FCA said:

We are focusing the debate on the following pricing practices:

- Firms charging different prices to different customers based solely on differences in consumers’ price sensitivity (also known as ‘price discrimination’)
- Firms charging existing customers higher prices than new customers (sometimes referred to as ‘loyalty pricing’ or ‘inertia pricing’)[^6]

These pricing practices lead to cross-subsidies between different groups of customers. The group of ‘losers’ is likely to include vulnerable customers who are less sensitive to pricing structures and/or less inclined to switch to products with better prices.

### 7.2.2 Cross-subsidies can become central

In a previous paper, *Our Future Mission* (FCA, October 2016)[^37], the FCA considered price discrimination and cross-subsidies between different groups of customers. The FCA recognized that some level of cross-subsidy was inevitable, but thought that, beyond a certain point, cross-subsidies can have harmful effects. It highlighted issues that arise when cross-subsidies become central to how a market works:

Once cross-subsidies become central to how a market works, firms can become highly focused on ways of extracting more and more profit from trapped or otherwise price-insensitive customers. Market forces may not change that dynamic. Any current firm or potential entrant that tries to educate consumers to be more price-sensitive, or seeks to change its charging structures or practices, may find that it cannot attract customers at all. More active or sophisticated consumers may not switch to a new entrant because they negotiate lower prices with their existing firm and are cross-subsidised by less active customers paying higher prices. If an entrant firm declines to make initial offers to attract customers, then it will attract neither naive nor sophisticated consumers. And if it educates any naive consumers it does acquire, it will lose them as they will move to firms that do cross subsidise to give lower prices to sophisticated customers.[^38]

### 7.2.3 Consumer behaviour in practice

Many FCA rules have been designed to ensure that firms provide transparency and disclosure for consumers, to make it easier for consumers to shop around and to support effective competition.

However, in *Our Future Mission*, the FCA recognized that disclosure and transparency may have only limited effects in correcting market failures, and that this is particularly true for higher-risk products or for more vulnerable customers.[^39]

In that same paper, the FCA also recognized that, in practice, consumers do not always respond to disclosures in the way that regulators have assumed. The FCA made three important statements about the behaviour of consumers and of banks in response to consumer behaviour:

- Consumers are not always able or willing to use the ‘official’ material. Instead they use less structured, more personal decision-making. They typically buy products based on a narrative of what they want and believe they deserve, rather than by logically balancing opportunity against risk.

- Consumers focus on the ‘here and now’. They zoom in on headline returns or other upfront product features and do not take account of associated contingent charges like overdraft fees or early exit charges – or of the risks of things going wrong. This means that, for them, potentially expensive product features can be ‘hidden in plain sight’.

- Firms, either deliberately or unconsciously, design contracts or use sales practices that take advantage of consumer psychology. Personal interaction, persuasion and trust will typically be the most relevant factors to consumers when they get risk warnings. If firms can first get consumers ‘bought in’ to the benefits of a product, and then give them the risks or downsides, these warnings are unlikely to get through to customers and so will be ineffective. Similarly, if firms preface risk warnings by saying that they are required to give them by regulators this, too, is unlikely to make consumers take them into account.40

### 7.2.4 Objectives and interventions of the regulator

The FCA may intervene to address market failures. Interventions may be demand-side, such as transparency and disclosure measures intended to help consumers to make better decisions, or supply-side, intended to restrict how providers design, market and price products.

Any interventions proposed or made by the FCA must be consistent with its objectives. The FCA restated its objectives at the beginning of the paper *Fair Pricing in Financial Services*:

Parliament has given us a single strategic objective: to ensure that relevant markets function well. As part of this, when exercising our general functions, we must advance one or more of our three operational objectives:

- to secure an appropriate degree of protection for consumers
- to protect and enhance the integrity of the UK financial system
- to promote effective competition in the interests of consumers41

### 7.2.5 Potential impact of Open Banking

As mentioned at the end of Section 7.1, we suggest that if proposing regulatory interventions to address price discrimination, the FCA should take account of the likely impact of Open Banking (noting the encouraging progress made in its initial period) and of its likely extension to Open Finance.

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41 FCA, *Fair Pricing in Financial Services*, October 2018, paragraph 1.10
7.3 Retail banking products

This chapter describes product features and pricing structures at the time of writing. These may change if the FCA proceeds with initiatives about which it has been consulting.

In the rest of this chapter, we look at four product markets in UK retail banking where cross-subsidies between different customer groups may, or may not, be associated with price discrimination. We consider whether these markets are operating in a way that is consistent with the FCA’s objectives. When the FCA has proposed interventions to address perceived shortcomings in markets, we consider whether the proposed intervention will support the objectives. We also consider whether the proposed intervention might have unintended consequences.

7.3.1 Cash savings accounts

In the UK, an established practice in the cash savings market has been for banks to offer new accounts at attractive prices and then to increase their prices over time. To achieve differentiation between front- and back-book pricing, some banks have offered a series of savings accounts, taken them off-sale after a period and replaced them with new accounts. For easy-access savings, the FCA found that, in 2015, there were 350 on-sale and just over 1,000 off-sale accounts. By 2018, these numbers had increased to 470 and 1,870 respectively.

In cash savings, customers who switch from old to new accounts get higher interest rates than inactive customers who stay with the same accounts for a long time. The FCA believes that lower interest rates for old accounts cannot be justified by higher costs of supporting old accounts than new accounts. The FCA has observed that banks’ pricing strategies can take advantage of the high level of customer inertia in the cash savings market.

As for other markets in which cross-subsidies are central to how the markets work, the FCA believes that the current market practice for pricing cash savings accounts will not change without some form of intervention. The FCA believes that demand-side interventions, such as a redesigned switching box or comparative interest rate information, would be unlikely to overcome the high level of customer inertia in this market. The FCA believes that supply-side interventions are necessary and has proposed a BSR – a variable interest rate that would apply to all easy-access cash savings accounts offered by a bank after they have been open for a specified period.

If implemented, the BSR will address the potential confusion created by the large number of on- and off-sale cash savings accounts. It will also reduce the advantage hitherto obtained by incumbent banks with large back books. However, it is not clear that the BSR will necessarily support the FCA’s objective of encouraging greater competition in the cash savings markets, with different banks offering different BSRs. Instead, the BSRs of different banks might be clustered together, with differentiation being limited to initial prices, reflecting banks’ needs for additional retail deposits to support their lending and liquidity strategies.

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42 FCA, Price discrimination in the cash savings market, July 2018, paragraphs 2.18-2.22
43 FCA, Price discrimination in the cash savings market, July 2018, paragraph 1.2
44 FCA, Price discrimination in the cash savings market, July 2018, chapter 5
The FCA has considered the possibility of limiting the difference between front- and back-book prices, but considers such an intervention to be inappropriate because it might be hard for consumers to understand and might limit banks’ ability to manage their liquidity. Another possible intervention might be to set a ‘floor’ for BSRs – this might seem an appropriate intervention if banks’ BSRs were to be clustered together and to decline over time. But the ‘floor’ could become the ‘norm’ and so could inhibit competition in the cash savings market.

**Proposed intervention in cash savings market versus FCA objectives**

- Market functioning well: The low level of engagement and high level of inertia suggest that the cash savings market is not functioning well for consumers. The BSR would make it easier for consumers to assess and compare cash savings products by reducing the potential confusion created by front- and back-book pricing and by the large numbers of on- and off-sale products.
- Protection for consumers: The BSR would reduce the extent to which inactive customers lose out to active customers (unless there is a large difference between initial interest rates and BSRs).
- Integrity of system: The BSR would not limit banks’ ability to manage their liquidity.
- Promoting effective competition: If BSRs were to be clustered together, the BSR would not necessarily lead to greater competition, based on BSRs. Competition might well continue to be focused on initial interest rates.

**7.3.2 Personal current accounts**

Most PCAs in the UK offer ‘free’ banking, more correctly known as ‘free-if-in-credit’ banking. While it is true that customers who remain in credit can enjoy free banking, customers using overdrafts pay high interest rates (currently around 20%) and a range of fees, which vary from bank to bank and according to account usage.

The complexity of PCA charges makes it difficult for customers to assess the likely cost of using their PCA, and even more difficult to compare the costs of PCAs offered by different providers. In future, PCWs using information gathered through Open Banking interfaces will enable customers to compare the costs of PCAs, allowing for their own behaviour in using their PCA. However, it remains to be seen whether this will reduce the currently high level of customer inertia in the PCA market.

Overdrafts may be arranged or unarranged. A customer enters into an unarranged overdraft when there are insufficient funds in their PCA (including any arranged overdraft) to make a payment, but the bank decides to make the payment. Unarranged overdraft charges are high – for each pound lent, banks make significantly more revenue from an unarranged overdraft than from an arranged overdraft. This seems much more than could be justified by relative costs, particularly now that banks’ decisions about whether to make payments that could lead to unarranged overdrafts are largely automated.

Unarranged overdraft charges are concentrated – the majority of these charges are paid by only 1.5% of PCA customers, who pay £450 per annum on average. To make matters worse, unarranged overdraft users are likely to include vulnerable customers – the regulator found that consumers living in more deprived areas are more likely to use an unarranged overdraft than consumers living in less deprived...
areas. In relation to the fair pricing of financial products, it seems unfair that overdraft users, including vulnerable customers, should subsidize free banking for more affluent customers who do not need to use overdrafts\textsuperscript{45}.

As an alternative to making a payment that leads to an unarranged overdraft, the bank may decide not to make the payment, and to charge the customer a refused-payment fee. Echoing its findings about unarranged overdrafts, the regulator found that the majority of refused-payment fees are paid by only 1.2\% of PCA customers, and that customers living in more deprived areas are more likely to have to pay refused-payment fees\textsuperscript{46}.

As a result of its analysis of the PCA market, the regulator made a number of proposals where it proposed that banks should not charge higher prices for unarranged overdrafts than for arranged overdrafts, that fees should be banned except for refused-payment fees – which should be cost-reflective – and that banks should charge for overdrafts a simple, single interest rate, which should be advertised with an annual percentage rate (APR)\textsuperscript{47}.

If implemented, the FCA’s proposals will reduce the burden of PCA charges on users of unarranged overdrafts, including vulnerable customers, and will make it easier for customers to compare the costs of PCAs. However, they may make banks more reluctant to make payments which lead to unarranged overdrafts, because they will be able to recover their costs of refused payments but will not be able to charge more for unarranged overdrafts, although their costs are likely to be somewhat higher than for arranged overdrafts.

The FCA’s proposals would benefit users of unarranged overdrafts but would not eliminate the cross-subsidy between overdraft users and PCA customers who do not use overdrafts. The proposals could have the unintended consequences of incentivizing banks to seek to offset some of their lost fee income from unarranged overdrafts by increasing their overdraft interest rates and/or by seeking to introduce new charges for overdrafts not covered by the ban of fees proposed by the FCA.

If banks were to increase their overdraft interest rates, a possible response by the FCA might be to set a ‘cap’ on overdraft interest rates. But the ‘cap’ might become the ‘norm’, further limiting competition in PCAs.

**Proposed intervention in PCAs versus FCA objectives**

- Market functioning well: The low level of engagement and high level of inertia suggest that the PCA market is not functioning well for consumers. The move to a simple, single interest rate would make it easier for consumers to assess and compare PCAs.
- Protection for consumers: The move to a simple, single interest rate would reduce the burden on customers, including vulnerable customers, using unarranged overdrafts.
- Integrity of system: The move to a simple, single interest rate would not have a significant effect on systemic risk.

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\textsuperscript{45} FCA, High-cost Credit Review: Overdrafts, May 2018, paragraph 4.9

\textsuperscript{46} FCA, High-cost Credit Review: Overdrafts, May 2018, paragraphs 4.27-4.28

\textsuperscript{47} FCA, High-cost Credit Review: Overdrafts, May 2018, paragraphs 4.45-4.52
• Promoting effective competition: If overdraft interest rates were to be clustered together, the move to a simple, single interest rate would not necessarily lead to greater competition.

### 7.3.3 Residential mortgages

Most new residential mortgages in the UK offer low interest rates for introductory periods. They respond to customers' preference that the cost of their mortgages should be as low as possible in the short term – and to their optimism about longer-term arrangements.

On these mortgages, the interest rate is fixed for an introductory period, normally two to five years, and then reverts to the lender’s SVR or to a tracker rate based on bank rate or some other reference interest rate. In practice, at the end of the introductory period, many borrowers switch to another mortgage with an introductory offer, either from the same provider or from a different provider. As a result of the focus on introductory deals and the high level of switching from one introductory deal to another, the proportion of mortgage balances on low-cost introductory deals was 83% in 2018, and the proportion on SVRs (or equivalent) was only 17%, down from 35% in 2013.\(^{48}\)

The high level of switching from one introductory deal to another suggests that customer engagement is higher, and inertia lower, in mortgages than in cash savings or PCAs – possibly because the economic benefit of switching is greater.

Over the period since 2009 (that is, after the banking crisis), two-year fixed rates have declined from around 4% to 2% or less, while SVRs have remained around or above 4%.\(^{49}\) The increasing spread between SVRs and introductory rates reflects strong competition for new mortgages with low-rate introductory offers, with less attention being paid to SVRs because most mortgage borrowers expect to switch to another introductory offer rather than to have to revert to SVRs.

In general, the pricing of mortgages does not seem to be unfair, in that their pricing is transparent, customers are engaged and active, and switching is straightforward, particularly to a new mortgage from the same provider. However, the increasing spread between SVRs and introductory rates, with competition being more focused on introductory rates than on SVRs, implies that there is a growing cross-subsidy between customers on SVRs and customers on introductory deals. And, to the extent that customers on SVRs include vulnerable customers, it is possible that their vulnerability is increased by having to pay SVRs rather than introductory rates.

The FCA is carrying out a market study on mortgages, and has published an interim report, in which it says that potential remedies include innovative online tools which would help consumers to find the right mortgage. These tools would enable consumers to identify products for which they are eligible at an early stage in the process, before moving to the advice (or execution-only) stage, and would give consumers choice about the support (including advice) that they wish to receive during the process.\(^{50}\)

Another potential remedy would make it easier for some customers on SVRs to switch to better deals.\(^{51}\)

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\(^{48}\) FCA, Strategic Review of Retail Banking Business Models Progress report, June 2018, paragraph 7.6

\(^{49}\) FCA, Strategic Review of Retail Banking Business Models Progress report, June 2018, Figure 7.2

\(^{50}\) FCA, Mortgages Market Study Interim Report, May 2018, Figure 9.2

\(^{51}\) FCA, Mortgages Market Study Interim Report, May 2018, paragraph 9.32
Mortgages market versus FCA objectives

- Market functioning well: The high levels of engagement and switching, and the low proportion of mortgage balances on SVRs, suggest that the mortgage market is working well for consumers who are willing to switch from one introductory deal to another.
- Protection for consumers: Although the proportion of balances on SVRs is low, it may include some vulnerable customers whose vulnerability is increased by having to pay SVRs rather than introductory rates.
- Integrity of system: With over 80% of mortgage balances now being on low-cost introductory deals, a reduced supply of introductory deals for existing borrowers, forcing borrowers to revert to their lender’s SVR, could lead to lower house prices and to a squeeze on consumers’ disposable income and spending, and so could contribute to recessionary pressures.
- Promoting effective competition: Competition appears to be focused on introductory rates, rather than on SVRs.

7.3.4 Credit cards

An important feature of the market for credit cards in the UK is cards with 0% introductory periods of up to around 30 months, after which the APR is typically around 20%, or higher.

It has been normal market practice in credit cards for borrowers to cross-subsidize revolvers, in the way that PCA overdraft users cross-subsidize PCA customers who do not use overdrafts. An additional feature of the credit card market is that borrowers paying 20% or more are subsidizing borrowers on 0% introductory deals as well as revolvers. Borrowers paying 20% or more will include some vulnerable customers, but some vulnerable customers with new cards will benefit from 0% introductory deals.

The FCA carried out a market study on credit cards in 2017. This study found that, in 2014, around 5.6 million people were in problematic debt, with 4 million in persistent debt after 18 months and 2 million in persistent debt after 36 months (persistent debt being defined by the FCA as where, over a period of 18 months, a customer pays more in interest, fees and charges than they have repaid in principal). The FCA announced a package of remedies, including some to address persistent debt. These remedies did not place any restrictions on 0% introductory deals.

Credit card market versus FCA objectives

- Market functioning well: The high levels of engagement and switching suggest that the credit card market is working well for consumers who are willing and able to switch from one introductory deal to another.
- Protection for consumers: Consumers not on introductory deals may include vulnerable customers who borrow and pay interest rates of 20% or more, rather than 0%. The credit histories of these customers may make it difficult for them to switch to another card, or to get an additional card.

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52 FCA, Credit card market study Final findings report, July 2016
• Integrity of system: The widespread availability of 0% rates for up to three years (or even longer) may have encouraged borrowing and may have contributed to the persistent debt on which the FCA focused in its credit card market study.
• Promoting effective competition: Competition appears to be focused on introductory deals, rather than on interest rates after introductory periods.

7.4 Fair pricing of retail banking products

The assessment of the fair pricing of retail banking products is a matter to which actuaries can contribute, using a framework such as the FCA’s objectives and analyzing the profitability, within a product market, of different risk segments and customer groups. In addition, actuaries can contribute to discussion about the fair pricing of retail banking products, in the public interest, by responding to regulatory consultations.
8 Retail Banking Pricing and Profit Analysis

8.1 Products

Retail banking products include current accounts, savings products, mortgages, credit cards and personal loans.

8.2 Methodology

A straightforward approach to product pricing and profit analysis uses DCFs to calculate NPVs and internal rates of return (IRRs) (return on equity capital).

Cohorts of new business are evaluated. This includes evaluating segments, within cohorts, by level of risk (loan products), term, size and channel.

Savings products are regarded as a profit centre rather than as funding for loan products. In evaluating savings and loan products, funds transfer pricing rates (set by the bank’s Treasury) are used, rather than rates on savings products.

Behavioural term, which is the actual term of a product based on the behaviour of customers, is used rather than contractual term, which is the term of a product defined in legal documentation. On mortgages, behavioural terms are typically much shorter than contractual terms, as customers tend to prepay their mortgages. On current accounts and easy-access savings accounts, behavioural terms are typically much longer than contractual terms as accounts remain open for very long periods.

The volume of a cohort normally declines over time – it is necessary to forecast retention rates. For a cohort of loans, cumulative default rate is analogous to the inverse of survival rate.

Some customers may switch to other products, and thus may need to be taken into account. In taking account of switching to other products, it may be prudent to assume lower margins on the other products, to allow for the likely impact of Open Banking in increasing competition.

In the UK, mortgages and credit cards offer introductory deals. For products sold on this basis, a critical issue is to estimate the percentage expected to continue at higher rates after the introductory period, the percentage expected to switch to another product and the percentage expected to leave.

Savings rates often decline over time. As above, the percentage expected to continue at lower rates, the percentage expected to switch to another product and the percentage expected to leave need to be estimated.

The analysis uses base case forecasts for economic and other variables. In addition, various sensitivities should be evaluated, possibly including stress scenarios used in the bank’s ICAAP. Also, for products with introductory deals, the analysis should evaluate sensitivities to percentages of customers expected to continue/switch/leave.

For each of income, credit losses, operational costs, funding costs, funds transfer pricing, discount rate and differentiation according to riskiness, this chapter includes notes on matters that should be considered.
8.3 Income

- Income comes from products sold.
- There is no need to allocate income between product categories.
- Income may be interest income or non-interest income (fees).
- Interest income may be fixed or variable.
- Interest income on loans may vary according to perceived risk, term, size and channel.
- Interest income on loans may be reduced for introductory periods:
  - Mortgages offer fixed-rate introductory deals, typically for two to five years.
  - Credit cards offer 0% introductory deals, typically for around three years.
  - On credit cards, different rates may apply to balance transfers, card transactions and cash withdrawals, and there may be a hierarchy of repayments.
  - Interest paid on easy-access savings accounts typically declines over the first few years.
- If interest rate risk is hedged, the costs of hedging may be allowed for as negative income.
- Hedging should be based on behavioural term rather than contractual term.
- Non-interest income may be initial, ongoing or final. Some fees may have to be spread over a period, under effective interest rate (EIR) accounting.
- Early repayment charges may be limited by regulations.
- Various elements of income depend on consumer behaviour – for example:
  - Interest income: Proportion of customers remaining after introductory period
  - Non-interest income: Fees paid by users of current account overdrafts

8.4 Credit losses

- Credit losses arise on products sold.
- There is no need to allocate credit losses between product categories.
- Credit losses are typically low at first, rise over time and then level out or even decline. Use loss curves for segments within a cohort.
- For sensitivity analysis, use loss curves appropriate for stress conditions.

8.5 Operational costs

- Costs may be direct or shared.
- Direct costs may be initial, ongoing or final.
- Direct costs vary by product.
- Direct costs of sales vary by distribution channel – branches or brokers or online.
- Consideration needs to be given as to whether the development costs of online banking should be allocated fully to that channel, or spread across all channels.
- Shared costs may include IT, Treasury, distribution, head office and central functions.
- It is necessary to allocate shared costs between product categories.
• Within a product, shared costs may be further allocated by risk category, term and channel.
• Judgement is required in the allocation of shared costs. Shared costs may not be greatly increased by new business.
• A bank may look at marginal costs as well as fully-loaded costs.
• Judgment is required in the evaluation of marginal costs versus fully loaded costs.

8.6 Funding costs

• Loans are financed by mix of common equity capital (CET1), debt capital (Additional Tier 1 (AT1) and Tier 2 (T2)) and deposits.
• Banks must hold capital to cover minimum capital requirements and capital buffers.
• Capital requirements:
  o Pillar 1 capital must include at least 56% CET1 and may include 19% AT1 and 25% T2 (as required by the Basel regulations).
  o Pillar 1 and Pillar 2A requirements for credit risk are specific for product categories.
• Apply appropriate credit risk weights to drawn and undrawn exposures.
• Capital for other risks may be allocated uniformly across products, or otherwise.
• Capital buffers:
  o Capital buffers must be in the form of CET1.
  o Capital buffers should be allocated according to the riskiness of product cohorts and segments, although this may be difficult in practice.

8.7 Funds transfer pricing

• The balance of loan exposures is financed at a rate determined by the Treasury function, normally above the rate paid for deposits and allowing for a term liquidity premium.
• With funds transfer pricing, both loans and savings products are regarded as profit centres.
• Funds transfer pricing avoids lending activities seeming too profitable (as they might, with low-cost funding through savings products).
• The determination of funds transfer rates requires judgement and is not straightforward.
• A bank may look at funding on a marginal basis – that is, if a bank is paying up for new deposits to fund the cohort new loans, it may increase its fund transfer rates for the new loans.
• Funds transfer pricing rates include a term liquidity premium, and so typically vary with term.
• It may be appropriate for funds transfer pricing rates, set by the bank Treasury, to vary with the product that they are funding. However, the determination of different funds transfer pricing rates for different products may be too complicated, and not practical within a large, diversified bank.
8.8 Discount rate (for calculation of NPV)

- All cashflow items should be discounted at appropriate rates.
- The average discount rate is likely to correspond to the bank’s cost of equity capital.
- Some practitioners argue that discount rates, used to calculate NPVs, should vary according to the product. However, doing this is difficult because of the lack of reference points such as quoted monolines to which the Capital Asset Pricing Model could be applied.

8.9 Differentiation according to riskiness

- Differentiation between cohorts/segments of loans, to allow for their riskiness, could be achieved in three ways:
  o Different levels of capital requirements and capital buffers
  o Different levels of funds transfer pricing rates, before term liquidity premiums
  o Different discount rates, reflecting different costs of equity capital
- The authors believe that the most practical method of differentiating for riskiness is to allow for amounts of capital requirements and capital buffers that are appropriate for lending cohorts/segments (in a manner consistent with the bank’s ICAAP) and to use uniform funds transfer pricing rates (before term liquidity premiums) and uniform discount rates reflecting the bank’s cost of equity capital.

8.10 Actuaries in pricing and profit analysis

Profit testing and sensitivity analysis are important processes in the pricing of banking products, especially when products are priced for risk. There are parallels with equivalent processes in pricing insurance products. In banking, actuaries can contribute to setting assumptions and applying discounted cashflow techniques in pricing products and analyzing their profitability.
9  The Move from IAS 39 to IFRS 9

9.1 Incurred loss accounting (IAS 39)

Under the IAS 39 incurred loss accounting methodology, up to 2017 provisions for credit losses were recognized when loss events occurred. However, incurred loss accounting was pro-cyclical. As economic conditions deteriorated during and after the banking crisis of 2007–2008, incurred losses increased and, in the absence of adequate provisions to cover them, they reduced banks’ capital resources – in a period when market conditions made it virtually impossible for banks to raise new capital.

In 2010, the BCBS announced a number of important changes to the regulatory framework, to address lessons learned in the banking crisis. Along with these changes, the BCBS said that it was advocating a change in the accounting standards towards an expected loss approach that “captures actual losses more transparently and is also less pro-cyclical than the current ‘incurred loss’ approach”\(^{53}\).

9.2 Expected loss accounting (IFRS 9)

IFRS 9 became effective on 1 January 2018. Under IFRS 9, banks must hold provisions for ECLs on all loans – not just provisions for loans on which credit loss events have occurred\(^{54}\).

Banks must allocate their loans to one of three categories:

- **Stage 1**: Performing loans
- **Stage 2**: Underperforming loans, where there has been a significant increase in credit risk but the borrower has not defaulted
- **Stage 3**: Non-performing loans, where the borrower is in financial difficulties or has defaulted

Banks must hold provisions equal to the following amounts:

- **Stage 1**: ECLs on loans over 12 months
- **Stage 2**: ECLs over the lifetime of loans
- **Stage 3**: ECLs over the lifetime of loans

Interest on the loans is quantified as follows:

- **Stage 1**: Interest on gross carrying amount
- **Stage 2**: Interest on gross carrying amount
- **Stage 3**: Interest on gross carrying amount net of provisions made

Estimates of ECLs must be based not only on past events and current conditions, but also on forecasts of future economic conditions. If economic forecasts get worse, provisions may increase by a large

\(^{53}\) Basel Committee on Banking Supervision, *Basel III: A global regulatory framework for more resilient banks and banking systems*, December 2010 (rev June 2011), page 6, paragraph 23

\(^{54}\) Bank for International Settlements, *IFRS 9 and expected loss provisioning - Executive Summary*
amount as loans move from Stage 1 to Stage 2 and provisions associated with them move from expected 12-month losses to expected lifetime losses.

Banks using the SA for credit risk may make specific provisions or general provisions. Specific provisions are defined as “provisions ascribed to identified deterioration of particular assets or known liabilities, whether individual or grouped”, while general provisions are defined as “provisions or loan-loss reserves held against future, presently unidentified losses”\(^{55}\).

For banks using the IRB approach, the Basel regulations define “total eligible provisions” as the sum of all provisions (e.g. specific provisions, partial write-offs, portfolio-specific general provisions such as country risk provisions or general provisions) that are attributed to exposures treated under the IRB approach\(^ {56}\).

The implementation of IFRS 9 was discussed in a paper issued by the Global Public Policy Committee (GPPC), a committee of representatives of the six largest accounting firms. In this paper, Chapter 1 discussed governance and controls – which are clearly important, given the need for modelling and the scope for judgement. Chapter 2 considered key modelling principles and, for each of expected loss methodology, PD, EAD and LGD, and staging assessment, discussed each of three possible approaches: a sophisticated approach, a simpler approach and approaches that would not be compliant\(^ {57}\).

The IAA BWG organized a webinar on how actuaries can bring value to banks in the implementation of IFRS 9. This webinar discussed the background to IFRS 9, how IFRS 9 works, the skills that are required to implement it and how the actuarial skillset is well suited for the implementation of IFRS 9\(^ {58}\).

### 9.3 Provisioning and capital adequacy

#### 9.3.1 Base case scenario

In its ICAAP, a bank must provide forecasts for its balance sheet and profit and loss (P&L) account over the next three to five years. The balance sheet shows the stock of provisions at that date: over a year, the stock of provisions is increased by impairments and reduced by write-offs. Impairments during the year are taken in the P&L account, and have a negative impact on the bank’s retained earnings and capital resources. Impairments are recognized (and retained earnings and capital resources are reduced) more quickly under IFRS 9 than they were under IAS 39.

Because general provisions are freely available to meet losses that subsequently materialize, they may be included in Tier 2 capital, up to 1.25% of credit RWAs. However, specific provisions may not be included in Tier 2 capital\(^ {59}\).

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\(^{56}\) Basel Committee on Banking Supervision, *Regulatory treatment of accounting provisions*, October 2016, page 5, section 1.2

\(^{57}\) GPPC, *The implementation of IFRS 9 impairment requirements by banks*, June 2016

\(^{58}\) IAA Banking Working Group webinar, *Actuaries Bringing Value to Banks by Implementing IFRS 9*, September 2017

\(^{59}\) Basel Committee on Banking Supervision, *Regulatory treatment of accounting provisions*, October 2016, page 4, section 1
For a given set of financial forecasts, the move from IAS 39 to IFRS 9 will increase the bank’s provisions and will reduce its retained earnings and capital resources. Indeed, the BCBS has recognized “the possibility that the impact could be significantly more material than currently expected and result in an unexpected decline in capital ratios”. Because of this, the BCBS proposed transitional arrangements, to give banks time to rebuild their capital resources60.

In the UK, for banks using the SA for credit risk and moving from IAS 39 to IFRS 9, the reduction in capital resources may be offset to some extent by a reduction in TCR for credit risk, through unchanged Pillar 1 capital requirements and lower Pillar 2A capital requirements.

For Pillar 1 capital requirements, the BCBS has not, or at least not yet, reduced SA risk weights to reflect the introduction of IFRS 9. However, the BCBS has recognized that, under the SA, there could be some double-counting, with expected loss amounts covering some portion of the credit risk that is already captured by the risk weights.

In the UK, the PRA expects banks using the SA for credit risk to consider, under Pillar 2A, whether they should hold additional capital for credit risk, on top of their Pillar 1 capital for credit risk. For this assessment, the PRA published a table showing IRB risk weights for various categories of loans, and allowed banks using the SA to offset over-provision versus the IRB approach in some categories (such as mortgages) against under-provision in other categories (such as credit cards)61. As a result of this, Pillar 2A capital for credit risk may be zero – but it can not be negative.

The PRA also published a second table showing, for the same categories of loans, IRB risk weights based only on unexpected losses rather than, as in the first table, on both unexpected and expected losses62. As would be expected, the IRB risk weights are lower in the second table. The PRA pointed out that the second table is more appropriate for banks using IFRS 9. The second table should lead to lower capital requirements for banks using the SA for credit risk. However, their ability to benefit from the lower IRB risk weights is constrained by the unchanged SA risk weights.

9.3.2 Stress scenario

At the outset of a macroeconomic stress scenario, it is hard to assess how bad things might get – and so it is hard for banks to assess their expectations for expected losses in future years throughout the stress scenario.

Over the period of a macroeconomic stress scenario, a bank will incur the same total amount of credit losses under IFRS 9 as under IAS 39. Also, after the period of stress, the bank’s capital resources will be the same under IFRS 9 as under IAS 39. However, the more rapid provisioning under IFRS 9 means that the bank’s capital resources will be lower in the early years under IFRS 9 than under IAS 39.

The lower level of capital resources under IFRS 9 means that a bank whose capital resources had exceeded the total of its capital requirements and capital buffer throughout a macroeconomic stress

60 Basel Committee on Banking Supervision, Regulatory Treatment of Accounting Provisions - Interim Approach and Transitional Arrangements, March 2017
61 PRA, The PRA’s methodologies for setting Pillar 2 capital, April 2021 (Updating December 2020), page 4, Table A1
62 PRA, The PRA’s methodologies for setting Pillar 2 capital, April 2021 (Updating December 2020), page 5, Table A2
scenario under IAS 39 might dip into the same capital buffer under IFRS 9 – but subsequently recover to the same level of capital resources after the period of stress.

9.4 Actuaries and their role in IFRS 9 expected credit loss modelling

IFRS 9 accounting standards fundamentally change how banks recognize and provide for credit risk. A crucial change is the requirement to calculate lifetime ECLs for customers whose credit quality, and the risk they pose to a bank, has changed materially. The standard also extends the reach of the provisioning to include off-balance-sheet commitments. This is done through ECLs. Loans to be provided for can be broken up into three stages:

<table>
<thead>
<tr>
<th>Stage</th>
<th>Description</th>
<th>Provision requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Loan/credit has not experienced a material difference in credit quality since origination</td>
<td>One-year ECLs</td>
</tr>
<tr>
<td>2</td>
<td>Loan/credit has experienced a material difference in credit quality since origination</td>
<td>Lifetime ECLs</td>
</tr>
<tr>
<td>3</td>
<td>Loan/credit is impaired or in default</td>
<td>Recognize impairment impact</td>
</tr>
</tbody>
</table>

Calculating ECLs adds complexity for banks. Banks need to break down and analyse the individual components of PD, LGD and EAD. This requires a bank to have an in-depth understanding of the credit risk on its books. The use of historical data and statistical techniques as well as expert judgement to ensure accurate forward-looking projections of components is critical.

When projecting forward, a bank needs to understand and allow for how an asset’s credit risk has changed relative to its origination date. This adds two complexities:

- Firstly, origination dates need to be well defined, a task that can prove challenging, particularly when considering revolving credit facilities such as credit cards.
- Secondly, a bank needs to consider how it should define credit risk deterioration to ensure a fair accounting approach, while limiting the volatility on its P&L caused by this staging trigger.

On top of this, ECL calculations are required to allow for changing economic circumstances, and therefore require both forward-looking economic projections and the relationship of the values and projections with ECLs’ driving components.

These complexities offer significant opportunities for actuaries and their skillset to add value to banks.

9.4.1 Application of mortality theory (survival models)

Credit risk modelling in general, and the calculation of ECLs under IFRS 9 in particular, leads to the application of traditional actuarial science to banking.
When thinking of one’s training, it is interesting to note how some behaviours have become natural. Let us give an example of driving a car. At first you concentrate a great deal on changing gears and manoeuvring between the clutch, accelerator and brake. Then, after much practice and much time in the driver’s seat, it all becomes a natural action. We have trained our body to perform those actions, and it becomes second nature.

We perhaps behave in a similar way when it comes to our professional skills. When faced with a problem, we naturally look to simplify it. This perhaps comes from mathematics, the subject that is the foundation of the actuarial profession. In mathematical training, we are often given problems to ‘simplify’, which is the Boolean algebraic process to simplify. Throughout the years of our training as actuaries, there are many examples of having to take an expression and simplify it, so much so that it becomes a natural reaction. We also spend much of our time expanding mathematical expressions.

Let us consider the LGD required to be computed in calculating ECLs. If we were to simplify it for better understanding by taking the literal meaning of it – ‘loss given default’ – it means the amount lost after the default event has taken place. One must be in a state of owing money to default. There is, therefore, an outstanding value which is then the reference point. Which means that from that point, it is important to track what is lost of the default amount. Logically, everything or nothing could be lost of the default amount, which means one must reference the default amount, and so an equation starts to develop, which is:

- $\text{LGD} = \frac{\text{Loss Amount}}{\text{Default Amount}}$

But the loss event occurs at a different time to the default event, so time value of money comes into question. Because of that, the equation expands to:

- $\text{LGD} = \frac{\text{PV of Loss Amount}}{\text{Default Amount}}$

Furthermore, constraints around the value can be derived just by understanding the banking collections environment. In some cases, fees could be levied for legal costs, increasing the default amount. How much more will the default amount increase by? The possibilities become endless. On the other side, collections stop at recovering the full amount owed. The bank could, therefore, lose nothing or an endless amount.

Mathematically, the LGD has bounds; that is,

$\text{LGD} \in [(0; \infty)]$

Having equations and constraints allows the actual value to be determined for the business. But it need not stop there, and it can be expanded in an actuarial way. Consider the future options. The LGD has a start point, default, which we can term ‘time 0’. But to determine a loss from that point, we must understand whether the customer makes a payment or not, or whether the bank writes-off the debt. When the bank decides to write-off, it could be any month after the default event. If one then begins asking from the point of default whether the account be written-off or not, and if it is not written-off – or rather, it survives the month – then does the customer make a payment or not? Then ask similar questions for the next month and the next, and then a new equation appears:

$p_1P_1(1+i)^{-1} + p_2P_2(1+i)^{-2} + \cdots$
where:

- \( P \) is the probability that a customer makes a payment at time \( t \)
- \( p \) is the probability that a customer does not make a payment at time \( t \) and the account is written off
- \( i \) is the discount rate

\[ t = 1, 2, 3 \ldots \]

Another example in credit risk modelling is the PD at time \( t \) or a lifetime PD that can also be modelled based on a survival model (a two-state Markov model), where a loan that survives to time \( t-1 \) can default in year \( t \). This is a two-state survival model where the states are default and active. The transition is then defined as moving from active to default.

Let us take a group of loans as an example where one must model the PD at time \( t \). The total waiting time – that is, the sum of waiting times for all loans – is calculated, and then we take the reciprocal of the waiting time to give a transition rate, \( \mu \), where:

\[
\text{transition rate (} \mu \text{)} = \frac{\text{total number of transitions}}{\text{total waiting time (days)}} \times 365
\]

The transition rate is then transformed into a probability as follows:

\[
P = \exp \left( - \int_0^t \mu x + s \right) dx
\]

where \( P \) is the probability of remaining in an active state for \( t \) years, and

\[ PD = 1 - P. \]

This gives a lifetime PD for a group of loans and is very useful in IFRS 9 provisioning models. A one-year PD at time \( t \) is determined by integrating the equation above between \( t-1 \) and \( t \).

This is one example of applying actuarial techniques into banking, confirming that we should not be limiting the techniques we studied to the traditional spheres of actuarial science. With the actuarial tool sets, actuaries are well equipped to solve complex problems beyond traditional areas of practice. This requires a mindset shift to transcend boundaries.

9.4.2 Application of general insurance techniques (run-off triangles)

Chain-ladder/run-off triangle and discounted cashflow approaches can be used to calculate the LGD.

One possible methodology for estimating the LGD is to use a chain-ladder or run-off triangle approach to project recoveries from the date of default onwards. This methodology is suitable for unsecured portfolios where recovery cashflows occur regularly from month to month. For secured portfolios, such as mortgages, this approach is not considered suitable, because the main recovery will be as a result of the disposal of the asset (a house, for example), which will result in large and lumpy recoveries distorting the development patterns in the triangle.

Another common methodology for estimating the LGD is to develop a discounted cashflow model of recoveries on defaulted assets. This works particularly well for retail portfolios where there is sufficient
default and loss data to allow for the development of the model. The LGD is then taken as the value of the exposure at the point of default less the discounted future recoveries.

These are actuarial techniques that are being applied in banking. There are many more actuarial techniques that are applicable in banking. The key is to innovate and apply such methods to solve problems. The move to IFRS 9 accounting provisioning presents such opportunities.

9.5 Implications of moving from IAS 39 to IFRS 9

9.5.1 Possible positive outcomes

The need to approve measures of ECLs for the bank’s accounts at each reporting date should increase management and board awareness of likely credit losses on each category of lending in which the bank is involved, under normal conditions and under stress conditions.

Should reported losses exceed expected losses in an accounting period, this should raise questions as to whether there has been a deterioration in the asset mix, albeit within the bank’s approved risk appetite, or whether there has been a deterioration in underlying economic conditions.

Management and the board will be aware, from the bank’s IAS 39 and IFRS 9 submissions, that stress conditions are likely to cause the bank’s capital resources to decline more quickly and to a greater extent under IFRS 9 than under IAS 39. This awareness may well lead to management actions, identified in the ICAAP, being implemented more quickly under IFRS 9 than under IAS 39.

9.5.2 Possible negative outcomes

Banks using the SA for credit risk may feel that they are being ‘unfairly penalized’ by having to use, for their Pillar 1 capital requirements, the same risk weights as before, as well as to hold provisions for expected losses.

Banks are likely to be reluctant to hold a higher capital buffer if the accounting change from IAS 39 to IFRS 9 causes their capital resources, under stress conditions, to dip into their capital buffer rather than to remain above it (as was previously the case, under IAS 39). Instead, some banks may use the transitional arrangements mentioned in Section 9.3.1.

In deteriorating economic circumstances, banks may be reluctant to increase their expected losses to such an extent that they put their capital adequacy – and share price – under pressure.

9.5.3 EU/UK developments 2020

During 2020, because of Covid-19 lockdowns, economic forecasts have moved from growth to recession. Banks need to hold much higher ECLs, and this could reduce their willingness to support existing customers and new lending. So, in what is known as the ‘CRR Quick-fix Package’, banks will be
allowed to smooth the impact of their higher ECLs by ‘re-setting’ the transitional arrangement mentioned in Section 9.3.1\textsuperscript{63}. In the UK, the PRA has supported this approach\textsuperscript{64}.


\textsuperscript{64} PRA, Statement by the PRA on the CRR ‘Quick Fix’ package, June 2020
10  Current Expected Credit Loss for US Banks

10.1  Foreword

If you go around looking, you will not find many actuaries in commercial banking in the USA. Even concrete statistics about how many actuaries are in the field have proved impossible to find. In my career, I’ve only met one other actuary working in the industry, and I think the profession is missing out on a huge opportunity.

I have never worked at an insurance company, so one might ask why I think I am qualified to say that actuaries can make the transition to banking. However, I know this to be true because there have been many instances in my banking career in which I have found myself thinking, “I studied this in preparation for an actuarial exam. Why am I the only actuary in the room?”

Jennifer Chancey (US actuary in the banking field)

10.2  Introduction

Banking entails managing a host of risks, just like insurance. Nothing proves that as much as bank reserving and stress testing. This chapter and the next discuss these topics in turn. While this chapter does not provide a link to insurance, it discusses the general methodologies used throughout the industry in the USA that relate to actuarial first principles.

10.3  Current expected credit loss modelling

One factor that significantly affects banks’ capital positions is the reserves they carry for losses on loans. Current ECL (CECL) is a new methodology, developed by the Financial Accounting Standards Board (FASB) that completely changes the way banks have historically determined these reserves. CECL under FASB in the USA is equivalent to ECL under IFRS 9.

CECL was developed as the FASB argued that the current incurred loss methodology for bank reserves did not provide the forward-looking information that users of financial statements needed, as evidenced by the Great Recession. Incurred loss essentially requires a bank to allocate for a loan loss when a triggering event causes the bank to believe that a borrower will not meet a financial obligation. The rationale was that if banks did not act until a triggering event, a credit crisis could already be occurring. The proposed solution was for banks to make a prediction about the probability and severity of a loss when putting a loan on its books based on the life of the loan. To do this, banks have to ask themselves these essential questions:

- Based on past experience, do we expect this borrower to fulfill the financial obligation?
- If not, when do we expect a default to occur?
- How much will we be unable to recover?

66  CECL also changes the accounting for investment securities and various other assets, but loans are the main focus of the regulation due to the significant impact it will have on the Allowance for Loan and Lease Losses throughout the industry.
10.4 Accounting background

The CECL methodology is one of the biggest accounting changes for the banking industry in history, and it became effective on January 1, 2020.\textsuperscript{67} For reference, it is useful to provide a quick bank accounting explanation. The current Allowance for Loan and Lease Losses (ALLL), or reserve for loan losses, appears on a bank’s balance sheet as a contra asset. A Provision for Loan and Lease Losses (PLL) appears on the income statement and is deducted from revenues. It is generally added to the ALLL upon determination of the appropriate amount of reserves.

The way that the ALLL and PLL move through the financial statements is important because they will ultimately have an impact on a bank’s capital ratios. The PLL has an impact on the ALLL. A significant increase in the PLL, which is the projected impact for the industry when CECL is implemented, will result in a dramatic increase in the ALLL. Additionally, because the PLL is deducted from net interest income, total retained earnings will decrease. Retained earnings are a component of the three levels of capital required for the regulatory capital ratios: CET1, Tier 1 and Tier 2 capital.

Tier 1 capital is a function of CET1 capital, and total risk-based capital is a function of Tier 1 capital. It is easy to see how an increase in the PLL, and therefore an increase in the ALLL and a decrease in retained earnings, can travel through the capital ratios, thereby reducing total capital and potentially limiting bank activities, such as dividend payouts or stock repurchases.

Second, the ALLL is included in Tier 2 capital if it is less than a capital limitation.\textsuperscript{68} An increase in the ALLL will then increase Tier 2 capital. This flows through to total risk-based capital. The decrease in Tier 1 capital would be offset by the increase in Tier 2 capital, and in the case that the ALLL does not increase enough to warrant the capital limitation, total risk-based capital will remain unchanged.

10.5 Data requirements

In order to create robust models, banks need historical loan data that shows how their loan portfolios reacted to different economic environments. Most banks might have started electronically collecting detailed loan data years ago, such as loan type, credit scores from the company FICO or LTV ratios. However, this might not be the case for the smallest banks, which will have to build models for the life of loan with data only going back a few years. In the rare case that a bank has an adequate amount of data, the likelihood that it is in a centralized database is low. The collection and centralization of the appropriate data has become the focal point of CECL preparation.

Like other data analytics professionals, actuaries also understand that data will never be perfect. Even though most banks have likely been collecting and retaining digital loan records, they have not necessarily been collecting the ‘most relevant’ data that will be most useful. What is the best indicator of default for an auto loan? Is it a FICO score? Maybe the term length of the loan? Not only that, but the type and amount of data collected will determine the granularity of the overall analysis. A loan for an apartment building is going to have different risk characteristics than a loan for a retail location. Yet, in

\textsuperscript{67} The deadline for US Securities and Exchange Commission (SEC) registrants is for fiscal years beginning after 15 December, 2019, which typically implies the first quarter of 2020. It is 1 January, 2022 for non-SEC registrants.

\textsuperscript{68} The Tier 2 capital limitation is 1.25% of Total Risk-Adjusted Assets and Off-Balance Sheet Items.
order to analyze these loans as separate pools, banks have to have enough historical and relevant data to develop a reasonable and comprehensible reserve estimate for each type.

10.6 Types of models

FASB did not specify a type of model that should be used for CECL. Banks must determine what methodology works for them based on the type and amount of data they have available. The five most common types of loss methodologies being utilized throughout the industry are loss rate analysis, vintage analysis, transition matrices, DCF models and regression analysis:

1. Loss rate analysis groups together loans that exist on a bank’s balance sheet at a specific moment in time based on certain risk characteristics, and tracks losses of that group over a period of time to determine a loss rate for the group. This is also referred to as cohort analysis.
2. Vintage analysis is similar to loss rate analysis, except that it specifies that loans in the same segment must have been originated around the same time, such as during a certain quarter or certain year.
3. Transition matrices determine historical loss rates based on the historical migration of loans to loss, also known as the probability of default. They combine an LGD, which is typically a historical average loss size, and EAD to create the whole loss picture. This is also referred to as the roll rate method or the PD/LGD model.
4. DCF would essentially apply a PD to each cash flow in a stream of cash flows and discount them to the current period.
5. Regression analysis creates an approximation of loss based on the historical relationship between loss rates and various inputs, such as credit characteristics or macroeconomic variables.

It seems that the majority of banks are implementing loss rate or vintage analysis for at least a portion of their loan portfolios, so it is useful to provide an example of each. A PD is calculated as an average of historical movement of loans from pass-rated to default. The table below is an example of one of those matrices. The left-hand column is the rating of a loan at the beginning of a period, such as the beginning of the quarter. A is the best rating, and S is the worst rating right before default. The top row is the rating of a loan at the end of the period.

In this example, 87% of loans that started the period as A-rated were A-rated at the end of the period, on average. What we are concerned with are the values in the Default column. Five per cent of C-rated loans default on average. That is our PD for this particular subset of loans. This PD is applied to an LGD. This is our historical loss severity for that same subset of loans. Finally, these percentages are multiplied by the EAD, or balance of that subset, to calculate our projected losses.
Opportunities for Applying Actuarial Techniques in Banking

Another common model being utilized is vintage analysis, which is similar to loss triangles in insurance. The vintage method uses origination year as the beginning period, not a triggering event such as a loan downgrade, and it also includes a triangle of forecasted values. It categorizes loans by origination year, or vintage, and then calculates expected loss rates for future periods based on historical experience for loans of a similar vintage. This average historical loss rate is applied to the current balance of each vintage segment to determine its allowance. The origination in the following table would be the year or quarter the loan was booked. Then each column of age, here also being a year or quarter, would include the total charge-offs as a percentage of loan balances from the period. The forecasted values would be the historical average of the column adjusted for any expected changes to current conditions, whether that be internal management of the portfolio or external economic impacts.

<table>
<thead>
<tr>
<th>Years Since Origination</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2012</td>
</tr>
<tr>
<td>2013</td>
</tr>
<tr>
<td>2014</td>
</tr>
<tr>
<td>2015</td>
</tr>
<tr>
<td>2016</td>
</tr>
<tr>
<td>2017</td>
</tr>
<tr>
<td>2018</td>
</tr>
</tbody>
</table>

10.7 Qualitative adjustments

Not only do banks have to analyze individual loan characteristics, but they also need to relate segments of the portfolio to the economy at large. It is entirely probable that growth of GDP, or lack thereof, will have an impact on commercial real estate (CRE) loans. Yet banks will have to create economic forecasts...
for macroeconomic indicators that they deem important to their portfolios, and these forecasts are required to be reasonable and supportable. According to the Moody's Analytics white paper Economic Scenarios: What’s Reasonable and Supportable? “The phrase ‘reasonable and supportable forecasts’ appears more than 30 times in the [FASB’s] CECL standard.” This means a bank’s CECL forecasting model “should be based on sound, generally accepted economic and statistical theory … and should incorporate inter-relationships and feedback effects among economic variables”. The common approaches suggested include time series analysis, dynamic stochastic general equilibrium models, machine-learning/data-mining algorithms and structural models.

After the most probable economic scenario is modelled, banks have to find a way to apply it to their portfolios. This application is known as a qualitative adjustment (QA). For example, let us say that the CRE portfolio is most affected by GDP, and a bank is projecting a moderate recession for the next two to three years. That is, GDP growth is going to be negative for a few quarters, which will result in an increase in both projected default rates and loss severities. What is the quantitative impact of this factor? Is it going to be a one-time spike in defaults and loss severities? What if it is a gradual build-up followed by a gradual improvement; that is, mean reversion? The way that banks apply this QA could have a huge impact on the volatility of the reserve.

10.8 CECL effects

One interesting result that banks are seeing in initial CECL testing is that reserves for riskier loan buckets are going down. This does not seem like it would be intuitive at first, but it makes sense when evaluating the structure of the models. With the current incurred loss methodology, there is something called a loss emergence period (LEP). This measures the time from the triggering event to the time the loss actually occurs. If a triggering event occurs in August 2018, but the actual loss does not materialize until August 2020, then the LEP would be two years.

With CECL, what matters is the duration of the loan. With large commercial loans, they could be revolving lines of credit that renew every year. This renewal starts a new life, so to speak, for the same loan. Thus, the duration could actually be less than a year. When the LEP does not match up with duration, reserves increase or decrease accordingly. So, while commercial loans might be much bigger and riskier, the models want us to reserve less for them because their maturities are shorter. On the other hand, mortgage loans with 15- or 30-year maturities, which typically would have a short LEP, would see reserves increase.

A major aspect of CECL that banks are concerned with is the volatility of reserves. This volatility can come from a variety of places: the model used to project PDs and LGDs, the factors used to create QAs to adjust for economic realities and probabilities, and the method of applying all of the above. The amount of volatility will also vary among banks, and the change in reserves will not necessarily be directionally consistent. Banks ultimately want to find the right balance between the most accurate estimate and the estimate that is easiest to explain. As actuaries know, there is always a trade-off between a more accurate estimate and projection simplicity. And in most cases, a simpler model is preferred to a more complex model, all else being equal.

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Reserves are expected to increase on day one in general across the industry. But going forward, the reserve and earnings have the potential to vary wildly from quarter to quarter mainly because of the economic forecast, which has been identified by the industry as the most impactful CECL assumption. A study of banks with relatively more volatile earnings compared to peers showed that they have been priced at a discount in the market historically. It seems safe to assume that share valuation will change because of CECL volatility. Thus, the drivers of the volatility – model selection and assumption calibration – are extremely important because they will have a direct impact on share price.

CECL is a complex financial issue dealing with significant financial risk and uncertainty to the financial security system in the USA, yet actuaries are not involved in guiding the market. While it might be too late for actuaries to lead banks through CECL implementation, there is great opportunity to improve the processes going forward.
11 Actuarial Techniques in US Banks

11.1 Stress testing

The banking regulators in the USA\textsuperscript{70} implemented a joint regulation, SR 12-7, \textit{Guidance on Stress Testing for Banking Organizations with Total Consolidated Assets of More Than $10 Billion}, in May 2012.\textsuperscript{71} Essentially the regulation says, “All banking organizations should have the capacity to understand fully their risks and potential impact of stressful events and circumstances on their financial condition.” The expectation is that this is performed through stress testing. According to the Guidance, stress testing should:

- Be consistent and repeatable
- Match the size, complexity and overall risk profile of the firm
- Incorporate multiple stress-testing approaches
- Be forward-looking and flexible
- Be clear, actionable, well supported and informative
- Include a commensurate model risk management framework
- Cover the full set of material exposures, activities and risks to which a bank is exposed

11.2 Multiple approaches

Let us take a deeper dive into multiple approaches. The Guidance suggests four different processes that should be familiar to actuaries:

1. Scenario analysis entails creating a story. This story should be logical, with details tied together through management experience or empirical facts. Scenarios can be bank-wide, or they could be granular and tell a story about a particular line of business. Using stochastic scenarios would provide a range of outcomes to build a distribution and calculate meaningful statistics, such as VaR and tail value at risk (TVaR).

2. Sensitivity analysis means to stress test the most impactful assumptions. For example, let us say we have a large CRE concentration. The CRE price index could be a big assumption for us. What happens if it plummets? That is what we want to know. Sensitivity analysis should be done periodically. Taking our example, let us say our portfolio shifts from CRE to residential real estate. That would make the House Price Index (HPI) more important, but we have not been checking its sensitivity. We need to be flexible and make sure we are always analyzing the most relevant inputs.

3. Enterprise-wide stress testing is a more comprehensive view of scenario analysis. We are only looking at scenarios that would impact the whole banking organization, so we want simple scenarios because they are easier to implement in the models. They can affect the entire economy, the industry or just the bank, and they should be severe enough to challenge the

\textsuperscript{70} The banking regulators include the Federal Reserve, the Office of the Comptroller of the Currency (OCC), and the Federal Deposit Insurance Corporation (FDIC).

\textsuperscript{71} \url{www.federalreserve.gov/supervisionreg/srletters/sr1207a1.pdf}
viability of the bank. There should be a logical conclusion in the form of measures of impact – such as capital ratios.

4. Reverse stress testing means we start with a known adverse impact – like the inability to satisfy financial obligations – and we find the event or events that will make this happen. We are essentially trying to break the bank, which is really interesting because it could lead to the discovery of blind spots that are more sensitive to shocks than previously thought.

11.3 Internal stress tests

Two of the most scrutinized areas within a bank are capital and liquidity adequacy. A typical procedure in capital stress testing is to show changes in earnings, losses, reserves and RWAs over a two-year forecast period, usually broken out by quarter, based on a particular scenario. These things are the biggest drivers of capital volatility.

The capital model is likely populated with results from other models. The projected components are driven by interest rates and credit gains and losses. That means a credit model will be needed to project the behaviour of loans including maturities, defaults and prepayments. Loan behaviour will have an impact on interest income. A typical bank will have investment securities as well, so a model will be needed to project purchases or maturities. Finally, an interest rate model will project the interest rate curve and how the shifting loan portfolio and securities portfolio are impacted by it. Interest rate and securities return modelling would be integral.

All of this leads to results that potentially show us where our strengths and weaknesses are and give us the ability to form an action plan in the event of a crisis.

Next up is liquidity stress testing. Here, we are looking at inflows and outflows. For simplicity, we have deposits, interest income and loan payments coming in, and we have loans, taxes and dividends going out. These are essentially things we anticipate happening and can estimate relatively reliably due to contractual obligations.

What are we not anticipating? For example, there could be a run on the bank. This means deposits would crash, and we have to find a way to support loans. We could borrow money or buy brokered deposits. Of course, there are costs associated with those options. While this is an extreme scenario, it is important to test hypothetical events like this to ensure that the bank will be able to meet financial obligations over the next quarter or month, or even week in tail-risk situations.

It is also recommended to project interactions between capital and liquidity, especially in a reverse-stress-test scenario. This means incorporating an event in the liquidity model that would cause the bank to fall below the well-capitalized capital levels. These things do not work in a vacuum, and it is important to show how they can have an impact on each other.

11.4 Regulatory stress tests

The two stress tests that were described in the previous section are internal stress tests. This means that the regulators make sure that banks are doing them, but they are not required to submit results, particularly to the public. However, there are two regulatory stress tests that affect large bank holding companies: the Dodd–Frank Act Stress Test (DFAST) and the Comprehensive Capital Analysis and
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Review (CCAR). The DFAST is required for banks with assets greater than $100 billion. It was applicable to banks between $10 billion and $50 billion until May 2018, so a significant portion of the banking industry has already developed some type of loan loss model. DFAST banks are required to submit their company-run results annually and then publicly disclose a portion of their results.

Additional stress testing is required for CCAR banks – that is, banks with assets greater than $250 billion. Not only are CCAR banks subject to quantitative testing, but they are also evaluated qualitatively. This means the comprehensiveness and reasonableness of its capital planning framework is assessed. Unlike the DFAST, CCAR banks are pass or fail. For example, they have to submit capital action plans, which include everything they plan to do with capital, such as pay dividends or repurchase Treasury stock. If a CCAR bank fails its stress test, it may not be able to execute its capital action plan.

11.5 Types of models

The regulatory agencies release three macroeconomic scenarios – baseline, adverse, and severely adverse – every year. Banks are required to use these scenarios in some capacity for their regulatory stress tests. An intuitive way to incorporate these scenarios is through the use of regression for loan losses. An internal loss statistic would be the dependent variable, and a few macroeconomic variables would be the independent variables. The reason that banks focus on loan losses for the stress tests is that during an economic downturn, loan losses are going to drive the biggest changes to a bank’s financial statements. Thus, they have the biggest impact on the capital adequacy.

Regression analysis is attractive for stress testing because it provides a direct and logical way for the macroeconomic scenarios to be applied to loan data. It is data-intensive for individual loans, but for a loan segment it is easily applicable. For example, PDs of a CRE portfolio could be estimated in the following way:

\[ PD_{CRE_t} = \text{Intercept} + \beta_1 \times PD_{CRE_{t-1}} + \beta_2 \times Real GDP_{t-2} + \beta_3 \times Unemployment Rate_{t-1} + \varepsilon \]

It would seem to make sense for the current and previous DFAST and CCAR institutions to continue using these methodologies for CECL, given that CECL requires the use of an economic forecast. The main difference is that they are now responsible for determining the most likely economic scenario to occur for the life of their loan portfolios. However, for smaller community banks that are now subject to CECL, these models might be inaccessible due to data, infrastructure and personnel constraints.

11.6 Opportunities in stress testing

With all that being said, there are opportunities to improve stress testing in banking. Typically, scenarios are run one at a time. There is a need for wider use of stochastic modelling, or the use of Monte Carlo simulation to create distributions of losses. Assumptions are often set individually, so they could benefit from the use of a cascade structure. For example, an interest rate curve would likely be estimated first. The next variable, such as the growth rate of loan balances, would be set based on the interest rate curve. Each variable after that would depend on the assumptions set above it so that the relationships between them are intuitive.

Another opportunity is the elimination of information silos. This means that data and processes should be centralized so that assumptions, scenarios, and so on are consistent across the bank. This would
lead to a consensus on modelling and its results, and ultimately more cohesive decision-making. Banks seem to be moving in this direction with the creation of an economic forecasting committee. This committee would set assumptions to be used in all bank processes, such as budgeting, stress testing and pricing. This is in line with integrating the previously isolated results with other processes. For example, the results of a stress test on loan losses could be integrated into the reserve projection.

11.7 Additional opportunities

Actuaries can contribute to the various aspects of banking processes – because they are processes which actuaries have studied and are qualified to evaluate, and in which they typically have experience. These include model risk management and general statistical analysis.

11.7.1 Model risk management

Banks are required to have sufficient model risk management practices. This is governed by SR 11-7, Guidance on Model Risk Management, and a summary is shown in the first diagram below. This process is very similar to the actuarial model control cycle, which is shown in the second diagram.

Model validation and governance, policies and controls would fall under model maintenance. Model validation specifically is another area in banking in which actuaries could have a significant impact. This is already the case in South Africa, where actuaries are involved in both model building and model validation. The purpose of model validation is to ensure that models are performing correctly and as expected, and to identify potential limitations. An unbiased validation is typically performed by a person that is independent of model development. However, this means that the person performing the validation must have the skills and expertise to assess the model.

A proposed Actuarial Standard of Practice (ASOP) on modelling details the proper procedures for validating a model in Section 3.5 Mitigation of Model Risk, Subsection 3.5.2 Model Validation, in the fourth exposure draft. Additionally, there are various ASOPs that govern actuarial disclosures, such as

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72 [www.federalreserve.gov/supervisionreg/srletters/sr1107.htm](http://www.federalreserve.gov/supervisionreg/srletters/sr1107.htm)
73 [www.actuarialstandardsboard.org/asops/modeling-fourth-exposure-draft/](http://www.actuarialstandardsboard.org/asops/modeling-fourth-exposure-draft/)
a validation report. Thus, actuaries have the necessary skills to do this in banking because it is a task that is overseen by high standards and that they already routinely perform. The use and complexity of models in the banking industry is expanding. Therefore, an established system for such activities is becoming increasingly important.

11.7.2 General statistical analysis

Most departments at a bank could benefit from the statistical expertise that actuaries can provide. The following list of activities by various departments that could benefit from this is by no means exhaustive:

- The Lending and Credit departments analyze credit metrics to underwrite a loan.
- The Compliance Department reviews loan denials, originations and pricing in combination with applicants’ characteristics to mitigate discriminatory lending.
- The Management Information Department evaluates portfolio characteristics for current credit concentrations and risk rating trends.
- The Human Resources Department analyzes branch operations to optimize staffing.
- The Risk Department:
  - Manages a bank’s enterprise risk management program
  - Evaluates and purchases necessary insurance policies
  - Scrutinizes depository patterns to detect fraud or money laundering, among other activities

These processes could be more informative with robust statistical analysis. Who better to help with such a task than professionals certified in statistical techniques? The lead author of this chapter, Jennifer Chancey, often finds herself working as a pseudo-consultant for statistical projects throughout her bank. This highlights the need for a more accessible pool of talent within the banking industry in the USA.
12 Customer Analytics in the World of Big Data

12.1 Customer analytics in banking

Customer analytics involves analyzing a customer’s behaviour to gain insights and deliver product offerings that are relevant, useful and timely. Banks use customer analytics to understand customer lifetime value, increase sales and/or cross-sales, improve service, and reduce or limit customer churn. Client value management is an important area where actuaries can use their skillset to add value to banking institutions.

The rate at which data is collected is accelerating rapidly, and the depth and wealth of data makes processing with traditional database management tools unsuitable. Key issues to consider in big data processing include storage, search, distribution, transfer, analysis and visualization.

Today’s biggest challenge is to unpack the hidden information from a variety of sources. Most organizations can collect large amounts of unstructured data using various methods and tools. However, with the rapidly growing volume of data, they may not have the capability for mining it and deriving necessary insights in a well-timed way.

Companies across the globe have recently been using big data to understand exactly which customers are satisfied with their service and which processes cause dissatisfaction, and to predict which customers are going to churn. This type of analysis enables management to rectify faulty processes or people, and may be able to retain at-risk customers.

The modern era has been termed the ‘Age of the Customer’, where customers drive business decisions. For this reason, it is imperative for companies to know their customers with greater precision and depth, and they are relying on their vast sources of data for this.

Organizational and system limitations have left some brands struggling to feed their analytics with quality data. This has made it challenging to develop a detailed view of the customer journey and experience that can reveal critical behavioural insights.

12.2 Actuaries and customer analytics

A key challenge in the world of customer analytics is the relationship between systems, data and information required for decision-making. This has reinforced the need for actuaries to operate beyond the basic number-crunching and to drive the system changes required in their organization and lead the decision-making process.

Actuaries are well equipped to build systems and processes that collect the right data, allow effective customer analytics and improve companies’ value proposition.
13 Operational Risks, Fraud and Cybersecurity

13.1 Foreword

In order to participate effectively in the world of cybersecurity, actuaries will need to augment their actuarial training with knowledge of basic networking, basic Structured Query Language (SQL), Python or other programming languages, and data science fundamentals that include machine learning.

_Tafara Muwandi (Zimbabwean actuary in the cyberspace field in the USA)_

13.2 Operational risk in banking

Operational risk refers to the risk of losses arising from inadequate or failed internal processes, people or systems.

Fraud cases have become complicated, with varying amounts, frequency and complexities. Fraud detection has also evolved from using security personnel observing transactions and identifying trends to models that detect and prevent fraud.

Firms use operational risk models to quantify and better understand the risks they face. These models can be used to inform senior management decisions. There is no blanket approach to modelling operational risk. Model design factors need to be carefully selected, considering the firm’s circumstances.

13.3 Actuaries and operational risk

Actuaries can play an integral role in modelling operational risk. They understand the ‘bigger picture’ and have strong mathematical and statistical skills, which are vital in any modelling exercise.

There is growing interest within the regulatory space to supervise operational risk models more to prevent losses. The models need to be adaptable or redeveloped to accommodate the changing risk environment. Most risks tend to be correlated with other seemingly independent events. Actuaries can assist in developing industry best practice to calculate the correlations in future.

In addition to statistical model validation, technical tests are required to ensure that the output is appropriate.

The stability of the model will be an important focus area for technical validation. This is to validate the parameters chosen in the development of the model. These tests focus on the sensitivity of results to changes in the key underlying assumptions. ‘Softer’ validation questions, such as whether people understand the model, governance concerning data quality and model assumptions should also be addressed. Actuaries can play key roles in all these areas.

13.4 Actuaries and cybersecurity

Actuaries are trained in the art of risk assessment and management. As banks become increasingly digital and reliant on the internet as a channel for doing business, the risks posed by cyber threats have become more evident. It is not possible to manage a bank’s risks effectively without factoring in cyber
threats and risks. The purpose of this section is to explore the cyber risks that banks face, and to highlight the role actuaries can play in the evaluation, assessment and management of these risks.

13.5 Cybersecurity and cybersecurity risks

Cybersecurity is the practice of protecting computers, servers, mobile devices, electronic systems, networks and data from malicious attacks. Cybersecurity is also known as (digital) information security and is made up of a number of different areas of specialty based on what is being protected and how. Examples of specialty areas include:

- Network security: Protecting the networks that host and transmit information
- Client/device security: Protecting devices that are used to access information
- Cloud security: Protecting cloud-hosted infrastructure and applications
- Physical security: Protecting the physical premises that host information
- Application security: Protecting the software applications that access the information
- Database security: Protecting the databases that store information

Cybersecurity is tasked with protecting three aspects of digital information and systems, as shown in the diagram below:

- Confidentiality: It is important that digital information be kept confidential and that only entities with permission to access it can do so. A hack or a data breach occurs when an unauthorized third party (the hacker) is able to get access to the information. A breach can occur irrespective of whether the unauthorized access was intentional or accidental.
- Availability: It is important that digital information is available for access and updating whenever it is needed. A denial-of-service attack occurs when hackers are able to take digital information and systems such as websites and mobile apps offline. By doing so, they deprive users of access to their information. Ransomware is a computer virus that encrypts all information, making it inaccessible unless the victim pays a ransom to the attacker to have the information decrypted. Both of these are examples of cybersecurity threats that affect the availability of information.
• Integrity: It is essential that the integrity/accuracy of information is maintained. Any incident that makes changes to the information to affect its accuracy is considered a cybersecurity incident. This includes deleting, inserting, changing, obscuring or otherwise tampering with important aspects of the data that will result in its incorrect interpretation or comprehension. A hacker with access to a bank’s systems might increase the balance in their account, create a fictitious payment to themselves from another customer’s account, cancel an existing loan/credit card balance or do other such things. All these will be breaches that affect the integrity of information.

13.6 How cybersecurity threats impact banks

We have already looked at a few examples of cybersecurity threats in the previous section. Now we are going to dig deeper into the threats and how they impact banks. Cybersecurity risks can be classified into the threats that face the bank’s customers and threats that face the bank and its partners.

13.6.1 Threats targeting a bank’s customers

13.6.1.1 Account takeover

A bank’s customers’ online banking accounts can be taken over or hijacked by hackers. This is done primarily with two main goals in mind: either to steal existing account balances or to apply for and draw down additional lines of credit on behalf of the victim. Attackers can also obtain personally identifiable information (PII), such as names, dates of birth, ID numbers, addresses and contact information, that they can use to steal the victim’s identity so they advance other fraud schemes that typically involve applying for credit on the victim’s behalf and then defaulting.

There are a number of ways in which a customer’s online bank account can be taken over:

• Credential stuffing: This occurs because people reuse the same username and password across multiple websites, apps and services. If a network breach happens at a large retailer, for example, and the hackers steal a million usernames and passwords, some of those one million victims will have an account at the bank and many of them might use the same username-and-password combination. Attackers are, therefore, able to test out the stolen retailer login credentials across a number of banks and successfully access a large number of customer accounts.

• Brute force/dictionary attacks: ‘Password123’ is still the most popular password in the world. People tend to use simple and easy-to-guess passwords. Attackers are, therefore, able to try and guess users’ passwords with surprisingly high success. To perform a brute force or dictionary attack, it is easier if a hacker has a list of accounts they know exist at the bank. They typically will achieve this in a number of ways; e.g. going to the ‘Forgot password’ page and trying a large number of email addresses and usernames. Most pages will give the attacker feedback as to the validity of a username. Equipped with a valid list of emails, the attackers can use brute force, which is random or sequential guessing of passwords. Some banks use a numeric password which is very easy for attackers to enumerate from 000000 to whatever number, and they can guess the password in a short period of time. For more complex passwords that some banks
require, the hacker simply has to look up the bank’s password requirements, use a password dictionary to identify the most common passwords that fit the bank’s requirements, and guess the password for customers using common passwords, thereby taking over their account.

- **Phishing/SMShing:** This is a technique used to fool a bank’s customer into handing over their login credentials to the criminals. This is done in phishing via email and SMShing via SMS message. The attacker will send communication claiming to be from the bank. They will typically claim something has gone badly wrong with the customer’s account and that they urgently need to click on a link in the message. The link, when clicked, takes the victim to a phishing website. This is a fake website made to look exactly like the bank’s. This site will ask the victim to type in their username and password, thereby giving it to the criminals.

- **Man-in-the-middle malware:** This is a high-tech technique where the bank customer’s computer is infected with a virus (malware) after they visit a malicious website or open a malicious email. This virus will then spy on the bank customer as they surf the web and will log all the usernames and passwords used to access bank accounts and other important sites, sending these credentials back to the malware’s creator. The malware can also be sophisticated enough to actually perform online transactions, such as transferring money out of the victim’s account via the victim’s own computer without their knowledge.

- **Online account hijacking:** This is a major problem for banks with an older clientele that have bank accounts but no online profile. A criminal can create an online login from scratch on behalf of that account holder using the criminal’s own details (username and password) without the bank customer’s knowledge. This gives the criminal full rights and access to that account.

The impact of account-takeover attacks is that they result in a bad customer experience, and customers may file complaints of unauthorized transactions. It costs the bank time and money to investigate the cases and reimburse affected customers. It may also lead to brand/reputational risk if affected customers take to social media and other platforms to tell the world about their experience. Regulators may also step in and fine the bank for breaches of data privacy laws. Banks therefore take these risks seriously.

### 13.6.1.2 Credit application fraud/ID theft

Criminals are able to use stolen identities and fake ID cards to impersonate someone else and open accounts or take out loans on behalf of that person. There are numerous places that criminals can obtain the PII required to steal someone’s identity. Once accounts have been opened or lines of credit availed, the criminals will draw down all the available credit and disappear, leaving the bank to try and collect their money from the victim, who will have no knowledge of the loan.

The result of this is similar to account takeover, where a lot of time and money is spent in investigations, litigation and collections. The victim, understandably upset, may tell the world about their experience, thereby negatively affecting the bank’s brand/reputation. If the case goes to the regulator, fines may be incurred.
13.6.2 Threats targeting the bank and its partners

There are some cybersecurity threats that target the bank itself, its employees and its partners. These attacks are more wholesale, take longer and require more resources to plan than attacks targeting customers, and have a lower probability of success, but have a much higher payoff if successful.

13.6.2.1 Network/database breaches

This is when attackers are able to gain unauthorized access to the bank’s back-end networks and computer systems. This can be achieved in a number of ways:

- **Employee account takeover**: Similar to bank customer account takeover, this involves the use of credential stuffing, brute force, dictionary attacks, phishing, SMShing or malware to take over an employee’s work systems access.
- **Employee social engineering**: The criminal will convince the employee to hand over their system credentials after establishing some credibility; e.g. by pretending to be from the bank’s IT department.
- **Vulnerability exploits**: Most banks use old computer systems that have not been patched or updated to address known security vulnerabilities. Attackers are able to use known hacking tools to scan and test for these vulnerabilities and exploit them to gain unauthorized access to the bank’s systems.
- **Physical breach**: This is a scenario where the attackers are able to get into the bank’s data centres or corporate offices and gain access to a terminal (e.g. an employee’s computer left unlocked) or an unsecured Ethernet port, and use it to gain access to the bank’s networks.
- **Third-party breach**: The hackers might gain access to the bank’s networks by breaching the bank’s partners – e.g. contractors developing the bank’s systems or open-source projects the bank uses in its systems – and sneak in backdoor code that gives the criminals access to the bank’s networks. If the bank uses third-party vendors with poor security practices, it might be easier for criminals to target the vendor and use the vendor to access the bank’s systems than to try and go straight for the bank.

13.6.2.2 Insider threats

An insider threat is when a trusted employee engages in criminal activity against the bank. This can be due to the employee’s willing participation in the criminal activity for personal reasons, or could be due to criminals blackmailing or otherwise coercing the employee. The end result is the employee using their privileged insider status to grant the criminals access to bank networks.

13.6.3 Social engineering

This is a catch-all bucket encompassing all the various types of fraud and criminals targeting bank customers. The criminal will use social engineering (information that establishes credibility) to convince the bank customer that they are someone they are not (e.g. a bank employee calling about their account). After establishing trust, the criminals will then ask the victim to hand over money or
information (that can be used to access their bank account; e.g. username, passwords, PINs, one-time codes). Social engineering scams do not just affect retail bank customers but businesses as well: criminals can call a business, pretending to be one of its suppliers, and ask it to send payment to a new account.

Social engineering scams usually result in the victim trying to stop or reverse fraudulent payments that have been made to the criminal. Some victims may pretend no knowledge of the transaction so as not to appear at fault and claim restitution from the bank. The impact of this kind of attack to the bank is similar to the other two types of attacks.

13.7 Areas of cybersecurity where actuaries can be involved

13.7.1 Cybersecurity insurance product design and pricing

Insurance companies offer cybersecurity insurance to banks and other companies. This insurance will pay out a given amount on the occurrence of an insured cybersecurity event, in exchange for a regular premium. These insurance companies need actuaries that understand cybersecurity to be able to design, price and reserve for these products. This is an area in which actuaries with cybersecurity expertise can get involved.

13.7.2 Reserving for cybersecurity fines due to cyber risks

The General Data Protection Regulation (GDPR) in the European Union and equivalent regulations in other countries are laws that were designed to protect consumer data and to encourage banks and other large companies to take cybersecurity risks and data privacy seriously. These regulations call for the creation of an office of data privacy as well as spelling out very steep fines for data breaches. These fines pose a large potential financial liability for banks and as such need to be properly modelled and reserved for. An understanding of the cyber threat landscape is required to fully quantify the probability of a range of cyber incidents, the scale of the incidents and the financial loss associated with each, including fines to be levied by the regulator.

13.7.3 Cyber risk detection

This involves designing anomaly detection models to identify cyber threats, including differences between manual and automated threats. Actuaries’ analytical skills can be used in various areas of cybersecurity detection and mitigation. Network log transaction data is the primary basis for most cybersecurity data analysis.

13.7.3.1 Network log transaction data

Network log transaction data contains a record of all transactions that happened on a given network or server. It contains information including, but not limited to:

- Information about the client (person/device/end user) that is interacting with a given network/server/system. The logs contain lots of details about the client, such as the:
  - Internet Protocol (IP) address
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- Internet service provider
- User agent (contains information on the kind of web browser, device and operating system)
- Transport Layer Security (TLS) fingerprints
- User/account names

- Information about the request or transaction that the client performed, such as:
  - Hypertext Transfer Protocol (HTTP) header information
  - Uniform Resource Locators (URLs) of resources accessed
  - Timestamps of when transactions occurred
  - Server response codes
  - The success/fail status of requests

This data is collected by an origin server and stored in the SIEM (security information and event management) system. The SIEM allows this log data to be analyzed and queried. Well known SIEMs include Splunk Enterprise Security, Imperva and IBM QRadar.

13.7.3.2 Cybersecurity data analytics

Network log transaction data can be analyzed to identify a wide range of cyber threats. Machine-learning models can be trained to detect these cyber threats and utilized for their automatic detection and mitigation. This is a role that actuaries can play in the cybersecurity space given their analytical expertise. There are three main areas of threats that can be detected from network log data:

1. Detection of automation: More than half the traffic on the internet is not generated by people, but by bots. Bots are automated computer programs that are designed to surf the internet and achieve a predetermined list of objectives. Google uses its Googlebot to go around and index all websites that exist on the internet, for example. Not all bots are good or benign: hackers and other cyber criminals also utilize automation for malicious purposes. It is, therefore, important to be able to tell apart transactions that are generated by real people and those that are generated by bots.

   **Kinds of automation targeting financial institutions**

   There are many different kinds of automation targeting financial institutions, but the following is a list of the most common ones:

   - Credential stuffing: A bot uses automation to test millions of usernames and passwords stolen from a third party against the bank's login page. Since some people reuse the same usernames and passwords, some of the credentials tested will be valid, and those accounts can be taken over and monetized by the attackers.
   - Credit application fraud: A bot uses automation to try and apply for credit cards or other loans using stolen PII. Information may be incomplete; hence automation is used to guess missing data – e.g. dates of birth.
• Account aggregation: A bot utilizes automation to access a large number of accounts controlled by the bot. The bot will access the accounts multiple times, performing predetermined functions on the accounts.
• Rate scraping: A bot uses automation to get a large number of quotes for insurance premiums or loan interest rates for different personas. By so doing the bot is able to reverse-engineer proprietary pricing algorithms used by the bank.
• SQL injection: A bot tries to force malicious SQL code into a web form on a bank’s website to access information that is not intended to be displayed. This process is automated since there are a large number of potential exploits that need to be tested.
• DDOS (distributed denial of service): This is when a bot makes a very large number of requests of a bank’s servers with the hope of overwhelming the servers and causing them to go offline. This will result in the bank’s customers being unable to transact.

By analyzing the log transaction data, actuaries can identify bot activity and categorize it into the kinds of bot attacks and motives.

1. Intrusion detection: An intruder is a hacker or unauthorized person accessing a computer system or network. Intrusion detection is the use of analytics to identify when there has been unauthorized access. This involves identifying external parties accessing restricted data, or internal staff accessing information they are not authorized to access. Access rights, past patterns of access, timing and frequency of access, and so on, are all factors that are analyzed in the network log transaction data to identify anomalous system accesses and intrusions.

2. Manual fraud detection: There are good and bad human users accessing any bank’s systems. Manual fraud detection is concerned with identifying fraudulent transactions that were not authorized by the true owner of an account. These can be transactions with stolen/cloned credit cards, money laundering, burst-out credit card fraud, cheque deposit fraud, unauthorized payments and transfers, illegitimate international transactions, etc. Network log transaction data can be analyzed to identify when manual fraud transactions are taking place.

13.7.4 Cyber risk reduction and mitigation

Actuaries, due to their expertise in enterprise risk management, can perform the role of Chief Risk Officer, or another risk management role. In this role, an actuary is responsible for the identification, reduction and mitigation of risks, including cybersecurity risks that the bank is facing. An actuary with knowledge of the cybersecurity landscape is well suited to quantify the cybersecurity risk facing the bank and can come up with ways to reduce and mitigate these risks, including deciding which risks to insure against.

13.7.5 Cryptography

Cryptography is a field of study that deals with the encryption of information. Mathematical formulas and algorithms are used to encrypt and decrypt information. These encryption algorithms form the backbone of cybersecurity. They are used to ensure the confidentiality of data both in transit and at rest.
Cryptographers work on developing and improving these encryption methods to ensure they are stronger (harder to break) and more efficient (execute faster with less processing power required).

The advent of quantum computing risks rendering all current encryption methods ineffective, and a lot of work is needed on coming up with the encryption standards of the future. Actuaries can play an important role in the world of cryptography, using their in-depth understanding of mathematics and modelling.

13.8 Additional skills actuaries need in cybersecurity

In order to participate effectively in the world of cybersecurity, actuaries will need to augment their actuarial training with knowledge of each of the following topics.

13.8.1 Basic networking

Actuaries interested in this area should learn how the internet and networks in general operate, and should understand the Transmission Control Protocols (TCP)/IP protocols as well as HTTP and HTTPS protocols. They need to comprehend how information is secured on a computer or mobile device (at rest) and in transit as it is transmitted between two devices on the internet. Knowledge of data encryption and the TLS standard is essential in understanding cyber risks.

13.8.2 Basic SQL, Python or other programming languages

Cybersecurity analytics deals mainly with the analysis of server logs. These logs contain metadata about all the connections that were requested to the bank’s systems via the internet. These logs are typically extremely large in volume and require more powerful analysis tools than the usual actuarial Excel spreadsheets. SQL, R, Python and other programming languages are essential to be able to analyze and query such large amounts of data. Knowledge of Splunk and other SIEM systems is not essential but would be an advantage, as is knowledge of business intelligence and other data visualization tools like Looker, Tableau, Kibana and QlikView.

13.8.3 Data science fundamentals (machine learning)

To truly maximize their impact in cybersecurity, actuaries need to be able to design models that can detect and mitigate cyber-threat actors. To do this, they need to be comfortable with the basics of machine learning. Actuaries should know how to create, train and test a machine-learning threat-detection model. The actuarial control cycle would enable the actuary to iterate and optimize the performance of the models to ensure maximum efficacy. An actuary’s training in advanced statistics will make the process of understanding more about machine learning a natural extension of their skillset.
14 Systems and Technology in Banking

14.1 Introduction

Over the last decade, the global banking industry has made significant investment in systems and technology. Ongoing infrastructure and maintenance costs represent a major portion of annual budgets. However, operational failures continue, with repeated instances of financial institutions experiencing operational failures. This section of the paper reviews operational issues related to banking and current issues related to systems and technology. It also considers how actuarial skillsets can be applied in the systems and technology field, and how this approach aligns with actuarial codes of conduct and standards of practice.

14.2 Key definitions

In order to provide insights into areas of overlap between the actuarial profession, systems and technology, two definitions need to be reviewed:

1. An actuary is a professional who applies analytical, statistical, mathematical and strategic thinking skills to value and bring greater understanding and improved decision-making to uncertain future events.\(^{74}\)
2. Operational risk is the risk of loss arising from inadequate or failed internal processes, people and systems, or from external events.\(^{75}\)

14.3 Actuaries in systems and technology

Actuaries have the skills required to break down complex problems and consider them in depth and from multiple perspectives. They can apply these skills to deliver practical solutions that make business sense. Banks, banking groups and related systems are complex entities which are active in the retail, commercial, corporate, investment, trading, insurance, reporting, compliance, governance and operations spaces across multiple jurisdictions and target markets. Inevitably, issues arise. Banks today cannot operate without having proper systems and technology in place, plus related data, processes and people.

So why do some banks experience operational failures? According to a prescient and still-relevant 1998 paper on the causes of banking difficulties in the European Economic Area:\(^{76}\)

- Management and control weaknesses were fundamental in almost all cases.
- Operational risk was a significant factor in many cases.
- A major risk factor was over-ambitious expansion, often into new areas, with systems and controls lagging behind.

\(^{74}\) ASSA: https://www.actuarialsociety.org.za/becoming-an-actuary/


Additional operational risk issues identified through research\textsuperscript{77} related to:

- Incorrect pricing and risk management
- Failed system implementation and data migration
- Inconsistent system implementation
- A lack of system and data integration
- A lack of straight-through processing
- A lack of a single customer view
- A lack of oversight and management
- Inconsistent definitions of exposure metrics
- Reliance on manual processes in exposure and risk monitoring
- The inability of calculation engines to address system- and process-related issues

In the view of the ASSA System and Technology Committee\textsuperscript{78}, these issues stemmed from various root causes, such as:

- Insufficient actuarial or related skills involved in decision-making
- A lack of a governance body for IT
- A lack of minimum software standards
- Limited responsibility or accountability
- A limited quality guarantee and no minimum timeline, penalties or fines on implementations
- Anyone can develop a system – but some developers have limited business experience or banking knowledge
- A lack of standard system audit and quality assurance processes

These issues are gradually being remedied from an enterprise risk management perspective through having the necessary policies, procedures, standards and regular updates attested to by principal risk owners. Actuaries are already involved in enterprise risk management policy-setting and implementation from a business perspective, so considering the systems and technology infrastructure side of banking in more detail is a natural extension of this involvement.

From a regulatory perspective, banks needed to achieve compliance with BCBS standard number 239, \textit{Principles for Effective Risk Data Aggregation and Risk Reporting},\textsuperscript{79} by the end of 2019. This standard speaks to the enterprise IT function and minimum standards for data when it comes to:

- Authoritative and golden sources of data
- Data lineage (how the data is tracked from source) and controls (reconciliations), and any compensating controls for limitations
- Systems architecture and operational robustness to deliver risk aggregation for monitoring

\textsuperscript{77} Banking System Failures in Developing and Transition Countries: Diagnosis and Prediction, Bank for International Settlements (1997), \url{www.bis.org/publ/work39.pdf}
\textsuperscript{78} \url{https://tinyurl.com/ASSASTseminar}
\textsuperscript{79} \url{www.bis.org/publ/bcbs239.pdf}
• Meaningful measures of financial services sector risks. To achieve this and to meet reporting needs, various data-quality controls and operating and service-level agreements and processes are required. The focus is on the data, models, systems and processes related to the risk-adjusted measurement for regulatory and board reporting purposes.

These principles, however, can be applied to any related systems or technologies. This gives actuaries a competitive advantage in that they have transferable skills applicable to different environments and emerging areas of risk management.

14.4 Actuarial codes of conduct and standards of practice

Actuaries operate under codes of conduct and standards of practice, including International Standard of Actuarial Practice 1 (ISAP 1) internationally and, for members of the UK’s Institute and Faculty of Actuaries (IFoA), the Actuaries’ Code and Technical Actuarial Standard 100 (TAS 100). Internationally, the IAA’s membership criteria for Full Member Associations (FMAs) specify the principles for a code of professional conduct to which FMAs must adhere. An example of such a code satisfying the IAA criteria is the UK’s. The Actuaries’ Code refers to principles that include:

• Professionalism (knowledge, expertise, values and behaviours)
• Taking responsibility and accountability
• Thinking about the public interest
• Having integrity
• Being competent and careful in everything that is undertaken;
• Being impartial
• Compliance
• Speaking up when necessary
• Being able to communicate with stakeholders
• Managing conflicts of interest appropriately
• Conducting peer reviews and having the necessary quality assurance, controls, policies, procedures in place to ensure adherence

These generic principles can be applied to almost any field, and the systems and technology space is no different. In fact, having these principles in place could result in fewer operational failures.

The TAS 100 document from the IFoA provides that:

The content of TAS 100 derives largely from the ‘Generic’ TASs (that will be withdrawn when the new framework comes into force) and includes principles and provisions on the following areas:

i. Judgement;
ii. Data;
iii. Assumptions;
iv. Models;

80 www.actuaries.org.uk/upholding-standards/standards-and-guidance/actuaries-code
81 https://tinyurl.com/IFOATAS100
v. Communications; and
vi. Documentation.

These principles are also essentially universal. Once again, the systems and technology space is no different. As noted previously, applying these principles could result in fewer operational failures and potentially reduce internal and external systemic audit or regulatory findings.

TAS 100 further discusses the concept of proportionality:

In considering how to apply proportionality, the following should normally be considered:

i. The significance of the piece of work including any financial, reputational or other consequences for the user;
ii. The complexity of the piece of work;
iii. The expectations of the user;
iv. The knowledge and expertise of the user; and
v. The extent to which judgement is required.

These principles are applicable to assessing systems and technology implementations: the size, degree, scope and business impact of BAU (business-as-usual) changes or significant new transformational initiatives for business must all be reviewed through a proportionality and materiality lens.

TAS 100 contains a specific section related to the development of software:

The development of software for actuarial work in-house or by specialist software houses e.g. systems for Solvency II internal models, for pricing general insurance products, and for pension scheme valuations … The development of these models requires actuarial expertise; actuarial principles are central to the work and judgement will be required throughout the development of the model. While this work is technical actuarial work, components of the overall exercise, for example, programming, might not be technical actuarial work.

Similar principles can be found in the IAA’s ISAP 1 document.82

More specific work is needed to build out the technicalities of the actuary’s systems and technology role and responsibilities.

Changes to the existing standards would be needed in order to achieve this, or perhaps a more specific TAS focused on systems and technology, especially in relation to BCBS 239 and other regulatory reporting frameworks.

14.5 Further review of the core actuarial skillset

Actuaries are known for in-depth analysis of complex data sets (both structured and unstructured) and building models to predict certain outcomes.

Such actuarial skills could be used to assess the viability of new systems and technology implementation based on the assessment of past experience, and to highlight areas of potential risk as well as issues and mitigating strategies. These skills can also be used to build business cases for innovative systems and technology projects and enhancement by calculating financial impact using

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82 https://tinyurl.com/IAASap1Dec2018
NPVs or IRRs, while taking into account the potential complexity of the many factors that contribute to cost and benefits.

Actuaries could also sit on strategic investment committees or fora for new or existing system changes. As actuaries have financial modelling skills, business acumen, commercial sense and strategic thinking abilities, some of which they may acquire through CPD, the profession is poised to add significant value in this area by ensuring that informed decisions are made.

Monitoring post-project costs and benefits is another important area. Generally, post-implementation analysis, monitoring and reviews are conducted by the Strategic Execution Office and are typically managed by Chief Operating Officers’ departments. Reviewing the actuarial control cycle at a high level involves defining the problem, developing a solution and monitoring the results.

These steps align with defining the initial technology solution to solve a business problem: namely developing the solution (as part of a project team working closely with the IT function or even within the IT team) and monitoring the post-project results. This in turn aligns with the full end-to-end change, project, process and software development life cycles.

Furthermore, when large infrastructure and IT projects are initiated, not only in banking but in many large organizations within and outside financial services, senior management may unwittingly tend to have certain types of cognitive biases – overconfidence in the short term and underestimation of costs and potential benefits in the long term; or confirmation biases – believing statistics and metrics and potentially investing more money into a failing project.

Other relevant biases may include framing or narrative fallacy biases and following the latest global trends ‘because everyone else is doing it’. Actuaries are expected to be impartial and to be aware of the outcomes for various stakeholders (including the public interest) and impacts related to materiality and proportionality. Applying the actuarial control cycle could reduce the likelihood of operational issues arising at a later stage.

Actuaries are trained and expected to communicate information, including technical information, clearly. They are expected to possess the necessary emotional intelligence (EQ) to maintain good interpersonal relationships and, through their training, to have an innate understanding of dynamic sets of stakeholders. While these attributes are not necessarily unique to actuaries, they are useful tools that actuaries can acquire through CPD and deploy in solving systems and technology problems.

Systems and technology implementation (and related business processes) can be complex and can impact on multiple user groups across many different locations, both horizontally and vertically across the corporate structure and job grades. Actuaries should ideally acquire management skills (task, team, people and process) through CPD to equip them to be good project managers. These projects may have multi-million-dollar budgets and immense potential benefits. Even if project management does not appeal to every actuary, it is clear that the actuarial skillset offers benefits in such business and process analysis.

The actuary’s skillset, however, needs to be regularly ‘updated’ with the latest developments through appropriate CPD opportunities. These could be related to: new coding languages and practices, new modelling methods and how these are implemented (for example, artificial intelligence and machine learning), user interfaces and experience methods, hardware developments (such as quantum computing), cloud computing, robotic process automation, and the benefits of new ways of working and
opportunities brought on by the developments in telecommunications (such as 5G). The systems and technology field are progressing extremely quickly and constantly changing; the actuarial skillset therefore needs to adapt and keep up.

New and potential risks may only become apparent when it is too late. A decade ago, cyber risk was not on everyone’s radar – but it certainly is now.

Actuaries can become involved in understanding the systems and technologies affected, where the gaps are and how to put in place compensating policies, procedures, controls and other mechanisms to reduce or mitigate the risks within banks (on an enterprise risk management level), and perhaps also be involved in risk transfer discussions with cyber risk insurers. The number of cyber risk breaches has increased exponentially over the last few years; there is a sizeable unknown tail of severity.

There is clearly substantial risk in not having proper cyber risk strategies in place; both monetary and reputational risk (in terms of potential fines from regulators and loss of customers). Other emerging risks related to banking include: blockchain technologies, cryptocurrencies, cloud computing, digital banking and mobile banking, payment platforms and other financial technologies. Risk management will change over the next 10 years to cater to these risks. A recent survey done by the ASSA’s System and Technology Committee revealed that there is a significant disparity in the understanding of cyber risk and its awareness, prevention methods and what is actually understood about this field. Applying the actuarial techniques mentioned above could reduce the operational failures caused by cyber risk, potentially minimizing the financial impact and managing this point-of-failure for banks.

Over the last few years, there has been an increased awareness of the implications of systems and technology and the role they play in the actuarial space. There have been professional skill-training videos for CPD points from the IFoA, and numerous articles in IFoA publications. This points to a potential increased role that actuaries could be playing in the systems and technology field. The profession is aware that it needs to become more involved across all practice areas; by bridging the gap now, it can avoid the need to play catch-up at a later stage.

Three years ago, there were no actuaries working in banking systems and technology, according to a paper by Peter Sinkis and Nick Scott. More recently, some actuaries have moved into the non-traditional, emerging field of systems and technology. This has opened up what might previously have been considered unconventional actuarial career paths within the middle- and back-office functions, such as:

- Business analysts and managers
- System product owners and managers
- Project and change managers

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86 [https://tinyurl.com/ASSAcyber2019](https://tinyurl.com/ASSAcyber2019)
14.6 Conclusion and outlook

The application of actuarial skills, principles and techniques has vast potential within this space. In order to pursue research and stimulate discussion, further work will be required to:

- Empower the profession on systems-and-technology-related matters
- Create awareness of operational risks associated with systems and technology
- Provide assistance and guidance to members (students and Fellows) working in this area
- Protect the profession’s reputation by producing standards, best practice guidance notes and educational papers – and in the longer term, include chapters on systems and technology in actuarial educational texts; and ultimately, this may become a discrete technical subject
- Providing guidance on the actuary’s role and responsibilities in these non-traditional roles and where sign-offs are needed

A start will be for those with actuarial skills to become involved in key projects that have a large IT component, such as BCBS 239, the Fundamental Review of the Trading Book, IFRS 9 and BAU operational issues related to model implementation, RWA regulatory reporting and other metrics that have business impacts. Key issues are those related to client capital management, such as RWA, potential future exposure, CVA, funding valuation adjustment, debit valuation adjustment and any other xVA (value adjustment) metrics.

In the future, these may include capital value adjustments, margin value adjustments and collateral value adjustments. As more people with actuarial skills actively pursue these non-traditional roles in systems and technology, it will build critical mass and cause people to take this field more seriously within the global actuarial profession.
15 Appendix: Evolution of the Basel Regulations

The Basel regulations have evolved and expanded since they were introduced in 1988, partly in response to the limited scope of the original Basel Accord and partly in response to shortcomings in Basel II which became apparent in the banking crisis of 2007–2008.


In its original form, the Basel Accord applied only to credit risk. It weighted banks’ credit assets according to their perceived riskiness. It specified five risk weights – 0%, 10%, 20%, 50% and 100% – and defined categories of loans to which each weight should be applied.

The Basel Accord required banks to hold total capital amounting to at least 8% of their total RWAs. Within their capital, Tier 1 capital (equity capital and non-cumulative perpetual preference shares) had to amount to at least 4% of total RWAs, within which equity capital had to amount to at least 2% of RWAs.

Although the Basel Accord had the merit of simplicity, it gave only an approximate measure of a bank’s credit risk, since the risk weights were broad-brush. An unintended consequence of the Basel Accord applying only to credit risk is that it contributed to some banks engaging in regulatory arbitrage by repackaging mortgages as asset-backed securities.

15.2 Basel I – Amendment to include market risk (1996)

*Overview of the Amendment to the Capital Accord to Incorporate Market Risks, BCBS, January 1996*

The requirement to hold capital for market risk was added in 1996. Banks had to quantify their market risk, determine the equivalent amount of RWAs, and apply the same ratios as before (such as 8% of equivalent RWAs, for total capital) to calculate their capital requirements for market risk.

In addition to the SA to market risk, for each of interest rate risk, equity position risk, foreign exchange risk, commodities risk and the treatment of options, as an alternative approach banks were allowed to use their own internal models to quantify market risk, provided that the models were approved by the national regulator. For this approach, the market risk amendment prescribed VaR models. It required that VaR should be computed daily using a 99th percentile, a one-tailed confidence interval, a minimum price shock equivalent to 10 days’ trading (holding period) and that the model should incorporate a historical observation period of at least one year.

With hindsight, various shortcomings in the methodology became apparent. For example, the VaR calculations did not capture ‘tail risk’ beyond the 99th percentile, and the holding period could be much longer than 10 days, especially when ‘problem assets’ became illiquid.
15.3 Basel II (2008)

*International Convergence of Capital Measurement and Capital Standards, BCBS, June 2006*

Basel II was agreed in 2004 and, after some amendments, was introduced in January 2007 and became effective in January 2008 – inconveniently, in the period of the banking crisis of 2007–2008. The Basel II regulations introduced the concept of three pillars, with Pillar 1 covering a quantitative assessment of banks’ risks and capital requirements, Pillar 2 the supervisory review process and Pillar 3 public disclosures to support market discipline.

Basel II required banks to hold capital for each of credit risk (including securitizations), market risk and operational risk. For each of these, it allowed banks to use either the SA specified in the regulations or, subject to regulatory approval, their own internal models.

Under Basel II, the SA for credit risk was similar to the original Basel Accord, but there was a greater range of risk weights according to the perceived riskiness of credit assets. For example, among retail loans, the risk weight was 35% for mortgages and 75% for credit cards. For corporate loans, there was a range of risk weights according to ratings awarded by credit rating agencies, from 20% for AAA to AA- to 150% for B+ and below.

- As an alternative to the SA for credit risk, banks were allowed, subject to approval by their national regulator, to use the IRB approach to quantify their credit risk. Under this approach, banks were allowed to use their own internal estimates of the PD, LGD and EAD – and, in some cases, effective maturity (M). Capital for credit risk was required for unexpected losses only, since expected losses were already allowed for in the pricing of loans. Within the IRB approach, there were two levels:
  - Foundation, where only PDs were estimated internally and the other risk components were prescribed
  - Advanced, where all three (or four) risk components were estimated internally

To obtain permission to use the IRB approach, a bank had to demonstrate to its national regulator that it had been using models to measure risk and make strategic decisions, that it had been using IRB-type rating systems for at least three years and that it had adequate governance arrangements in place around the models. It also had to demonstrate that it had adequate data to build the models – normally, this meant having data for at least five years, and having sufficient data to reflect the economic cycle.

Large banks were expected to use their own internal models, at least for credit risk and market risk. It was believed that the use by banks of their own internal models would lead to better risk analysis and more effective risk management. Banks were incentivized to use their own internal models by the expectation that this would lead to lower capital requirements than under the SA.

An unintended consequence of the use of internal models was that it encouraged some banks to engage in what the Bank of England called “RWA optimisation” – which led over time to lower risk weights and
lower capital requirements (see Constraining Discretion in Bank Regulation, Andrew Haldane, Bank of England, 2013, Chart 1)\(^ {89}\).

### 15.4 ‘Basel 2.5’ (2009)

A principal cause of the banking crisis of 2007–2008 was large mark-to-market losses on complex securities which became seen as ‘toxic’, such as collateralized debt obligations (CDOs) and credit default swaps (CDSs). With hindsight, it can be seen that the regulations did not require banks to hold sufficient capital to cover the losses suffered by some banks in the extreme conditions that led to the banking crisis. In three papers that were published in July 2009, ‘Basel 2.5’ addressed shortcomings in the Basel II framework for assessing market risk.

**Enhancements to the Basel II Framework, BCBS, July 2009\(^ {90}\)**

The first of these three papers set out proposals for enhancing the Basel II framework for securitizations and said that banks must apply higher risk weights to resecuritizations. It also required banks to make additional disclosures about their securitizations in their Pillar 3 disclosures.

**Revisions to the Basel II Market Risk Framework, BCBS, July 2009**

The second paper specified changes to the Basel II market risk framework under both the SA and the IMA. For example, it said that factors that are deemed relevant for pricing should be included as risk factors in the risk model. It also said that banks must calculate a stressed VaR measure reflecting a 12-month period of stressed conditions such as those experienced in 2007–2008, and prescribed how stressed VaR measures should be allowed for in banks’ quantification of their capital requirements.


The third of these papers set out guidelines for computing capital for incremental risk in the trading book – that is, default risk that is incremental to any default risk captured in banks’ VaR models. The paper recognized that large losses suffered by some banks did not reflect actual defaults, but a combination of credit downgrades, widening credit spreads and reduced liquidity.

### 15.5 Basel III (2010)


This paper covered a number of important amendments and additions to the existing regulations. These amendments and additions were intended to address various shortcomings in the regulations which had become evident in the banking crisis of 2007–2008.

\(^{89}\) https://www.bis.org/review/r130606e.pdf

\(^{90}\) https://www.bis.org/publ/bcbs157.pdf
Amendments included new regulations to strengthen the quantity and quality of banks’ capital, and to require banks to hold capital for potential mark-to-market losses associated with deterioration in the credit-worthiness (but not default) of counterparties to over-the-counter (OTC) derivative exposures. Additions included requirements for banks to hold capital conservation buffers and countercyclical buffers on top of their capital requirements, and to exceed a minimum leverage ratio, based on their unweighted assets, as well as minimum (risk-weighted) capital ratios.

**Quantity and quality of capital**

In the banking crisis of 2007–2008, some banks did not have sufficient equity capital to absorb the losses that they suffered. This paper introduced the term ‘Common Equity Tier 1 capital’ and said that, from 2015, banks would have to have at all times a CET1 capital ratio of at least 4.5% of total RWAs, a Tier 1 capital ratio of at least 6.0% of total RWAs and a total capital ratio (Tier 1 plus Tier 2) of at least 8.0% of total RWAs.

Definitions of ‘capital’ had not been consistent across countries. Part 1 of this paper set out criteria for CET1 capital, Additional Tier 1 capital and Tier 2 capital. It also required prudent treatment of matters such as minority interests, deferred tax assets, goodwill and other intangibles, deferred tax assets, defined benefit pension fund assets and liabilities, investments in own shares and significant investments in financial institutions.

**CVA risk**

The BCBS recognized that although Basel II covered the risk of default by counterparties, it did not cover the risk of mark-to-market losses associated with deterioration in the credit-worthiness (but not default) of counterparties to OTC derivative exposures – and that this was one of the main causes of losses in the banking crisis of 2007–2008. This risk is known as credit valuation adjustment (CVA) risk.

Basel III required banks to hold capital for CVA risk, and explained how they should quantify their charge for CVA risk under an advanced approach, if they already had approvals to use their own internal models, or under an SA, if they did not have approvals to use their own internal models.

In a further move to reduce systemic risk in the financial sector, the BCBS stated its intention to incentivize banks to move OTC derivative exposures to central counterparties (CCPs) by setting a relatively low risk weight for banks’ marked-to-market exposures to CCPs that met certain standards.

**Capital buffers**

One of the most fundamental problems that became evident in 2007–2008 was that although banks entered 2007 with risk-weighted capital ratios that were above the regulatory minimum, they were not sufficiently far above to absorb the losses suffered by some banks in this period without coming close to their minimum capital requirements, in conditions which made it difficult to raise new capital.

Basel III, therefore, required banks to hold a capital conservation buffer amounting to 2.5% of their RWAs, and that this buffer should be held in the form of CET1 capital. It was recognized that banks might have to dip into this capital buffer under stress conditions. However, the existence of the buffer would reduce the risk that banks’ risk-weighted capital ratios would fall below the regulatory minimum.
Through a combination of the minimum required CET1 capital of 4.5% of total RWAs and the capital conservation buffer of 2.5% of total RWAs, in CET1 capital, banks must now hold CET1 capital amounting to at least 7% of their total RWAs — much more than ahead of the banking crisis, when banks had to hold Tier 1 capital of at least 4% of total RWAs, within which equity capital had to amount to at least 2% of total RWAs.

If a bank’s capital ratio falls below 7% as a result of the bank dipping into its capital buffer, there are progressive restrictions on how much the bank can pay out for dividends, share buybacks and discretionary bonus payments.

In practice, banks’ CET1 capital ratios are typically much higher than the minimum 7%: at the end of 2019, the CET1 capital ratios of many European banks were in the range of 13% to 15%, twice the minimum level.

**Leverage ratio**

A feature of the years before the banking crisis of 2007–2008 was the expansion in the leverage of some banks — measured as multiples of their total assets (as opposed to their RWAs) to their Tier 1 capital (see *Constraining Discretion in Bank Regulation*, Andrew Haldane, Bank of England, April 2013, Chart 291). To address this, Basel III said that banks should meet a minimum Tier 1 leverage ratio of 3%.

**Liquidity ratios**

An important aspect of the banking crisis of 2007–2008 was the liquidity crisis — widely known as the ‘credit crunch’ — which became apparent a year before the failure of Lehman Brothers in September 2008.

With the aim of preventing a recurrence of this, Basel III required banks to meet short-term (one-month) and long-term (one-year) liquidity requirements, known respectively as the liquidity coverage ratio (LCR) and the net stable funding ratio (NSFR):

- The LCR is defined as the ratio of the stock of high-quality liquid assets to total net cash outflows over the next 30 calendar days, and must be at least 100%.
- The NSFR is defined as the ratio of total available stable funding (ASF) to total required stable funding (RSF), and must be at least 100%.

**Minimum Capital Requirements for Market Risk, BCBS, January 2016**

This paper sets out revised standards for the quantification of minimum capital requirements for market risk, under either the SA or under the IMA approach. It replaced the previous BCBS regulations for market risk.

The paper introduced a number of important changes:

- The revised SA is more risk-sensitive, and so is more appropriate for use as a fallback measure, or as a base measure in the input floor.

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91 [https://www.bis.org/review/r130606e.pdf](https://www.bis.org/review/r130606e.pdf)
The revised IMA requires a more rigorous model-approval process. Banks must use ES measures of risk under stress – this will help them to overcome the inability of VaR models to capture ‘tail risk’. Banks must allow for a sudden and severe reduction in liquidity across markets, rather than assuming that it will be possible to exit or hedge positions within 10 days. The boundary between the banking book and the trading book was revised, to reduce the incentive for banks to engage in arbitrage by switching assets between them.

15.6 Basel III final reforms (2017)

*Basel III: Finalising Post-Crisis Reforms, BCBS, December 2017*

This paper describes further amendments to the Basel III regulations. These amendments are to be implemented on 1 January 2023, except for the output floor, which will be phased in between 1 January 2023 and 1 January 2028.

One theme of these amendments is to make the SAs for credit risk and operational risk more risk-sensitive – and so, like the revised SA for market risk, more appropriate for use as a base measure in the output floor.

Another theme is to remove permission to use internal models for some risks. Banks will no longer be allowed to use Advanced IRB models for some assets where probabilities of default are low, and will no longer be allowed to use any kind of internal model for operational risk or for CVA risk, both of which are hard to model.

Globally, systemically important banks will be subject to an (unweighted) leverage ratio buffer as well as a (weighted) systemic risk buffer.

**Credit risk**

- Standardized approach: Revisions have been made to the SA, to improve its risk sensitivity. For example:
  - On residential mortgages, risk weights will vary by LTV band. Weights will increase from 20% (for LTVs below 50%) to 70% (for LTVs above 100%).
  - For corporate loans, risk weights will vary by external credit rating. Weights will increase from 20% (for credit ratings from AAA to AA-) to 150% (for credit ratings below BB-). In addition, banks will be required to conduct sufficient due diligence when using external ratings.
- IRB approach: From 1 January 2023, banks will be allowed to use the Foundation IRB approach (but not the Advanced IRB approach) for exposures to banks and other financial institutions or

92 [https://www.bis.org/bcbs/publ/d424.pdf](https://www.bis.org/bcbs/publ/d424.pdf)
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for exposures to corporates with total income of more than €500 million. Banks will be allowed to use the Advanced IRB approach (but not the Foundation IRB approach) for retail exposures.

In addition, banks using the IRB approach will have to comply with 'floor' values for PDs (if using either the Foundation IRB or the Advanced IRB approaches) and for LGDs and EADs (if using the Advanced IRB approach).

**CVA risk**

Because of the complexity of CVA risk, the BCBS has come to the view that it “cannot be modelled by banks in a robust and prudent manner”. So, from 1 January 2023, banks will no longer be allowed to use their own internal models to quantify their capital requirements for CVA risk. They will have to use one of two new approaches: either an SA or a basic approach. These new approaches have been calibrated to be consistent with the revised approaches to market risk.

However, if the aggregate notional amount of a bank’s non-centrally-cleared derivatives is less than €100 million, the bank will be allowed to quantify its CVA capital charge as a multiple of its counterparty credit risk charge.

**Operational risk**

The BCBS has recognized that it is difficult to use internal models to quantify capital requirements for operational risk. In the UK, the PRA has observed that the quantification of operational risk capital represents “a significant challenge” because of fat-tailed loss distributions and limited data.

So, under Basel III, banks will no longer be allowed to use the AMA, which is based on banks’ own internal models. In future, instead of the AMA, or any of the three SAs that are currently allowed, banks will have to use a new SA based on prescribed measures of total income and of past operational risk losses. The prescribed formula for quantifying a bank’s capital requirements for operational risk assumes that operational risk increases progressively with total income and that banks which have experienced high operational risk losses are more likely to do so in future.

**Leverage ratio buffer**

A bank that is subject to a systemic risk buffer will have to hold a leverage ratio buffer amounting to 50% of its systemic risk buffer. For example, if a bank has to hold a systemic risk buffer set at 1% of its total RWAs, it will have to hold a leverage ratio buffer amounting to 0.5% of its Tier 1 capital.

As for the capital conservation buffer, banks which dip into their leverage ratio capital buffer will be subject to progressive constraints on the percentage of their earnings that they could pay out.

**Output floor**

From 1 January 2023, the total RWAs of banks using their own internal models will have to be at least a required percentage of their total RWAs based on the revised SAs for credit, market and operational risk. This will limit the extent to which banks can benefit from lower regulatory capital requirements by using their own internal models.
The output floor will be phased in over five years: the required percentage will be 50% from 1 January 2023, will increase by 5% per annum to 70% from 1 January 2027, and will then increase to 72.5% from 1 January 2028.
### Abbreviations

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<th>Abbreviation</th>
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<td>ACS</td>
<td>Annual cyclical scenario</td>
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<tr>
<td>AIRB</td>
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