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POOYA FARAHVASH

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Asset-Liability and Liquidity Management

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POOYA FARAHVASH

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To my parents: Mahin and Ahmad

Contents

About the Author	xvii
Preface	xix
Abbreviations	xxiii
INTRODUCTION	1
Asset-Liability Management Metrics	5
ALM Risk Factors	7
Organization of This Book	8
CHAPTER 1	
Interest Rate	17
Interest Rate, Future Value, and Compounding	18
<i>Use of Time Notation versus Period Notation</i>	22
<i>Simple Interest</i>	23
Accrual and Payment Periods	24
Present Value and Discount Factor	29
<i>Present Value of Several Cash Flows</i>	32
<i>Present Value of Annuity and Perpetuity</i>	33
Day Count and Business Day Conventions	34
Treasury Yield Curve and Zero-Coupon Rate	40
<i>Bootstrapping</i>	43
LIBOR	48
Forward Rates and Future Rates	49
<i>Implied Forward Rates</i>	50
<i>Forward Rate Agreements</i>	55
<i>Interest Rate Futures</i>	56
Swap Rate	58
<i>Determination of the Swap Rate</i>	61
<i>Valuation of Interest Rate Swap Contracts</i>	66
<i>LIBOR-Swap Spot Curve</i>	70
	vii

Interpolation Methods	75
<i>Piecewise Linear Interpolation</i>	76
<i>Piecewise Cubic Spline Interpolation</i>	78
Federal Funds and Prime Rates	84
Overnight Index Swap Rate	87
<i>OIS Discounting</i>	88
<i>Secured Overnight Financing Rate</i>	94
Components of Interest Rate	95
<i>Risk Structure of Interest Rate</i>	97
<i>Term Structure of Interest Rate</i>	98
Expectation Theory	100
Market Segmentation Theory	102
Liquidity Premium Theory	102
<i>Inflation and Interest Rate</i>	102
Negative Interest Rate	103
Interest Rate Shock	105
<i>Parallel Shock</i>	106
<i>Non-Parallel Shock</i>	107
Interest Rate Risk	109
Summary	110
Notes	112
Bibliography	114

CHAPTER 2

Valuation: Fundamentals of Fixed-Income and Non-Maturing Products	115
Principal Amortization	116
<i>Bullet Payment at Maturity</i>	116
<i>Linear Amortization</i>	117
<i>Constant Payment Amortization</i>	118
<i>Sum-of-Digits Amortization</i>	121
<i>Custom Amortization Schedule</i>	123
Fixed-Rate Instrument	124
<i>Valuation</i>	124
<i>Yield</i>	130
<i>Duration and Convexity</i>	133
Dollar Duration and Dollar Convexity	142
Portfolio Duration and Convexity	143
Effective Duration and Effective Convexity	144
<i>Interest Rate Risk Immunization</i>	145

<i>Key Rate Duration</i>	155
Fisher-Weil Duration	156
Key Rate Duration	160
Floating-Rate Instrument	165
<i>Pre-Period-Initiation Rate Setting</i>	166
<i>Post-Period-Initiation Rate Setting</i>	166
<i>Valuation Using Estimated Interest Rates at Future Reset Dates</i>	168
Using Implied Forward Rate	168
Using Forecasted Rate	171
<i>Valuation Using Assumption of Par Value at Next Reset Date</i>	177
Duration and Convexity	182
<i>Valuation Using Simulated Interest Rate Paths</i>	184
Non-Maturing Instrument	191
<i>No New Business Treatment</i>	192
<i>No New Account Treatment</i>	196
<i>Constant Balance Treatment</i>	197
Inclusion of Prepayment and Default: A Roll Forward Approach	198
Summary	207
Notes	210
Bibliography	210

CHAPTER 3

Equity Valuation	213
Dividend Discount Model	214
Discounted Free Cash Flow Method	217
Comparative Valuation Using Price Ratios	226
Summary	233
Note	234
Bibliography	235

CHAPTER 4

Option Valuation	237
Stock Option	238
Boundary Values	240
<i>Call Option</i>	241
<i>Put Option</i>	243
Put–Call Parity	247
<i>Underlying Stock Does Not Pay Dividends</i>	247
<i>Underlying Stock Pays Dividends or Provides Yield</i>	251
Binomial Tree	252

The Black–Scholes–Merton Model	267
<i>Generalization of the Black–Scholes–Merton Model</i>	272
Option Valuation Using Monte Carlo Simulation	273
Sensitivity of Option Value	282
<i>Sensitivity to Underlying Price</i>	282
<i>Sensitivity to Volatility</i>	288
<i>Sensitivity to the Interest Rate</i>	290
<i>Sensitivity to the Passage of Time</i>	291
Volatility	292
<i>Historical Volatility</i>	292
<i>Implied Volatility</i>	295
<i>Non-Constant Volatility</i>	297
ARCH and GARCH Models	298
<i>Forecasting Volatility Using the GARCH Model</i>	303
<i>The GARCH-M Model</i>	305
<i>The Exponentially Weighted Moving Average Model</i>	306
<i>The EWMA Model for Covariance</i>	310
Option Valuation Using a GARCH Model	312
Futures Options	319
<i>Futures Contract</i>	319
<i>Option on Futures Contract</i>	320
<i>Put–Call Parity for Futures Options</i>	323
<i>Black Model</i>	324
<i>Using a Binomial Tree for Valuation of Futures Options</i>	326
Summary	328
Annex 1: Derivation of Put–Call Parity When the Underlying	
Pays Dividends	331
Annex 2: Derivation of Delta, Gamma, Vega, Rho, and Theta	338
Notes	343
Bibliography	344

CHAPTER 5

Interest Rate Models	347
Instantaneous Forward Rate and Short Rate	347
Vasicek Model	354
Hull-White Model	358
Ho-Lee Model	366
Black-Karasinski Model	367
Interest Rate Options	368
<i>Swaption</i>	368
<i>Interest Rate Cap and Floor</i>	370

Analytical Valuation of Bonds and Options	373
<i>Zero-Coupon Bond</i>	373
<i>Option on a Zero-Coupon Bond</i>	374
<i>Interest Rate Cap and Floor</i>	375
<i>Option on a Coupon-Bearing Bond</i>	376
<i>Swaption</i>	376
Interest Rate Tree	377
<i>The Hull-White Tree</i>	382
<i>The Black-Karasinski Tree</i>	400
Calibration	405
<i>Calibration Using the Analytical Method</i>	408
<i>Calibration Using the Interest Rate Tree</i>	413
LIBOR Market Model	420
Summary	425
Annex: Derivation of Zero-Coupon Bond Price Using a Δt -Period	
Rate from the Hull-White Tree	427
Notes	429
Bibliography	430
 CHAPTER 6	
Valuation of Bonds with Embedded Options	433
Callable Bond	433
<i>Option-Adjusted Spread</i>	441
Puttable Bond	444
Summary	446
Note	447
Bibliography	447
 CHAPTER 7	
Valuation of Mortgage-Backed and Asset-Backed Securities	449
Mortgage-Backed Securities	450
<i>Fixed-Rate Conventional Mortgage Loans</i>	452
<i>Prepayment</i>	460
<i>Impact of Prepayment on Mortgage-Backed Securities</i>	463
<i>Valuation of Mortgage-Backed Securities</i>	476
Short Rate Model	476
Mortgage Refinancing Rate Model	480
Prepayment Model	483
Cash Flow Generator	483
Discounting and Aggregation Platform	484

<i>Number of Simulated Paths and Convergence</i>	486
<i>Impact of Default on Mortgage-Backed Securities</i>	488
Collateralized Mortgage Obligations	503
<i>Valuation of Collateralized Mortgage Obligations</i>	511
Asset-Backed Securities	513
<i>Auto Loan ABSs</i>	517
Collateral	517
Structure	520
Prepayment	521
<i>Home Equity Loan ABSs</i>	522
Collateral	522
Structure	523
Prepayment	524
<i>Student Loan ABSs</i>	524
Collateral	524
Structure	528
Prepayment	529
<i>Credit Card Receivable ABSs</i>	529
Collateral	529
Structure	530
Cash Flow Distribution Method	531
Prepayment	534
Early Amortization Event	534
<i>Valuation of Asset-Backed Securities</i>	535
Summary	550
Annex: Derivation of Survival Factor	552
Notes	553
Bibliography	554

CHAPTER 8

Economic Value of Equity	557
Economic Value of Equity: Basics	559
Duration Gap	562
Risk-Adjusted Yield Curve	567
Interest Rate Scenario Analysis	574
<i>Product Type and Value Sensitivity</i>	575
<i>Impact of Interest Rate Shocks on EVE</i>	584
<i>Balance Sheet Type and EVE Sensitivity</i>	593
Currency Exchange Rate Scenario Analysis	594
Economic Value of Equity Risk Limits	597
Balance Sheet Planning and EVE Forecasting	597

Basel Accord Guidance on EVE Analysis	600
<i>Principles of Managing Interest Rate Risk in the Banking Book</i>	601
<i>Scenario Construction and EVE Analysis</i>	604
Standardized Framework	607
Summary	608
Notes	610
Bibliography	611

CHAPTER 9

Net Interest Income	613
Interest Income and Expense: Basics	614
Interest Income and Expense for Floating-Rate Instruments	620
<i>Using the Implied Forward Rate</i>	621
<i>Using the Forecasted Rate</i>	631
Incorporating Balance Sheet Change in NII Analysis	638
<i>Runoff View: No New Volume</i>	638
<i>Static View: Replacement of Matured Positions</i>	642
<i>Dynamic View: Incorporation of Business Plan</i>	644
Earning Gap	648
Interest Rate Scenario Analysis	653
<i>Parallel Shocks</i>	654
<i>Non-Parallel Shocks</i>	664
<i>Balance Sheet Type and NII Sensitivity</i>	670
Impact of Interest Rate Options on NII	673
Currency Exchange Rate Scenario Analysis	683
<i>Currency Forward and Interest Rate Parity</i>	683
<i>Exchange Rate Shock Scenarios</i>	687
Net Interest Income Hedging	691
Net Interest Income Risk Limits	697
Required Data and Other Considerations in NII Analysis	699
Basel Accord Guidance on NII Analysis	701
Summary	702
Notes	704
Bibliography	704

CHAPTER 10

Equity and Earnings at Risk	705
Introduction to Value-at-Risk	706
<i>Variance-Covariance Method</i>	708
<i>Historical Sampling Method</i>	710
<i>Monte Carlo Simulation Method</i>	713
<i>Conditional Value-at-Risk</i>	717

Application of VaR Methodology in ALM	719
Scenario Generation	721
<i>Historical Sampling</i>	721
<i>Monte Carlo Simulation</i>	726
Standard and Generalized Brownian Motion	726
Multi-dimensional Brownian Motion	730
Geometric Brownian Motion	731
Mean-Reverting Brownian Motion	734
Geometric Mean-Reverting Brownian Motion	739
Calibration	743
Equity-at-Risk	743
<i>Interest Rate Risk Factor</i>	744
<i>Component Contribution</i>	748
<i>Approximation Techniques</i>	749
<i>Currency Exchange Rate Risk Factor</i>	752
Sample Size and Convergence	758
Earnings-at-Risk	762
<i>Interest Rate Risk Factor</i>	763
<i>Currency Exchange Rate Risk Factor</i>	769
Summary	775
Notes	776
Bibliography	777

CHAPTER 11

Liquidity Risk	779
Funding Source and Liquidity Risk	780
<i>Deposits</i>	781
<i>Short-Term Debt</i>	783
<i>Medium-Term Notes</i>	788
<i>Long-Term Debt</i>	789
<i>Securitization</i>	790
<i>Credit and Liquidity Facilities</i>	793
<i>Eurodollar Deposit and Federal Funds Market</i>	795
<i>Other Sources of Funding</i>	796
Short-Term Secured Funding: Repurchase Agreements	796
<i>Repo Basics</i>	796
<i>Repo Margin</i>	800
<i>Collateral Delivery Methods and Triparty Repo</i>	801
<i>Use of Repo</i>	802
<i>Security Lending</i>	807
Repo and Liquidity Risk	809
<i>Managing Liquidity Risk of Repo</i>	811

Cash Flow Gap Analysis and Liquidity Stress Tests	816
<i>Cash Flow Gap: Business-as-Usual</i>	823
<i>Cash Flow Gap: Idiosyncratic Stress</i>	833
<i>Cash Flow Gap: Market-Wide Stress</i>	841
<i>Cash Flow Gap: Multi-Currency</i>	849
Funding Concentration Risk	854
Basel Accord Liquidity Risk Monitoring Tools	855
<i>Liquidity Coverage Ratio</i>	856
High-Quality Liquid Asset	857
Total Net Cash Outflows in Next 30 Days	859
<i>Net Stable Funding Ratio</i>	873
Available Stable Funding	874
Required Stable Funding	874
<i>Intraday Liquidity</i>	884
Early Warning Indicators	892
Liquidity Contingency Plan	893
Summary	893
Notes	896
Bibliography	897
 CHAPTER 12	
Funds Transfer Pricing	899
Funds Transfer Pricing: Basics	900
Pool Method	906
Matched Maturity Method	910
<i>FTP Rate for Fixed-Rate Maturing Products</i>	910
Weighted Average Method	913
Duration Method	914
Refinancing Method	915
<i>FTP Rate for Floating-Rate Maturing Products</i>	917
<i>FTP Rate for Non-Maturing Products</i>	920
Behavioral Model Method	920
Replicating Model Method	930
Components of FTP Rate	932
Characteristics of a Good FTP System	934
Summary	936
Notes	938
Bibliography	938
 Appendix: Elements of Probability and Statistics	939
 Index	1003

About the Author

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Preface

In recent years, use of quantitative methods in asset-liability management (ALM) has increased significantly, particularly among medium- to large-size banks and insurance companies. This partly reflects the importance of effective balance sheet planning and managing related risks in achieving earnings and equity valuation targets. Traditionally and in the past, balance sheet management efforts were mainly focused on funding activities to ensure that the bank's assets are properly funded at the lowest cost possible. Lack of risk awareness, however, was always a major weakness in this approach and recent history has shown that poorly managed balance sheets can lead to catastrophic events for banks. In one view, the failures of several banks and investment banks during the financial crisis of 2007–2009 were partially due to ineffective balance sheet management practices. Newer banking strategies rely on ALM techniques that are based on accurate and precise calculations to evaluate the impact of various risk factors on earnings and value of the firm. These metrics are designed to assess the efficiency of the balance sheet management efforts while taking various risks, such as interest rate risk, into consideration.

This book presents the fundamentals of asset-liability management in banking. During my years of practice as an ALM analyst in various banks, I generally felt that there was a need for a book that provides a comprehensive view of ALM as it is exercised in practice. The goal of this book is to present the fundamentals and methodologies that are commonly used by banks in their ALM analysis. The book is written for professionals who are active in asset-liability management, financial risk management, and treasury analytics. This book can also be used as the main textbook for a graduate-level course in the aforementioned areas.

The main materials in the book are organized in three parts. The first part, consisting of Chapters 1 through 7, is focused on the interest rate concept and related topics, interest rate modeling methods, and valuation of financial instruments. Many ALM analyses require valuation of positions on the balance sheet of a bank, as well as valuation of off-balance-sheet exposures, such as derivative contracts. Materials in this part provide the fundamentals for valuation of common financial instruments, including fixed- and

floating-rate loans, fixed-income securities such as bonds, equity securities, mortgage-backed and asset-backed securities, and callable or putable bonds. Valuations of common derivative products such as stock options, future options, interest rate swaps, interest rate forwards, interest rate caps and floors, and swaptions are also discussed. Since some topics reviewed in the interest rate models chapter require knowledge of valuation methods, that chapter is placed after the fundamentals of valuation are explained.

The second part of the book, consisting of Chapters 8, 9, and 10, is focused on two fundamental ALM metrics: economic value of equity and net interest income, and their related scenario analysis. The topics discussed in this part rely on the materials explained in Part One.

The third part of the book, consisting of Chapters 11 and 12, covers two topics that are closely related to ALM: liquidity risk and funds transfer pricing. Liquidity risk is the risk factor behind one of the gap measurements that the ALM process aims to optimize and funds transfer pricing is an internal allocation method of the net interest income. There are some practitioners who view liquidity risk management and funds transfer pricing as separate and independent topics from ALM. Recent trends, however, indicate that banks are moving toward a holistic view in managing the interest rate risk and the liquidity risk by combining the resources and required analysis of the two risk types. Particularly, there are many commonalities between data required for ALM and liquidity risk management. Funds transfer pricing, if done properly, internalizes the interest rate risk and liquidity risk among business units of a bank, and hence plays an important role in balance sheet management.

Asset-liability management studies are part of quantitative finance. In ALM, mathematical modeling and statistical concepts are mixed with high-level business decision making on how to run a bank. For the quantitative techniques discussed and used in this text, the general approach is to focus on applications and outcomes rather than providing deep discussions on supporting theories and proof of equations. For readers who are interested in theoretical background, each chapter provides a list of references for the origins of methods and further discussions. Since several subjects introduced in this book rely on statistical concepts, an appendix is added to cover the basic elements of probability and statistics in a concise form. These materials should help a reader who is not proficient in statistics to gain an understanding of the subjects that are needed in other parts of the book.

Methods discussed in this text when applied to the entire balance sheet of a bank require extensive computations. For the most part, examples provided are simple enough so the reader can follow and understand the topics. In practice, software packages are available that can perform the analysis explained here for balance sheets with a large number of positions. The book is not written with any particular software in mind, however, as the

concepts discussed here are applicable to any ALM analysis, regardless of the software used.

In some of the examples and illustrations throughout the book I occasionally use a LIBOR–swap curve for coupon calculation of floating-rate instruments or for discounting. The principles discussed, however, are applicable if any other interest rate, such as SOFR or OIS, was used instead. In some of the examples presented in the book, the reader may notice some minor differences between the results shown here and results if calculations are performed using a spreadsheet software. This is due to rounding errors that may occur at a calculation step and those errors generally make no difference in the final outcomes.

I would like to thank those individuals who commented on the manuscript, and those who were involved in the production process of the book.

Pooya Farahvash
New York
February 2020

Abbreviations

ABCP:	asset-backed commercial paper
ABS:	asset-backed security
ACT:	Actual (used in day count conventions)
ADR:	annual default rate
AFC:	available funds cap
ALLL:	allowance for loan and lease losses
APR:	annual prepayment rate
APS:	absolute prepayment speed
BAU:	business as usual
BBA:	British Bankers' Association
BCBS:	Basel Committee on Banking Supervision
BHC:	bank holding company
BIS:	Bank for International Settlements
bps:	basis points (0.01%)
CB:	coupon-bearing bond
CD:	certificate of deposit
CDF:	cumulative distribution function
CDO:	collateralized debt obligation
CDR:	constant default rate
CDS:	credit default swap
CFP:	contingency funding plan
CMBS:	commercial mortgage-backed security
CME:	Chicago Mercantile Exchange
CMO:	collateralized mortgage obligation
CP:	commercial paper
CPI:	Consumer Price Index
CPR:	constant prepayment rate
CVaR:	conditional value-at-risk

DCF:	discounted cash flow
DF:	discount factor
DR:	default rate (periodic)
DV01:	dollar value of a basis point
DVP:	delivery versus payment
EaR:	earnings-at-risk
EBIT:	earnings before interest and taxes
EBITDA:	earnings before interest, taxes, depreciation, and amortization
ECB:	European Central Bank
EMTN:	Europe medium-term note
EONIA:	Euro Overnight Index Average
EPS:	earnings per share
EVE:	economic value of equity
EWI:	early waning indicator
FASB:	Financial Accounting Standards Board
FCFE:	free cash flow to equity
FCFF:	free cash flow to firm
FDIC:	Federal Deposit Insurance Corporation
Fed:	Federal Reserve System
FOMC:	Federal Open Market Committee
FRA:	forward rate agreement
FRBNY:	Federal Reserve Bank of New York
FSA:	Financial Services Authority
FTP:	funds transfer pricing
FX:	foreign exchange
GDP:	gross domestic product
GMRA:	global master repurchase agreement
HELOC:	home equity line of credit
HIC:	hold in custody
HQLA:	high quality liquid asset
IBF:	international banking facility
IBR:	income-based repayment
ICAAP:	internal capital adequacy assessment process
ICE:	Intercontinental Exchange
IID:	independent and identically distributed
IRRBB:	interest rate risk in the banking book
ISDA:	International Swaps and Derivatives Association
LCR:	liquidity coverage ratio
LGD:	loss given default
LIBOR:	London Interbank Offered Rate

LR:	loss rate
LRNVR:	locally risk-neutral valuation relationship
LTV:	loan to value
MBS:	mortgage-backed security
MDR:	monthly default rate
MMDA:	money market deposit account
MPR:	monthly payment rate
MSRP:	manufacturer's suggested retail price
MTL:	month to liquidation
MTN:	medium-term note
NAS:	non-accelerated senior
NII:	net interest income
NOW:	negotiable order of withdrawal
NSFR:	net stable funding ratio
NWCI:	net working capital investment
OAS:	option-adjusted spread
OIS:	overnight index swap
OTS:	Office of Thrift Supervision
PAC:	planned amortization class
PB:	price-to-book value
PCA:	principal component analysis
PD:	probability of default
PDF:	probability density function
PE:	price-to-earnings
PFE:	potential future exposure
PLUS:	Parent Loan for Undergraduate Students
PMF:	probability mass function
PPC:	prospectus prepayment curve
PR:	prepayment rate (periodic)
PS:	price-to-sales
PSA:	Public Securities Association
PV:	present value
PV01:	present value of a basis point
QRM:	qualified residential mortgage
Repo:	repurchase agreement
Reverse repo:	reverse repurchase agreement
RMBS:	residential mortgage-backed security
ROE:	return on equity
SDA:	standard default assumption
SIV:	structured investment vehicle

SLABS:	student loan asset-backed security
SMM:	single monthly mortality
SOFR:	Secured Overnight Financing Rate
SONIA:	Sterling Overnight Index Average
SPE:	special purpose entity
SPV:	special purpose vehicle
VaR:	value-at-risk
WAC:	weighted average coupon
WACC:	weighted average cost of capital
WAM:	weighted average maturity
ZB:	zero-coupon bond

Introduction

A bank at its core is a financial intermediary institution that collects funds from those individuals or entities who do not have immediate use for them and lends to those who can use the capital to generate economic benefits. Depositors with excess cash can benefit from the interest earned on their deposits while borrowers can benefit from the borrowed funds for their personal needs, such as purchasing real properties, or business needs, such as investing in their small business ventures. As the facilitators of such fund transfers, banks earn the difference between the interest paid to the depositors and the interest earned from the borrowers. A bank with an asset-driven business model seeks to originate assets through lending activities and simultaneously pursue funding methods to fund those assets, whereas a bank with a liability-driven business model primarily focuses on collecting deposits and then attempts to lend or invest the proceeds from the deposits. While traditionally deposits are the main *source of funds* in the banking industry, nowadays banks use a variety of methods to raise funds, including the issuance of short-term and long-term notes, securitization, and collateralized borrowings. *Use of funds* is also evolved from traditional lending in the form of loans to individuals and businesses, in investment in securities, and even in speculation using derivatives. The net revenue a bank makes is the difference between the costs associated with its sources of funds and earnings from the instruments where available funds are invested and used.

A bank manages its sources and uses of funds by trying to match them based on different criteria. One such criterion is based on the principal cash flows. The status of a bank as a financial intermediary, which is often supported by the central bank of the country, allows it to have a lower cost of funds compared to other entities. In particular, the bank's short-term borrowings are usually significantly cheaper compared to long-term alternatives. This allows the bank to fund long-term assets that are more profitable by cheaper short-term liabilities. While economically this seems like a sound business model, it potentially increases the risk for banks of not being able to fulfill their obligations when they are due. When the return of the principal amount borrowed by the bank is due before the principal lent is returned, this may

lead to the bank's failure, should it not have any alternative source to replace the needed funds. A prudent banking practice is to align or overlap the terms of asset and liability positions such that there are always available funds to cover short- to medium-term liability maturities. However, in practice this is hard to achieve for individual asset or liability positions. Except in rare cases in which a particular debt position is raised to fund a large asset portfolio or a particular investment project, individual asset positions, such as loans and investment in securities, are not funded by distinct liability positions. Banks raise funds in micro form through deposits or in bulk form by issuing bonds. This makes the principal matching between assets and liability difficult, if not impossible. Due to this, banks may attempt to match the principal cash flows on a portfolio level. But even this approach has its limitations, since non-maturing products such as credit card accounts or savings accounts do not have contractual maturity dates. To overcome this, existing balances of non-maturing products are assumed to follow some modeled *runoff profiles* that act as amortization schedules for them. This allows the bank to estimate principal cash flows related to these products and to create *principal cash flow schedules* at an aggregated level, for example, for the bank as a whole or at a subsidiary level. Such schedules provide an overview of amounts and timings of expected principal cash flows and help in the planning and coordination of asset originations and debt issuances. This approach, however, does not incorporate planned changes in the assets and the liabilities. For example, if the bank is planning to grow a certain asset portfolio or to issue new debt securities in the near future, they are not reflected in a *static cash flow schedule*. Particularly, expected changes in balances of non-maturing products due to macroeconomic factors are not included. A *dynamic cash flow schedule* incorporates planned and expected changes in the asset and liability portfolios. A more sophisticated version of such a schedule considers all principal and interest payments to create a comprehensive view of cash flows a bank can experience in a short- to medium-term time horizon in the future. *Cash flow gap*, sometimes referred to as *maturity gap*, is the net value of cash flows generated by assets and liabilities in a specific time period. Minimizing cash flow gap is one way to reduce the risk of adverse events due to the mismatch between asset and liability cash flows, particularly their principal flows.

A bank may manage its uses of funds based on the reliability and persistency of the sources of funds. Funding sources being unavailable when they are needed may lead to the bank's failure. To assess their readiness, banks often perform scenario analysis to evaluate the impact of unavailability of one or more funding sources on their cash flow schedules and ultimately on their balance sheets. This enables them to obtain a view of the potential *liquidity gap* they may face in the future.