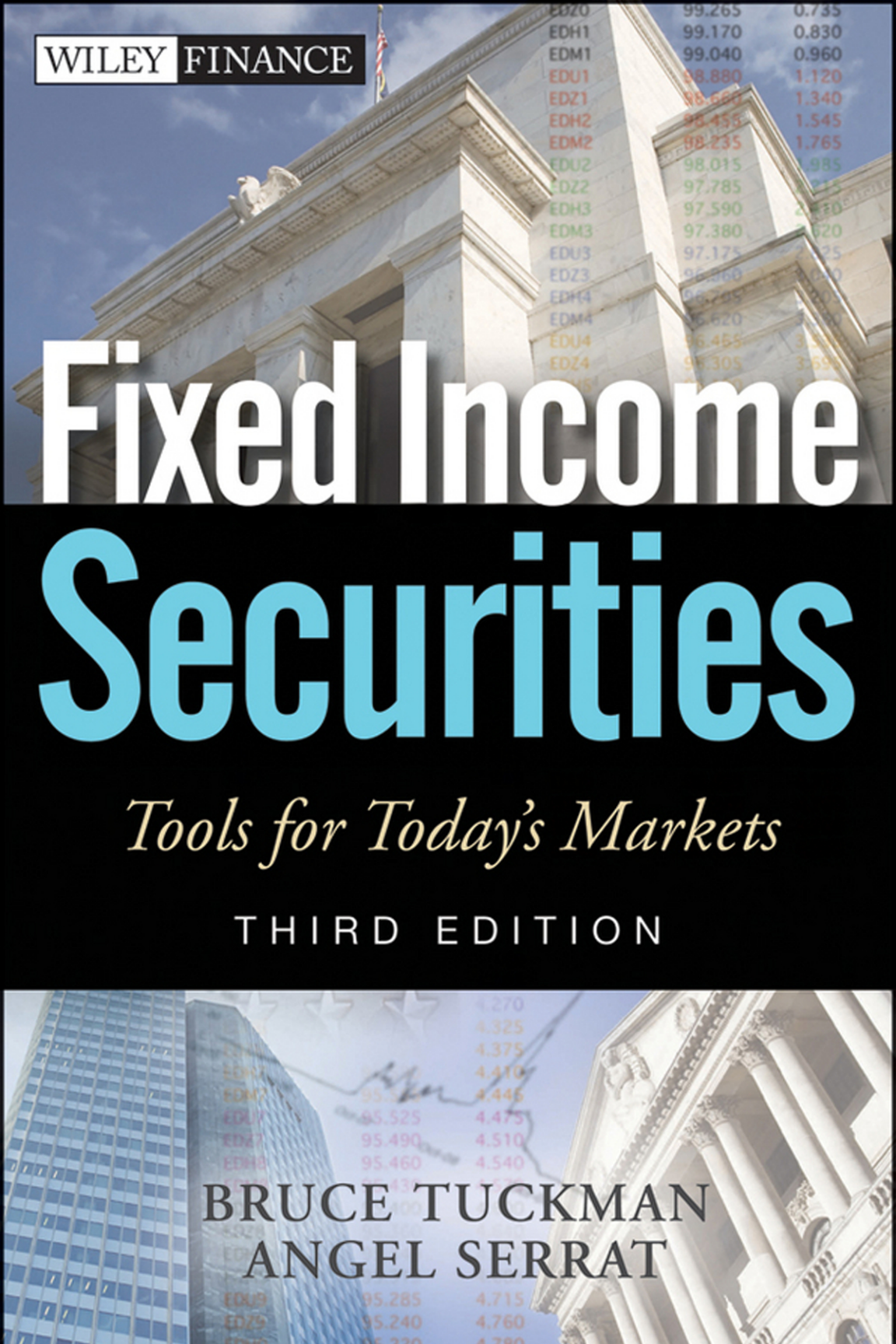
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Fixed Income Securities

Tools for Today's Markets

Third Edition

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John Wiley & Sons, Inc.

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.
Published simultaneously in Canada.

Library of Congress Cataloging-in-Publication Data:

Tuckman, Bruce.
Fixed income securities : tools for today's markets / Bruce Tuckman, Angel Serrat. – 3rd ed.
p. cm. – (Wiley finance series)
Includes index.
ISBN 978-0-470-89169-8 (hardback)
ISBN 978-0-470-90403-9 (paperback); ISBN 978-1-118-13394-1 (ebk);
ISBN 978-1-118-13395-8 (ebk); ISBN 978-1-118-13396-5 (ebk)
1. Fixed-income securities. I. Serrat, Angel. II. Title.
HG4650.T83 2012
332.63′2044–dc23

2011037178

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

Contents

Preface to the Third Edition

The goal of this book is to present conceptual frameworks for pricing and hedging a broad range of fixed income securities in an intuitive, mathematically simple, and applied manner. Conceptual frameworks are necessary so as to connect ideas across products and to learn new material more easily. An intuitive and mathematically simple approach is certainly useful to students and practitioners without very advanced mathematical training, but it is also really a good way for everyone to learn new material. Finally, an applied approach is crucial for several reasons. First, examples go a long way in solidifying conceptual understanding. The introduction of practically every concept in this book is followed by an example taken from the markets or, at the very least, by an appropriately calibrated example. Second, important details emerge from applications. Third, only by working through real or realistic examples can orders of magnitude be learned and appreciated. For example, a study of $DV01$ is not complete without having absorbed that the sensitivity of a 10-year bond is about 8 cents per 100 face amount per basis point, as opposed to 0.8 cents, 80 cents, or 8 dollars.

The book begins with an Overview of global fixed income markets. This section provides institutional descriptions of securities and market participants along with data designed to illustrate absolute and relative sizes of markets and players. A well-informed fixed income market professional has some idea about how central banks around the world have reacted to the financial crisis of 2007–2009 and can say whether the size of the mortgage market in the United States is one-tenth the size of GDP, about equal to GDP, or 10 times GDP.

For securities with fixed cash flows, Part One of the book presents the relationships across prices, spot rates, forward rates, returns, and yields. The fundamental notion of arbitrage pricing is introduced and is central to the analysis. Part Two describes how to measure and hedge interest rate risk, covering one-factor metrics, namely, $DV01$, duration, and convexity (in both their general and yield-based forms); two-factor metrics like key-rate '01s, partial $PV01$s, and forward bucket '01s; and empirical methods like regression and principal component analysis.

Part Three turns to the arbitrage pricing of contingent claims, i.e., of securities with cash flows that depend on interest rates, like options. The science of arbitrage pricing in this context is followed by a framework in which

to think about the shape of the term structure of interest rates in terms of expectations, risk premium, and convexity. One-factor term structure models are then described, to be used both in their own right, when appropriate, and as building blocks toward more sophisticated models. Chapter 11, the last chapter in Part Three, has two parts. First, it presents a multi-factor model for use in relative value applications, along with suggestions for estimating its parameters empirically. Second, it introduces the *LIBOR* Market Model, an extremely popular model for pricing exotic derivatives, in a particularly accessible manner.

Finally, Part Four applies the knowledge gained in the previous three parts to present and analyze a broad and extensive range of fixed income topics and products including repo, bond and note futures, rate futures, swaps, options, corporate bonds and credit default swaps (CDS), and mortgage-backed securities.

This edition substantially revises and expands the second. The only parts of the book that have remained essentially unchanged are Chapters 7 through 10 on pricing contingent claims with one-factor term structure models. The rest of the material that was in the second edition has been updated and, with the exception of a couple of particularly interesting case studies, the numerical illustrations, examples, and applications are all new. In addition, several chapters in this third edition are completely new and others significantly expanded. New chapters include the Overview, Chapter 17 on how the realities of financing have changed the practice of discounting cash flows, and Chapter 19 on corporate bond and CDS markets. Significantly expanded chapters include Chapter 6 on empirical hedging, which now includes principal component analysis; Chapter 11, which was discussed above; Chapter 18 on volatility and fixed income options, which now covers a very broad range of products, Black-Scholes pricing, and a mathematically simple introduction to martingale pricing; and Chapter 20, on mortgages and mortgage-backed securities, which takes a much more market-oriented approach and adds material on pool characteristics, TBAs, and dollar rolls.

Acknowledgments

The authors would like to thank the following people for helpful comments and suggestions: Amitabh Arora, Larry Bernstein, John Feraca, Lawrence Goodman, Jean-Baptiste Homé, Dick Kazarian, Peyron Law, Marco Naldi, Chris Striesow, and Doug Whang. We would like to thank Helen Edersheim for carefully reviewing the manuscript and sparing readers from phrases like "options wroth about $2" and the like. Finally, we would like to thank Bill Falloon, Meg Freeborn, and Natasha Andrews-Noel at Wiley for their patience and support throughout the process of putting this book together.

An Overview of Global Fixed Income Markets

This overview begins with a snapshot of fixed income markets across the globe and continues with concise reviews of fixed income markets in the United States, Europe, and Japan. These reviews have three goals: one, to describe how households and institutions achieve their borrowing and investing objectives through fixed income markets; two, to highlight the magnitude of the amounts of securities outstanding and of the balance sheets of market participants; and three, to emphasize the themes that are particularly relevant and significant for understanding today's markets.

A SNAPSHOT OF GLOBAL FIXED INCOME MARKETS

While fixed income markets are truly global, the vast majority of securities originate in the United States, Europe, and Japan. Figure O.1 shows the notional amounts outstanding of debt securities by residence of issuer, arranged in order of decreasing size. The largest markets by far are in the United States, the *Eurozone*, Japan, and the United Kingdom. (The Eurozone includes countries that are part of the European Union and also use the Euro as their currency.) The amounts outstanding for many Eurozone countries are shown individually in the graph, and indicated with asterisks, because several of these markets rank among the largest in the world on their own.

Derivative securities do not have an issuer in the same sense as do debt securities, but the distribution of the notional amounts of over-the-counter (OTC) interest rate derivatives across currencies tells a story similar to that of Figure O.1. According to Figure O.2, which shows amounts outstanding of single-currency, OTC interest rate derivatives, markets are dominated by contracts denominated in EUR (Euro), USD (United States dollar), JPY (Japanese Yen), and GPB (British Pound).[1] And with respect

[1]The other currencies appearing in the graph are CHF (Swiss Franc), SEK (Swedish krone), CAD (Canadian dollar), AUD (Australian dollar), NOK (Norwegian krone), HKD (Hong Kong dollar), DKK (Danish krone), and NZD (New Zealand dollar).

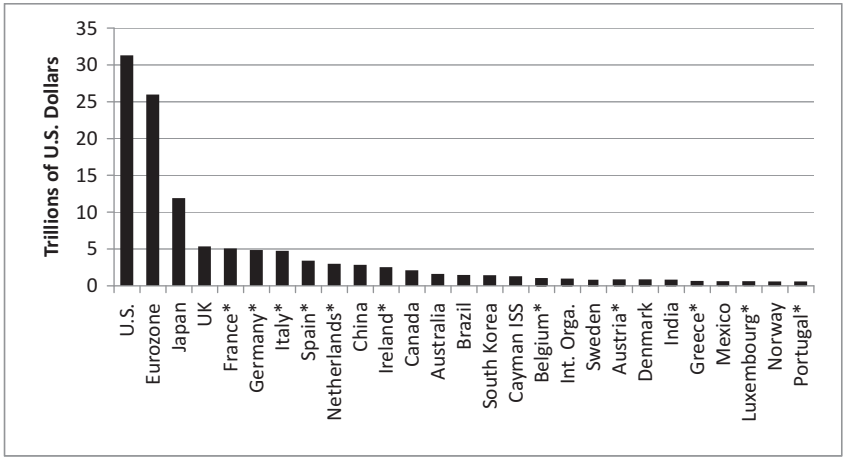

FIGURE 0.1 Debt Securities by Residence of Issuer as of March 2010
Source: Bank for International Settlements.

to exchange-traded derivatives, Table O.1 shows that Europe and North America comprise almost all of the outstanding notional amount.

It is worthwhile noting that Figures O.1, O.2, and Table O.1 report the place of origination of fixed income securities rather than the place of residence of the ultimate owners or counterparties. So, to take one of the more significant examples, China's ownership of nearly $850 billion of U.S.

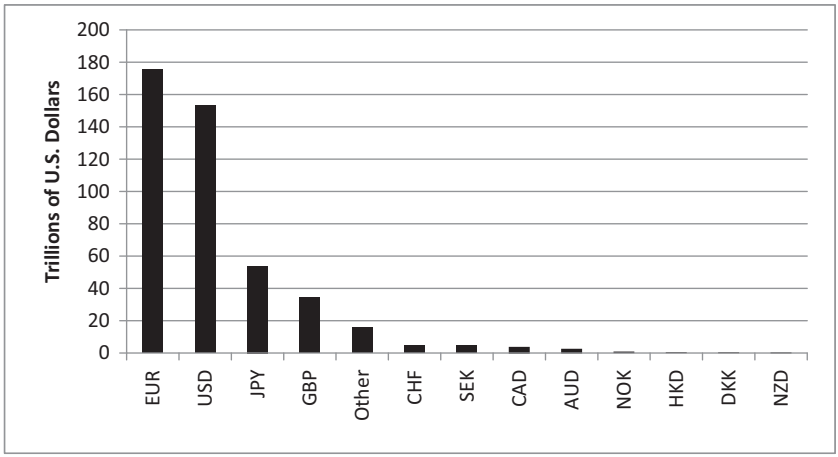

FIGURE 0.2 Amounts Outstanding of OTC Single-Currency Interest Rate Derivatives as of December 2009
Source: Bank for International Settlements.

TABLE 0.1 Exchange-Traded Interest Rate Derivatives as of March 2010, in Billions of U.S. Dollars

Region	Notional
Europe	27,807
North America	22,604
Asia and Pacific	10
Other	934

Source: Bank for International Settlements.

Treasury securities does not appear anywhere in Figure O.1. Nevertheless, even accounting for such instances, the data presented here justify this book's focus on fixed income securities and markets in the United States, Europe, and Japan.

As a final note before turning to the three overviews, Figure O.3 gives a coarse breakdown of the composition of debt securities in the United States, the Eurozone, Japan, and the United Kingdom. (The totals are the same as those reported in Figure O.1.) While the proportions of debt issued by governments, financial institutions, and corporations are similar in the United States and the Eurozone, debt markets in Japan are dominated by governments while those in the United Kingdom are dominated by the issues of financial institutions.

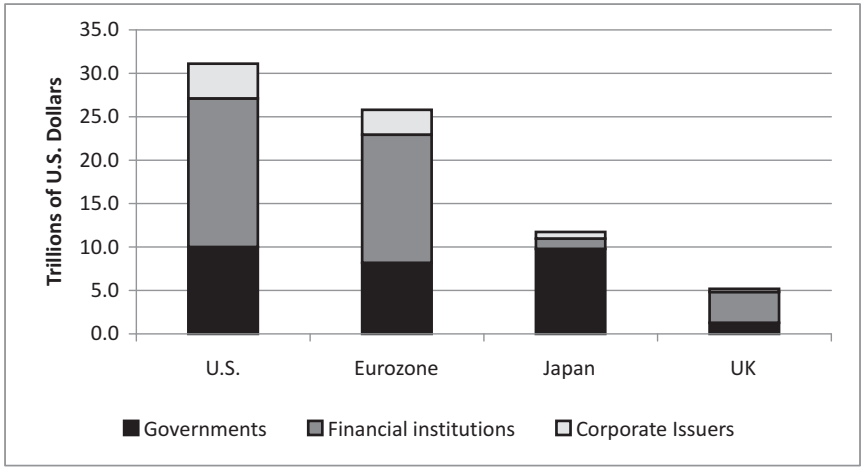

FIGURE 0.3 Debt Securities by Residence of Issuer and Sector as of March 2010
Source: Bank for International Settlements.

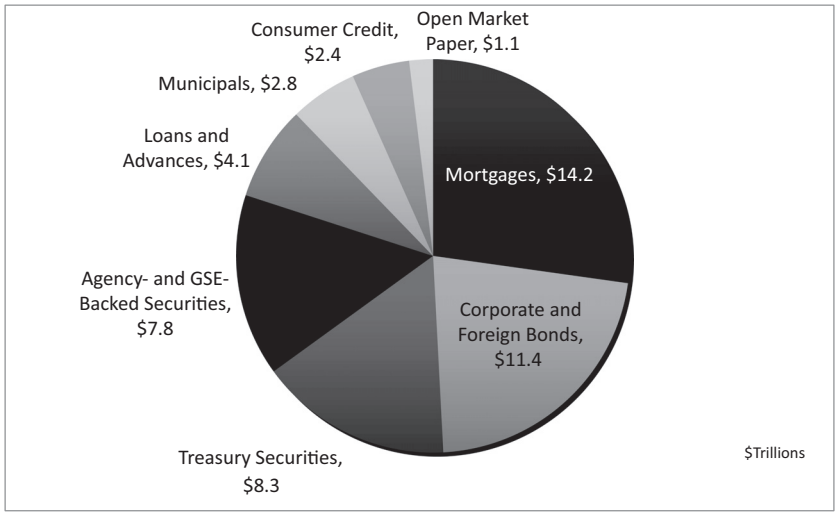

FIGURE 0.4 Credit Market Debt in the United States as of March 2010
Source: Flow of Funds Accounts of the United States.

FIXED INCOME MARKETS IN THE UNITED STATES

Securities and Other Assets

Figure O.4 shows the major categories of credit market debt in the United States, along with the size of the market for each, as of March 31, 2010.[2] Due to the definition of credit market debt in this cut of the data, several assets are not explicitly mentioned here (e.g., deposits, money-market fund shares, security repurchase agreements, insurance and pension reserves, equities), but will be included in the discussions of households and institutions later in this section.

Mortgages The largest single category of debt in the United States is *mortgages*, at a size of $14.2 trillion. A mortgage is a loan *secured* by property, so that if a borrower fails to make the payments required by a mortgage, the lender has a claim on the property itself. Exercising this claim, the lender could keep proceeds from the sale of the property up to the amount still owed; or the lender could seize or *foreclose* on the property, sell it, and recover the outstanding loan amount that way. In practice there might be

[2]The data for this figure and for much of this section come from the Board of Governors of the Federal Reserve System, "Flow of Funds Accounts of the United States," June 10, 2010. See also the accompanying "Guide to the Flow of Funds Accounts."

restrictions on the immediate or full exercise of this claim, like bankruptcy and other borrower protections or any tax liens on the same property. Finally, depending on the laws of the relevant state, the lender might or might not have *recourse* to the borrower's other assets to collect any remaining amount owed after the sale of the property.

Of the $14.2 trillion outstanding, $11.6 trillion is home or other residential mortgages, $2.5 trillion is commercial mortgages, and $138 billion is farm mortgages. To put the size of this market into context, two comparative statistics are useful. First, the annual gross domestic product (GDP) of the United States as of the first quarter of 2010 was $14.6 trillion.[3] Hence, it would take almost the entire output of the economy for one year to pay off all mortgage debt. Second, as of March 31, 2010, the public debt of the United States, at a historical high of $12.8 trillion, was $1.4 trillion less than the amount of mortgage debt outstanding.

Mortgages and mortgage-backed securities are the subject of Chapter 20.

Corporate and Foreign Bonds The second largest category of debt in Figure O.4 consists of corporate and foreign bonds. Corporate bonds are sold by businesses to finance investment, like the building of a new plant, the purchase of other businesses, or the purchase of investment securities. Bonds are also sold to *refinance* outstanding debt issues, that is, to retire existing debt not with corporate cash, which might have better uses, but with the proceeds raised by selling new debt. Motivations for retiring existing debt include redeeming maturing debt, repurchasing an issue to be rid of bond covenants that have become overly onerous, or exercising an embedded option to repurchase bonds at some prespecified and currently attractive call price.

As of the end of March 2010, $11.4 trillion of corporate and foreign bonds were outstanding, $5.6 trillion of which were sold by corporations in the financial sector. Proceeds raised by the financial sector, as will be discussed shortly, are used for the most part to purchase other securities.

Corporate bonds and derivatives on corporate bonds, namely, *credit default swaps*, or *CDS*, are the subject of Chapter 19.

Treasury Securities The next category is *Treasury securities*, obligations of the U.S. government incurred to finance its spending. U.S. Treasuries are among the most liquid securities in the world, meaning that investors can almost always buy and sell large amounts of Treasuries at prices close to relatively transparent market levels. In addition, while the finances of the U.S. government have deteriorated by historical standards, its debt is still

[3]Source: Bureau of Economic Analysis, U.S. Department of Commerce.

perceived as one of the safest investments in the world; when world events scare investors and trigger a "flight to quality," demand for U.S. Treasuries increases and their prices rise. As shown in Figure O.4, at the end of March 2010, there were $8.3 trillion of such securities outstanding, $7.7 trillion of which were *marketable*, i.e., traded in markets.

With respect to the credit quality of Treasury securities, it is important to note that Treasuries do not constitute the entire public debt of the United States, which, as mentioned in the discussion of mortgages, is $12.8 trillion or about 88% of GDP. The public debt includes *intragovernmental holdings*, i.e., debt that one part of the government owes to another in support of third-party claimants (e.g., holdings of government debt in the Medicare and Social Security trust funds). There is a statutory ceiling on the amount of public debt, which, of course, limits the issuance of Treasury securities as well, although this limit has been increased many times. An increase on February 12, 2010, the latest as of the time of this writing, raised the limit to $14.294 trillion. In any case, the ratio of public debt to GDP is used as an indicator of the credit quality of government debt, although it is widely recognized that certain economies can sustain higher ratios than others. With this caveat, the ratio of 88% in the United States is low compared with Japan but high compared with several, although certainly not all, European countries. Furthermore, 88% is very high relative to recent U.S. history: at the end of 2006, the public debt was $8.7 trillion and GDP $13.4 trillion, for a ratio of only 65%.

With the increasing global scrutiny of government financing, the maturity structure of government debt has taken on new importance. Since shorter-term rates are usually lower than longer-term rates, there is always an incentive to reduce borrowing costs by concentrating borrowing at shorter maturities. But this strategy can be dangerous; the more debt with shorter maturities, the greater a government's difficulties should investors suddenly become reluctant to purchase its new bond issues. While the United States has not had any trouble selling its debt, as Greece and Ireland recently

TABLE O.2 Maturity Structure of U.S. Treasury Marketable Securities as of March 31, 2010

Maturity Years	Outstanding $Billions	Percent %
< 2	3,482	45
2–5	1,953	25
5–10	1,528	20
> 10	782	10

Source: Monthly Statement of the Public Debt of the United States, March 31, 2010, and authors' calculations.

have, in the spirit of this new scrutiny Table O.2 presents the maturity structure of marketable U.S. Treasury securities. In comparison with the maturity structures in Europe and Japan (see Tables O.12 and O.18, respectively), government borrowing in the United States is relatively heavy at the shorter maturities.

Turning now to taxonomy, the U.S. Treasury issues securities in several different forms. Treasury *bills*, or *T-bills*, mature in one year or less and are *discount* securities, meaning that they make no payments until the promised payment at maturity and, consequently, sell for less than, i.e., at a discount from, that promised payment. Treasury *notes* are *coupon-bearing* securities, issued with 10 or fewer years to maturity, that make semiannual interest payments at a fixed rate and then return principal at maturity. Treasury *bonds* are also coupon-bearing securities, but with original maturities greater than 10 years. This separate classification of notes and bonds continues today, but is a historical artifact: bonds used to be subject to a maximum, statutory rate of interest, but this limit was eliminated in 1988.[4] In any case, this book uses the term "bond" loosely to refer to notes or bonds.

The U.S. Treasury also issues *TIPS*, or *Treasury Inflation Protected Securities*. The principal of TIPS adjusts to reflect changes in the consumer price index so that the coupon, together with the return of indexed principal, preserves a real return, i.e., a return above inflation. The maturing principal of a TIPS, however, will never be set below the original principal, no matter how much deflation might take place. As of March 31, 2010, the amount of TIPS outstanding was a relatively small $573 billion, less than 7% of the $8.3 trillion of Treasury issues. Nevertheless, TIPS have a significance beyond their size as their prices reveal market expectations about future inflation.

The last category of U.S. Treasury securities to be mentioned here, simply because they are well known, are U.S. savings bonds, which are nonmarketable, discount securities sold mostly to retail investors. As of March 31, 2010, the amount of savings bonds outstanding was a relatively tiny $190 billion.

In a largely successful effort to foster the liquidity of Treasury securities, the U.S. Treasury auctions them to the public at preannounced auction dates and quantities. The schedule of which maturities are offered and at what frequencies changes slowly over time with the financing needs of the Treasury. Currently, bills with maturities of 4, 13, and 26 weeks are sold weekly, while bills maturing in 52 weeks are sold every four weeks. Notes with 2-, 3-, 5-, and 7-year maturities are sold monthly. There are quarterly issues of 10-year notes and 30-year bonds, although individual issues are

[4] *Marcia Stigum, The Money Market, 3rd Edition*, (Dow Jones-Irwin, 1990) p. 37.

reopened, i.e., sold through subsequent auctions.[5] Finally, 5- and 30-year TIPS are issued annually and reopened twice per year while 10-year TIPS are issued semiannually and reopened four times per year.

Agency- and GSE-Backed Securities *Agency- and GSE-backed* securities are obligations of agencies of the U.S. government and of *GSEs* or *government-sponsored entities*. This category consists of three subcategories:

- Debt issues of U.S. agencies, which comprise only $24 billion of the $8.1 trillion total.[6]
- Debt issues of such GSEs as FHLMC (Federal Home Loan Mortgage Corporation or "Freddie Mac"), FNMA (Federal National Mortgage Association or "Fannie Mae"), and FHLB (Federal Home Loan Banks), which comprise $2.7 trillion of the total. These debt issues are used to finance a portfolio of mortgage-related investments, mostly portfolios of mortgages in the case of FHLMC and FNMA and mostly secured loans to banks making mortgage loans in the case of FHLB.
- Issues of mortgage-backed securities by FHLMC, FNMA, and of the wholly-owned government corporation GNMA (Government National Mortgage Association or "Ginnie Mae"), which comprise $5.4 trillion of the total. Aside from the *portfolio business* described in the previous bullet point, FHLMC and FNMA have a *guarantee business*, as does GNMA. This business consists of guaranteeing the performance of *conforming* mortgages (i.e., mortgages that meet specified criteria) in exchange for a fee. These mortgages are then bundled into mortgage-backed securities, which, in turn, are sold to investors.

The historical justification for GSEs has been that they serve a public purpose in addition to making profits for their shareholders. In the case of the mortgage-related GSEs, this public purpose has been to facilitate home ownership. As a result of this mix of public and private objectives, there

[5]As an example, consider the issuance and two scheduled reopenings of the 2.625% notes maturing on August 15, 2020. A face amount of $24 billion of these notes was initially sold to the public on August 11, 2010. Subsequently, in the first reopening auction, on September 8, 2010, another $21 billion of this issue was sold. Then, in the second and final scheduled reopening, on October 13, 2010, yet another $21 billion was sold.

[6]This discussion of agency- and GSE-backed securities uses Flow of Funds data as of December 2009 instead of March 2010, as in Figure O.4. As of 2010, mortgage pools were consolidated into the balance sheets of FNMA and FHLMC, blurring the distinction between GSE debt securities and mortgage-backed securities.

has always been furor about the extent to which the U.S. government is responsible for agency or GSE debt that it has not explicitly guaranteed, particularly in the cases of FNMA and FHLMC. These GSEs have been able to borrow at advantageous terms[7] because the global investment community has believed there is an implicit U.S. government guarantee, despite occasional statements by officials denying that to be the case. And in fact, after September 2008, when FNMA and FHLMC were failing and placed into government conservatorship, the U.S. government did exert considerable effort to protect and calm bondholders.[8]

Municipal Securities Municipal securities or *munis* are for the most part issued by state and local governments. The variation across issues is particularly large in this market, with over 55,000 different issuers[9] and a staggering number of distinct issues. Shorter-term issues are typically used for cash management purposes, e.g., to manage time gaps between tax collections and expenditures, while longer-term debt issues are often used to finance infrastructure projects. *General obligation (GO)* bonds are backed by the full faith and credit of the issuing municipality while *revenue* bonds are backed by the cash flows from a particular project. Municipal bonds as an investment class have historically had very low rates of default, but perceived creditworthiness does vary dramatically across issues. At the safest extreme are GO bonds of the most creditworthy states while at the other extreme are *revenue* bonds dependent on particularly risky projects. At the time of this writing the credit quality of municipals is under increased scrutiny because spending commitments made in better economic environments are now straining municipal budgets.

An extremely important feature of the municipal bond market is that the interest on the vast majority of issues is exempt from U.S. federal income tax. As a result, municipalities are able to pay much lower rates of interest than would otherwise be the case. Nevertheless, investors subject to the highest marginal federal tax rate earn a higher rate on municipal bonds, particularly those of longer term, than they earn, on an after-tax basis, on otherwise comparable taxable bonds.

Muni investors often enjoy advantages with respect to state income taxes as well, although the exact treatment varies by state. Most commonly,

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[7]The Congressional Budget Office has estimated that the implicit government guarantee enables the GSE to raise funds at a rate savings of 0.41% through their debt issues and 0.30% through their mortgage-backed security issues. See "Updated Estimates of the Subsidies to the Housing GSEs," Congressional Budget Office, April 8, 2004.

[8]See, for example, Federal Housing Finance Agency, "U.S. Treasury Support for Fannie Mae and Freddie Mac," Mortgage Market Note 10-1, January 20, 2010.

[9]See the Municipal Securities Rulemaking Board website, www.msrb.org.

a state exempts interest on bonds it has issued while taxing interest on bonds sold by other states.

The much-heralded Build America Bond (BAB) program, created in February 2009, expired at year-end 2010 and, as of the time of this writing, has not been renewed by Congress. Bonds under this program were typically sold as taxable to the investor, with the U.S. government rebating 35% of the interest to the issuing municipality. As of the end of October 2010, only about $150 billion of BABs had been sold, compared with approximately $3 trillion of municipal bonds outstanding,[10] but the program was very popular with municipalities. BABs opened the municipal market to investors in low or zero tax brackets who typically buy taxable bonds. On the other hand, the program is costly for the U.S. government to maintain.[11]

Other Categories Loans and advances of $4.1 trillion in Figure O.4 include loans made by banks and others (e.g., government, GSEs, finance companies) that are not included in any other category. Almost all of consumer credit of $2.4 trillion consists of credit card balances and automobile loans. Finally, open market paper of $1.1 trillion consists almost exclusively of *commercial paper*. Commercial paper issuers borrow money from investors on an unsecured and short-term basis, with maturities extending up to 270 days[12] but averaging about 30 days.

Households and Institutions

Figures O.5 and O.6 show the largest sectors that borrow and that lend funds through credit markets, respectively. These sectors are now discussed in turn, leaving out those that were already described in the securities subsection. (Note that, as in Figure O.4, only securities defined as credit market debt are included in Figures O.5 and O.6. Other assets, however, are included in the balance sheets to follow.)

Households Table O.3 shows the balance sheet for households and nonprofit organizations as of March 2010. Note that the percentage of liabilities is exactly that, and not the percentage of liabilities plus net worth. Hence, there is no percentage associated with net worth.

---

[10] Source: U.S. Build America Bond Issuance, Securities Industry and Financial Markets Association (SIFMA), and Flow of Funds Accounts of the United States.

[11] The argument that the program is costly is that since BABs, like all heavily taxed assets, are bought primarily by investors in low or zero tax brackets, the tax paid on BABs is very much below the 35% subsidy. It has been argued by some, however, that the relevant tax rate is higher so that a larger portion of the subsidy is recouped.

[12] Longer maturities would trigger Securities and Exchange Commission (SEC) registration requirements.

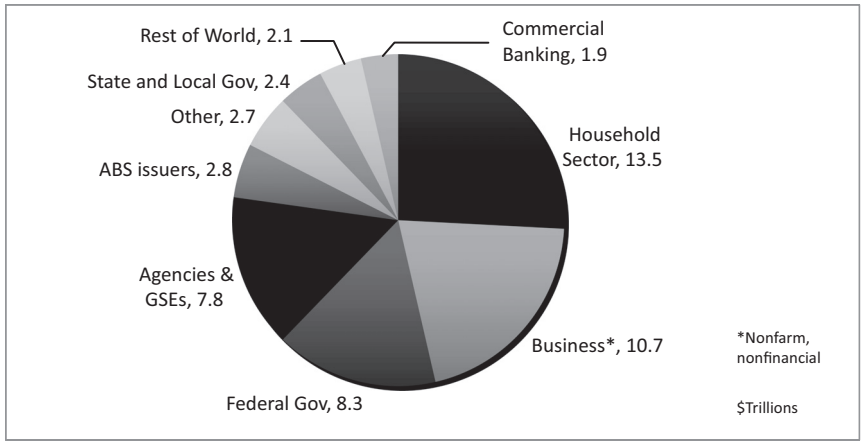

FIGURE 0.5 Credit Market Debt Owed as of March 2010
Source: Flow of Funds Accounts of the United States.

The largest asset of households is real estate followed by pension fund savings. Holdings of other assets are spread relatively evenly, with a significant percentage in equity of noncorporate business, e.g., relatively small, family-run businesses. The liabilities of households are predominantly mortgages and consumer credit, the latter consisting mostly of credit card debt and automobile loans. In short then, households own their homes and durable goods and invest in a wide range of financial assets, a significant portion of which are held through pension funds. Households borrow mostly

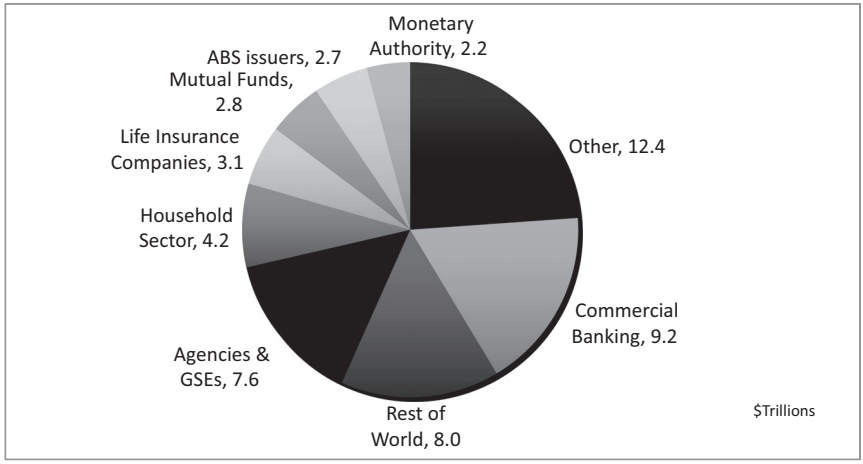

FIGURE 0.6 Credit Market Assets Held as of March 2010
Source: Flow of Funds Accounts of the United States.

TABLE O.3 Balance Sheet of Households and Nonprofit Organizations as of March 2010, in Trillions of Dollars

Assets	**68.5**	**100%**
Real Estate	18.1	26.5%
Consumer Durables	4.6	6.8%
Deposits and Money Market Funds	7.7	11.2%
Credit Market Instruments	4.2	6.1%
Corporate Equities	7.8	11.4%
Mutual Funds	4.3	6.3%
Pension Fund Reserves	12.3	18.0%
Equity in Noncorporate Business	6.5	9.5%
Life Insurance Reserves	1.3	1.8%
Miscellaneous	1.7	2.5%
Liabilities	**14.0**	**100%**
Home Mortgages	10.2	73.3%
Consumer Credit	2.4	17.3%
Miscellaneous	1.3	9.4%
Net Worth	54.6	

to finance their housing and durable purchases, but also to manage their short-term cash requirements. The European market overview, by the way, will discuss pension funds in more detail.

Since the financial crisis of 2007–2009 has had a significant impact on the balance sheets of households and institutions, it is noted here and in subsequent discussions how balance sheets have changed since the end of 2006. With respect to households, net worth has fallen from $64.4 to $54.6 trillion, or by more than 15%. And of this $9.8 trillion drop, $7.1 trillion or 11% was from a fall in the value of real estate assets and most of the rest from falling values of stocks and noncorporate equity.

Nonfinancial, Nonfarm Businesses Table O.4 gives the balance sheet of corporate and noncorporate businesses, excluding the financial and farm sectors. Businesses in the financial sector will be covered in later subsections and the farm sector is relatively small.

Nonfinancial business assets consist of real estate and equipment, along with a large portion classified as miscellaneous. There is a reasonable amount of trade financing, amounting to 7.2% of assets and 10.8% of liabilities. As for longer-term liabilities, businesses finance property with mortgages while financing other assets with loans and corporate bonds.

Table O.4 is not a snapshot of an individual business but an average across the sector, which obscures the life-cycle of financing a business. Initial capital comes from "friends and family" and bank loans. Then, as a

TABLE O.4 Balance Sheet of Nonfinancial Nonfarm Businesses as of March 2010, in Trillions of Dollars

Assets	**36.4**	**100%**
Real Estate	12.1	33.1%
Equipment and Software	5.0	13.6%
Inventories	1.8	4.9%
Deposits and Credit Market Instruments	2.7	7.3%
Trade Receivables	2.6	7.2%
Miscellaneous	12.4	33.9%
Liabilities	**18.9**	**100%**
Corporate Bonds	4.2	22.5%
Mortgages	3.4	18.1%
Trade Payables	2.0	10.8%
Loans and Miscellaneous	9.2	48.7%
Net Worth	**17.5**	

business grows, it may obtain loans from investor groups and from *private placements* of debt (e.g., negotiating the terms of a loan with one or several insurance companies). Finally, a larger business, with a track record and name recognition, can tap public bond markets.

From year-end 2006 to the end of the first quarter of 2010, the balance sheet of nonfinancial businesses deteriorated along with those of households: liabilities rose and assets fell, the latter predominantly because of real estates' values falling. As a result, net worth fell by about $5 trillion, or 23%, from $22.6 to $17.5 trillion. Or, taking a different perspective, the ratio of liabilities to assets increased from 42% to 52%.

Commercial Banking Table O.5 gives the financial assets and liabilities of the commercial banking sector as of March 31, 2010. Note that unlike the previous balance sheets, this one lists only financial assets and liabilities. This is a reasonable view for financial intermediaries whose nonfinancial assets are relatively insignificant.

The sources of funds for the commercial banking sector as a whole are deposits, *federal funds* (overnight loans between banks in the federal reserve system; see Chapter 15), and *repurchase agreements* or *repo* (usually very short-term loans secured by relatively high-quality collateral; see Chapter 12), bonds, and other sources. These funds are invested in a broad range of assets, although a significant percentage of these are mortgages (26%) or mortgage-related (i.e., agency- and GSE-backed securities at 8.8%). Banks make money by earning spreads between the rates they pay on their sources of funds and the rates of return they earn on their assets. But to earn spreads, banks have to take certain risks. In particular, banks typically take on three types of risk. First, banks take *credit risk* by lending to homeowners and to

TABLE 0.5 Financial Assets and Liabilities of Commercial Banks as of March 2010, in Trillions of Dollars

Financial Assets	**14.4**	**100%**
Reserves at Federal Reserve	1.0	6.7%
Agency- and GSE-backed Securities	1.3	8.8%
Corporate and Foreign Bonds	.8	5.4%
Loans	1.8	12.2%
Mortgages	3.8	26.0%
Consumer Credit	1.2	8.1%
Other and Miscellaneous	4.7	32.7%
Financial Liabilities	**12.8**	**100%**
Deposits	7.6	59.6%
Federal Funds and Repo (net)	.9	6.7%
Open Market Paper	.2	1.6%
Corporate Bonds	1.4	10.7%
Other Loans and Advances	.4	2.8%
Other and Miscellaneous	2.4	18.6%

businesses that may not repay their borrowings as promised. This source of risk is not a main focus of this book, but will be discussed in Chapter 19. Second, banks may take *interest rate risk* by borrowing with shorter-term securities but investing in longer-term assets. Shorter-term funds can usually be borrowed at relatively low rates of interest but, as these borrowings come due, banks run the risk of having to pay higher rates of interest on new borrowing. At the same time, longer-term lending is usually initiated at relatively high rates of interest, but these rates are fixed for years. Hence, should a bank's shorter-term borrowing costs rise relative to its fixed lending rates, its profit margin or spread will narrow or even turn negative. Interest rate risk is the subject of Part Two of this book.

The third source of risk for banks is *financing risk*. Deposits are regarded as relatively stable sources of funds because of deposit insurance: because the FDIC (Federal Deposit Insurance Corporation) insures deposits, at least up to a limit, depositors do not need to pull deposits at the first breath of rumor about a bank's financial health. Corporate bonds, with their relatively long maturities, also constitute a stable source of funds in the sense that a bank has time between the surfacing of any financial problems and the maturity of its bonds to sort out its difficulties.[13] Federal funds and repo, however, along with open market paper, are shorter-term sources of funds and are less stable: at the first sign that a bank is in financial difficulties, its ability to finance itself with federal (fed) funds and repo can erode in days, to be

[13] Of course, corporations typically stagger the maturities of their longer-term debt to ensure that only manageable amounts come due at any one time.

followed over subsequent months by the erosion of its ability to sell open market paper. Depositors with amounts above the insured limit may also withdraw the excess amounts.[14] And should all this happen, a bank cannot simply let its assets mature commensurately because most of the assets are of much longer term. Hence, the only way to meet short-term maturing obligations might very well be a fire-sale of assets at a substantial loss. Such a dramatic and sudden loss of short-term financing is often called a *run on the bank* and can certainly lead to bankruptcy. Chapter 12 revisits financing risk in the context of broker-dealer balance sheets during the financial crisis of 2007–2009.

As discussed with respect to the business sector, the balance sheet of a sector does not show variation across individual entities within that sector. As larger banks have better opportunities to borrow than do smaller banks, they tend to rely less on funding from deposits: the ratio of deposits to liabilities for the largest 25 U.S.-chartered banks was 69% in March 2010, compared with 84% for the smaller banks.[15] Another significant source of variation across banks is the historical reliance of smaller banks on local real estate lending, which reliance resulted in significant losses and failures during the 2007–2009 crisis. For the smaller U.S.-chartered banks, 54% of their assets as of March 2010 were related to real estate, 45% in the form of loans and 9% in the form of mortgage-backed securities. For the 25 largest U.S.-chartered banks, by contrast, 43% of assets were real estate–related, with 30% in loans and 13% in securitized form.[16]

A significant difference between household and nonfinancial business balance sheets compared with that of commercial banking is *leverage*, or the amount of assets supported by a given amount of liabilities. From Tables O.3 and O.4, the assets of the household sector are 4.9 times the liabilities, and the assets of the nonfinancial business sector are 1.9 times the liabilities. And at the end of 2006, before the financial crisis, the ratios were somewhat higher, at 5.8 and 2.4 respectively. Nevertheless, the vale of the assets of these sectors can fall significantly before assets are insufficient to pay off liabilities. By contrast, the ratio of finanical assets to financial liabilities of the commercial banking sector, from Table O.5, is only 1.1. Put another way, according to the table, the *equity* or the cushion of assets over liabilities equals $1.6 trillion. Thus, an 11.1% drop in the value of the $14.4 trillion

[14] Lines of credit, which allow customers to draw loans from banks, up to pre-specified amounts, also contribute to financing risk. In times of stress, customers will draw their lines while banks are losing their sources of funds.

[15] Source: Board of Governors of the Federal Reserve System, "Assets and Liabilities of Commercial Banks in the U.S." Note that the category U.S.-chartered commercial banks is a subset of the larger commercial banking sector described by Table O.5. This explains why these ratios do not bracket the comparable ratio in the table.

[16] Ibid.

in assets would wipe out the equity of the sector. And of course, any agent that had more leverage than its sector average would suffer commensurately larger losses of equity for any given loss of asset value.

This simplified discussion of leverage can explain how the banking sector got into trouble during the 2007–2009 financial crisis. At year-end 2006, 41.9% of assets were in mortgages and in agency- and GSE-backed securities. Taking bank capital, which, roughly speaking, is the cushion between the value of bank assets and liabilities, to be 10% of assets,[17] it takes only a 12% drop in the 41.9% of mortgage-related assets, assuming no other assets fall in value, to reduce asset value by 41.9% × 12% or 5% and cut bank capital in half. And to the extent that a particular bank had an even larger fraction of mortgage-related assets, or to the extent that other assets, like loans to troubled businesses also fell in value, the effect would be that much greater.

Monetary Authority, or the Board of Governors of the Federal Reserve System (Fed) The liabilities of the Fed are predominantly the reserves and deposits of banking institutions in the federal reserve system. The conduct of monetary policy is far beyond the scope of this book, but, to review, in the simplest of terms: the Fed's goals are given by the Federal Reserve Act, namely, "to promote effectively the goals of maximum employment, stable prices, and moderate long-term interest rates." Therefore, when the Fed believes that economic growth could be greater without causing inflation, it lowers short-term interest rates in an attempt to encourage borrowing and investment. And the way in which the Fed lowers interest rates is to increase the supply of funds relative to the demand by lending money to banks and taking securities as collateral. This collateralized lending is done through repo, which technically means that the Fed buys securities while simultaneously agreeing to resell them at a fixed price at some short time in the future. (See Chapter 12.) The Fed's balance sheet increases with these operations: its assets increase by the amount of securities taken as collateral (i.e., temporarily bought) from banks and its liabilities increase by the deposits made by banks with the amounts borrowed (i.e., temporarily sold). The process works in reverse when the Fed believes that inflation risks dominate and decides to raise short-term interest rates to discourage borrowing and invesment. In this case the Fed borrows money and gives

[17] A fuller discussion of bank capital ratios is beyond the scope of this overview. Measures of capital ratios and their corresponding regulatory thresholds vary depending on which forms of financing count as capital and on how assets are measured. With respect to capital, common equity always counts, but, for example, subordinated debt is included only by the broader definitions in the spectrum. And with respect to assets, the computation is typically either a simple sum or a risk-weighted sum of individual asset values, where the risk-weights are determined by regulators.

securities as collateral, which reduces its balance sheet: assets fall by the amount of securities temporarily sold and liabilities fall by the decrease in bank deposits to pay for securities temporarily purchased. Traditionally, the Fed has invested the proceeds from incurring bank reserve and deposit liabilities in U.S. Treasuries, the safest and most liquid domestic securities available.

The 2007–2009 financial crisis dramatically changed the Fed's balance sheet. Responding to the crisis and the ensuing economic slowdown, the Fed lowered rates from 5.25% at the end of 2006 to between 0% and 0.25% in December 2008. Then, believing that the traditional lowering of interest rates by supplying the banking system with reserves was not spurring growth as desired, and worried that the real estate and mortgage markets remained dangerously fragile, the Fed also bought mortgage-related securities directly. The idea was to inject cash into the system in a different way while stabilizing the real estate and mortgage markets. The scale of these operations raised the assets on the Fed's balance sheet from $908 billion at the end of 2006 to $2.3 trillion at the end of March 2010. Furthermore, over the same period, the composition of the Fed's assets changed from over 90% in either Treasuries or loans against Treasury collateral to about 33% in Treasuries and 53% in agency- and GSE-backed securities. Or, from another perspective, the Fed held no agency and GSE-backed securities at the end of 2006 but held about 16% of the amount outstanding of these securities by the end of March 2010. A concern about this situation is that with $1.2 trillion of mortgage-related securities, the Fed's balance sheet is subject to an unprecedented amount of risk. From this point of view, one facet of the U.S. government's intervention through the crisis was to move mortgage-related assets from the private sector's balance sheet to that of the Fed.

Issuers of Asset-Backed Securities In the boom before the 2007–2009 crisis, there was great demand for securitized assets, i.e., it was profitable to acquire assets, most often mortgage-related but also including student loans, business loans, automobile loans, and credit card receivables, and then sell securities with payouts that depended, sometimes in complex ways, on the performance of those assets. Chapter 20 discusses the securitization process for mortgages.

There are "on–balance sheet" and "off–balance sheet" approaches to securitization. In the on–balance sheet approach, a financial institution acquires the underlying assets outright and then recovers these funds, hopefully at a profit, when selling the securities. In the off–balance sheet approach, a financial institution sets up a separate financial entity, called an *SPV* for *special purpose vehicle* or an *SIV* for *special investment vehicle*, which purchases the securities by issuing short- and long-term debt whose performance ultimately depends on that of the underlying assets. Before the 2007–2009

crisis, financial institutions preferred the off–balance sheet approach for two reasons. First, they wanted to be in the "moving" business rather than the "storage" business, i.e., they wanted to be paid for the acquisition and eventual sale of assets but did not want any of the resulting risks on their books. It turned out, however, that many SPVs could not sell debt without various guarantees from their sponsors. While providing these guarantees made the risk of the off–balance sheet approach similar to that of the on–balance sheet approach, there was the second reason for preferring the former. Regulatory capital requirements and pressure from the investment community discouraged a direct increase in balance-sheet assets and liabilities without commensurate increases in capital while indirect claims on the balance sheet through the guarantees were not penalized as readily.

An inherent problem of asset-backed vehicles that rely on the sale of short-term debt or commercial paper is financing risk. Should the market begin to doubt the quality of the underlying assets, short-term debtholders will refuse to roll their loans at anywhere near the originally contemplated rate levels and new lenders will be equally difficult to find. In that case the SPV might very well not be able to redeem the claims of these short-term debt holders and would either default or fall back on any guarantees provided by the sponsoring financial institution. During the 2007–2009 financial crisis, there were many instances in which SPVs were unwound and put back onto the balance sheets of their sponsors.

At the end of 2006, there were $4.2 trillion of assets in these special purpose entities, 74.3% of which were mortgage-related. Furthermore, 19.9% of the liabilities of these entities were in the form of commercial paper. The assets in these entities continued to grow for a while, reaching $4.5 trillion at the end of 2007, but the decline in real estate prices and the resulting effect on mortgage-related securities soon took their toll. By March 31, 2010, the assets in these entities had fallen to only $2.8 trillion and the fraction of commercial paper in their liabilities was reduced to 4.4%.

Life Insurance Companies Life insurance companies sell insurance and annuity products that investors find particularly attractive for tax reasons, in particular, for tax-free death benefits and tax-deferral of savings. From the sale of these products, life insurance companies collect premiums that they invest so as to meet the obligations incurred and to earn an excess return. They choose to invest a large portion of their portfolios in longer-term assets, both to match the term of their liabilities better and to meet their return hurdles. They also take on default and equity risk to meet these hurdles. As of March 31, 2010, they invested a significant fraction of their assets in corporate and foreign bonds (39.9%) and in equities (27.1%). The former constituted 17% of the amount outstanding of corporate and foreign bonds, making insurance companies significant players in that market.

Broker-Dealers The magnitude of the balance sheet of broker-dealers (B/Ds), at a bit over $2 trillion at the end of March 2010, did not warrant inclusion in Figures O.5 and O.6. The sector, however, is clearly important to fixed income markets and to the functioning of the financial system.

Broker-dealers have three lines of business, although the three cannot always be cleanly separated from one another. First, investment banking helps customers raise money from capital markets. Second, sales and trading facilitate customer trading in a broad range of securities with the B/D acting as a broker, i.e., buying or selling on behalf of a customer, or as a dealer, i.e., trading on the B/D's own account for later trading with a customer. Third, proprietary trading or positioning, broadly defined trades securities for profit on the B/D's own accounts. Investment banking, strictly defined, does not require much in the way of funding, although there is an associated proprietary side of the business in which, as part of a larger client transaction, a B/D commits its own capital to the client on a short-term or even longer-term basis. Sales and trading often require funding, as broker-dealers find it necessary to hold an inventory of securities to facilitate customer trading. Finally, a proprietary business, which by its nature holds positions, requires longer-term funding.

The asset side of B/D balance sheets consists of a range of securities, consistent with making markets and proprietary positions across different markets. The liability side also has some corporate bonds that serve as a long-term source of funds. Security credit, which is made up of loans to the B/D from banks to finance securities and customer deposits with B/Ds, are a larger part of the liability side. Finally, liabilities include secured borrowing through repos. Repo borrowing can usually be achieved at relatively low credit spreads since the loans are short-term and secured. Precisely because repo borrowing is usually short-term, however, with most being overnight, B/Ds are subject to the same financing risks as discussed in the context of commercial banks. In fact, during the 2007–2009 crisis, when lenders became nervous about the credit quality of B/Ds, repo funding became hard to maintain on any terms and contributed to the stress on B/Ds. (See Chapter 12 for examples of this.) Since then, B/Ds have tried to rely less on short-term repo financing than previously. Even more dramatically with respect to managing financing risk, all of the major investment banks that survived through the fall of 2008 converted to bank holding companies, giving them access to the safety net of the Fed's discount lending window.

FIXED INCOME MARKETS IN EUROPE

An overview of European fixed income markets is particularly challenging. European markets are comprised of many individual country markets which, as mentioned at the start of this chapter, can be divided in many different

TABLE O.6 Financial Assets of Households, by Asset Class, 2007

	GDP	Financial Assets		Currency and Deposits	Pensions and Insurance	Equities	Other and Misc.
	$Trillions	% of GDP	$Trillions	% of Assets	% of Assets	% of Assets	% of Assets
Germany	3.328	188	6.270	36	26	25	13
UK	2.800	296	8.285	27	54	16	3
France	2.598	189	4.905	29	38	27	6
Italy	2.118	241	5.100	27	17	34	22
Spain	1.443	182	2.631	38	14	42	6
Netherlands	.779	280	2.184	22	59	15	4
Belgium	.459	271	1.244	28	23	40	9
Switzerland	.434	375	1.628	24	42	25	9
Denmark	.227	235	0.533	21	43	30	6

Sources: IMF and Eurostat.

ways: politically (i.e., countries in the European Union), by currency (i.e., countries using the Euro), by the intersection of the two, (i.e., countries in the Eurozone), or by other subdivisions (e.g., the Benelux countries, including Belgium, the Netherlands, and Luxembourg). Not surprisingly then, there is no single source of data that looks across all of the relevant countries with consistent classifications of securities or of financial market participants. Consequently, the data presented in this section come from many different sources, neither with perfectly consistent categories nor with a single 'as of' date.

Households and Institutions

Households[18] Table O.6 describes the financial assets of the household sector in several European countries. The countries are listed in order of decreasing GDP and financial assets are presented both as a percentage of GDP and in absolute terms. As often the case when several currencies are involved, all absolute quantities have been expressed in U.S. dollars.

The financial assets listed in Table O.6 range from $1.2 to $8.3 trillion and sum to about $33 trillion. In magnitude, then, the financial assets of the household sectors of individual European countries are small relative to those in Japan or the United States. Taken together, however, as a bloc, the financial assets of the household sector in Europe exceed those in Japan,

[18] The data for this subsection come mostly from "Financial Assets and Liabilities of Households in the European Union," Eurostat, 2009.

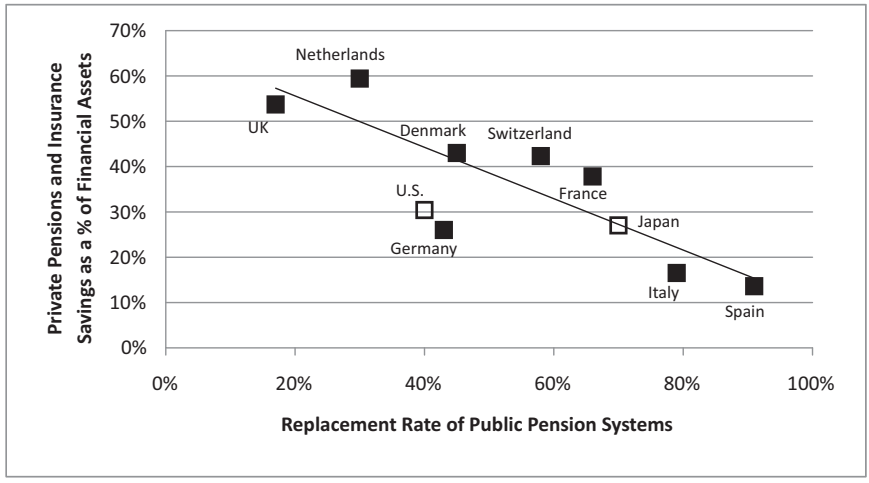

FIGURE O.7 Private Pensions and Insurance Savings of Households in Europe, as a Percentage of Financial Assets, vs. the Replacement Rate of Public Pension Systems, 2006–2007

but still fall short of those in the United States. (See Tables O.13 and O.3, respectively.[19])

The rightmost four columns of Table O.6 give the percentages of financial assets invested in particular asset categories. The first of these categories is currency and deposits. The percentage of financial assets held in this extremely safe and liquid form may be taken as a rough measure of the risk aversion of households with respect to personal investments. These percentages vary from 21% to 38%, which are all large relative to the 17% for U.S. households[20] but small relative to the 55% for Japanese households.[21]

The next column of Table O.6 shows that the percentages of European household financial assets held through private pensions and insurance products, two forms of long-term savings, vary widely across countries, from a low of 14% in Spain to a high of 59% in the Netherlands. Much of this cross-sectional variation can be explained by the variation of state-provided retirement benefits across countries. Figure O.7 graphs the pensions and insurance allocations from Table O.6 against the *replacement rate* of state plans, where the replacement rate is a ratio of pre-tax benefits to retirees'

[19] These tables, with 2010 numbers, are not strictly comparable to the 2007 numbers of Table O.6. Comparing the relevant magnitudes with data from a single year, however, would yield the same qualitative results.
[20] See Table O.3, noting that real estate, consumer durables, and some of the miscellaneous category are not considered financial assets. Also see footnote 19.
[21] See Table O.13 and footnote 19.

most recent pre-tax income.[22] Clearly, the more generous the state-provided pension benefit, the less the household sector devotes on its own to retirement and long-term savings vehicles. The trend line of this relationship in Europe applies to the United States[23] and Japan[24] as well, which are included in Figure O.7 for comparison.

Returning to Table O.6, summing the percentage allocations in currency and deposits with those in pensions and insurance products gives an indicator of the extent of financial intermediation of household savings in Europe. The average of these sums across countries is about 63%, which is high relative to the United States, at about 48%,[25] but low relative to Japan, at about 82%.[26] The exception to this ordering is Italy, at a sum of 43.5%, partially because of the high replacement rate of its public pension system, through the effect described in the previous paragraph, and partially because households can easily purchase domestic government bonds given the relatively large supply available (see Table O.12).

Pension Funds Pensions provide people with an income when they are older and, most likely, no longer employed. While the structure of pension provisions in Europe varies dramatically across countries, all models are based on a three-pillar system. The first pillar is made up of public pensions, paid by the state; the second pillar is comprised of occupational pension schemes, paid by employers to their retired employees; and the third pillar consists of private retirement plans, through which individuals accumulate savings to provide a pension upon retirement.

In the private plans of the second and third pillars, employers and employees, in some combination, contribute to a fund, often managed by a trustee, and often with certain tax advantages (i.e., tax-deductible contributions and tax-free accumulation of investment income and capital gains). Then, upon retirement, the beneficiary is given a lump-sum payment, an annuity, or a combination of the two. Private pension plans can be divided into three major categories: *defined benefit* plans, *defined contribution* plans, and *hybrid* plans. In a defined benefit plan, the sponsor of the plan promises

[22] Source: Allianz, as of 2006 and 2007.

[23] For replacement rates, see, for example, Chart 1 and Table O.1 of Patricia P. Martin, "Comparing Replacement Rates Under Private and Federal Retirement Systems," *Social Security Bulletin*, Vol. 65, No. 1, 2003/2004. For household asset allocations see Table O.3 and footnote 19 in this chapter.

[24] For replacement rates, see, for example, Eiji Tajika, "The Public Pension System in Japan: The Consequences of Rapid Expansion," The International Bank for Reconstruction and Development/The World Bank, 2002. For household asset allocation, see Table O.13 and footnote 19.

[25] See footnote 20.

[26] See footnote 21.

payments to retirees according to some formula, which depends on several factors, e.g., the number of years worked, the level of contributions to the plan, and salary history. Consequently, the sponsor bears the investment risk of the fund. In a defined contribution plan, payments to retirees depend on the accumulated principal plus investment performance of contributions. In these plans, therefore, the beneficiaries of the fund bear its investment risk. (Note that third pillar pensions are, by nature, defined contribution plans.) Lastly, in a hybrid plan, payments typically depend on investment returns, as in defined contribution plans, but the sponsor bears some of the investment risk. Examples include guarantees of paid-in principal (Germany) and minimum guaranteed returns (Switzerland). Historically, almost all pensions were defined benefit plans. For some time now, however, the global trend has been a marked shift to defined contribution and hybrid plans. The effect of this shift, of course, has been to shift the investment risk of pension benefits from employers to employees.

Defined benefit plans can be funded or unfunded. If funded, the plan sponsor uses contributions to buy assets, the income and sales proceeds of which are used to meet pension obligations as they become due. Of course, depending on investment returns, this portfolio of assets may or may not be sufficient to meet promised obligations.

In the case of unfunded defined benefit plans, sometimes called *pay-as-you-go* or *PAYG* plans, the sponsor uses current contributions to meet current obligations, with surpluses or deficits accumulating based on the difference between the two. Assets are bought or sold to manage these accumulated surpluses or deficits.

Most first pillar or public pension plans are PAYG. These can be further divided into *Bismarckian* systems, with contributions and benefits linked to pre-retirement earnings (Austria, Belgium, France, Germany, Italy, and Spain) and systems characterized by relatively low contributions and benefits that are designed to prevent poverty in old age (Ireland, the Netherlands, and UK). In any case, following the years of post-war, baby-boom-generation contributions to public pension systems, many plans have accumulated assets. However, any such accumulation of assets by no means implies a fiscally healthy position; most national plans are *underfunded* in the sense that current surpluses plus projected contributions are not nearly sufficient to meet future, promised obligations.

Returning for a moment to the case of a funded, defined benefit plan, the asset management challenge is to predict future obligations and to invest current assets so as to meet those obligations with high probability. Predicting future obligations requires tools outside the area of finance, such as mortality analysis, while the investment of assets is a risk-return problem in the general field of asset-liability management. Not surprisingly, long-dated fixed income assets are particularly suitable to meet projected, long-term obligations. Furthermore, the substantial demand from pension funds in

TABLE O.7 Asset Allocations of Pension Fund Assets in Selected Countries as of December 2010

	Equities	Bonds	Other
Germany	40%	45%	15%
UK	60%	31%	9%
Italy	20%	75%	5%
Spain	20%	65%	15%
Netherlands	28%	48%	24%
Switzerland	27%	36%	37%
Denmark	42%	51%	7%

Source: Watson Wyat, 2008.

Europe for such long-dated assets is critical in the determination of the prices of these assets. (See, for example, the trading case study in Chapter 2.) Having established this, it is also the case that pension funds invest in *real assets* (i.e., assets expected to generate a return that is relatively independent of inflation, like equities and real estate) since pension benefits are often explicitly or implicitly linked to inflation. From this perspective, inflation-linked bonds would be a natural choice for pension investments, but the supply of such bonds is very limited relative to the size of pension portfolios. Table O.7 shows the allocations across equities and bonds for the largest pension systems in Europe and will be referenced further in the discussion of individual country pension systems.

Pension Funds in the UK The largest pension system in Europe is in the UK, with about $1.75 trillion of assets as of year-end 2009,[27] which is about 80% of GDP. About 60% of these assets are part of corporate defined benefit plans, with benefits, subject to some caps, linked to inflation by statute. In fact, the legal requirement that pension benefits increase with inflation in the UK goes far in explaining why inflation-linked fixed income security markets are most developed in the UK.

Historically, UK pension funds have been invested primarily in equities, the legacy of which can be seen in Table O.7. But a combination of poor investment results and relatively high benefit levels have left many corporate defined benefit plans in the UK underfunded.[28] Consequently, many companies have closed plans to new employees, curtailed benefits (sometimes even within closed plans), and started to offer new, mostly younger employees, far less generous defined contribution plans.

[27] Source: Watson Wyatt, "Global Pension Assets Study," 2008.

[28] According to Aon Consulting, the 200 largest companies in the UK faced a combined deficit of close to $150 billion as of March 2010.