Retail Banking and Household Finance

Unit 1 Household Wealth and Risk Preferences

Contents

Unit Overview

In this unit you will study the key features of household wealth, and household liabilities, as well as household risk preferences. You will examine the components of so-called lifetime wealth. You will see how lifetime wealth can be categorised as tangible assets and intangible assets. Tangible assets can be further divided into financial assets and real assets. You will consider the main types of financial instruments used by households, and describe what types of financial assets households tend to hold. You will also examine the main types of household liabilities, and the role of household debt in financial crises. In the unit you will also discuss the preferences of households towards risk, and how we can try to measure the degree of risk aversion of households.

Learning Outcomes

When you have completed your study of this unit and its readings, you will be able to:

- analyse the role of human capital in household lifetime wealth
- discuss the factors affecting the allocation of wealth between real and financial assets
- explain the potential role of household debt in financial crises
- explain and interpret coefficients of relative and absolute risk aversion
- examine how we can measure the degree of risk aversion of households.

Reading for Unit 1

Guiso L and P Sodini (2013) 'Household finance: An emerging field'. In: GM Constantinides, M Harris and RM Stulz (Eds.) *Handbook of the Economics of Finance.* Volume 2B. Oxford and Amsterdam: North Holland, pp. 1397–1532.

Mian A and A Sufi (2011) 'House prices, home equity–based borrowing, and the US household leverage crisis'. *American Economic Review*, 101 (5), 2132–56.

1.1 Introduction

In general terms, wealth usually refers to money, real estate, and other types of financial assets, such as stocks or bonds. However, to enable us to undertake a more precise analysis, we can say that households can count on two types of wealth over their lifetime: human capital, which represents intangible wealth; and tangible wealth, which can comprise both financial assets (stocks, bonds), and real assets (for example, precious metals or real estate).

In this unit we start by introducing the concept of human capital, and study how to assess the value of human capital. Then, in section 1.3, you will compare the main features of real and financial assets. You will also examine the allocation of wealth between real and financial assets, and between different types of financial assets, and how these allocations vary across households organised according to levels of tangible wealth. This analysis gives a preliminary indication of the extent to which investment decisions, and attitudes to risk, vary according to the wealth of the household. In section 1.4 you will investigate why households raise debt financing, and assess whether household liabilities are a contributory factor in financial crises. In section 1.5 you will consider household preferences towards risk more analytically. The analysis of risk preferences allows us to examine what drives households' investment decisions, what influences the decision to allocate financial wealth in risk-free and risky assets, and suggests ways we can measure household preferences towards risk.

1.2 Household Intangible Wealth

Are you aware you are in possession of wealth, which, even based on conservative assumptions, has an estimated value equal to hundreds of thousands of dollars? That's the good news. Unfortunately, this wealth is also uncertain, its value is difficult to estimate, it is very illiquid and not easily tradable. Have you guessed what it is yet? It is your human capital. And, although its precise value is uncertain, and it is not tradeable, human capital is influential in shaping the financial decisions of households in relation to saving, borrowing, investment in education, and participation in financial markets.

In this section you will consider the basic features of human capital, the methods available to estimate the value of human capital, and what influences the value of human capital.

1.2.1 Human capital: basic features

Human capital is an intangible component of wealth whose value is hard to assess. This is often the case with valuing intangible assets (for example, the value of a brand for a retail apparel company). In addition, the value of human capital tends to change over the lifetime of an individual, and depends on factors such as education and work experience.

Another key characteristic of human capital, which differentiates it from other components of wealth (such as stocks), is the fact that it cannot be easily traded. For example, imagine that you hold 100 shares of Company A, which is a large corporation listed on the New York Stock Exchange (NYSE). The market for these shares is likely to be very liquid, meaning that you can easily find a counterparty to buy or sell stock. Therefore, if you plan to sell 50 shares of Company A, it is very likely that you will find a counterparty willing to buy these shares at a reasonable price.

However, for human capital this is not the case. For example, imagine that you hold an undergraduate degree from a university. You are not allowed to buy or sell the degree to another household. Other non-tradable components of human capital include personality, health, and skills.

Moreover, human capital is strongly dependent on age. Education usually occurs early in life, and it affects the expected lifetime earnings of a household. For this reason, human capital tends to follow a life-cycle: it is higher for young people and it declines with age. As people age, they tend to earn and save more, and therefore the portion of total wealth represented by tangible assets (for example, savings, real estate) increases. On the other hand, as people age, the portion of total wealth represented by human capital decreases, because the number of years for which human capital is expected to generate income decreases as a person approaches retirement.

Finally, human capital is not a risk-free asset. In finance, risk refers to the variability of the returns of assets. Returns can be positive, or negative, and will vary around their expected value. Unfortunately, a person may lose her job during her lifetime (which represents downside risk). However, she could also be promoted and be awarded a pay rise (representing upside risk). We say that labour income represents the returns on human capital; labour income, and therefore the return on human capital, may vary unpredictably over time; so we can conclude that human capital is a risky asset.

1.2.2 How can we value human capital?

So far you have seen that human capital represents intangible wealth, which in itself is non-tradable and hard to value. However, you have also seen that labour income, earnt over a lifetime, represents the return on human capital. To get an idea of how to value human capital we need a way of valuing the flow of labour income we expect to earn in the future. To see how this could be done we can consider how we value a risk-free coupon bond. The bond pays a fixed coupon, *C*, every year, and at maturity the principal or face value of the bond is repaid (in this example the principal is 100). The method for valuing the future cash flows associated with the bond are shown in equation (1.1).

$$B = \frac{C}{(1+r)} + \frac{C}{(1+r)^2} + \ldots + \frac{C}{(1+r)^T} + \frac{100}{(1+r)^T} \tag{1.1}$$

In equation (1.1) B is the value or market price of the bond, and C is the annual coupon payment. When valuing cash flows that will take place in the future we use a method called discounting, which takes account of the time value of money. This means we prefer to receive money sooner rather than later, so that one dollar received now is worth more to us than one dollar received in, say, ten years. Discounting also takes into account the opportunity cost of the investment in the bond – what is the next best alternative that we are giving up by investing in the bond?

In equation (1.1) you can see that the cash flows are multiplied by

$$\frac{1}{(1+r)}, \frac{1}{(1+r)^2}, \text{ up to } \frac{1}{(1+r)^T}$$

These are the discount factors that we apply to the cash flows in each year, going to T, the maturity of the bond when the principal is repaid. r is the discount rate that we use to discount the future cash flows. If this is a risk-free bond (meaning there is no likelihood the issuer will default), then we could use the general risk-free interest rate as the discount rate. In equation (1.1) the valuation of the bond assumes that the discount rate is unchanged for the life of the bond. If at a later date interest rates changes, then we would revalue the bond using a more relevant discount rate.

As noted, the discount rate is the rate we use to calculate the present value of the future cash flows associated with the bond. The discount rate does not have to equal the coupon rate on the bond (which is specified in the terms of the bond). Let us demonstrate these points with an example. Consider a bond with maturity of four years, with annual coupon payments of 4% of the principal (which is equal to 100). The prevailing market interest rate is 5%. The value of the bond is therefore

$$B = \frac{4}{(1+0.05)} + \frac{4}{(1+0.05)^2} + \frac{4}{(1+0.05)^3} + \frac{104}{(1+0.05)^4} = 96.454$$

Review Question 1.1

Suppose the general level of interest rates reduced from 5% to 3%.

- Would the value you place on this bond increase, decrease, or stay the same?

The discount rate, r, appears in the denominator of the discount factors. If you use a lower discount rate, the discount factors will increase, and the present value of the future cash flows associated with the bond will increase. So if you apply a lower discount rate, the value or market price of the bond will increase. Specifically, with a discount rate of 3% the value of the bond increases to 103.72.

Therefore, to value a bond we need to discount the future cash flows generated by the bond using a suitable discount rate. Can we apply the same method to estimate the value of human capital? What variables would we need to consider in a simple equation to value human capital?

As noted above, the return on human capital usually takes the form of labour income. Therefore, the key variable that generates cash flows can be represented by future expected labour income.

Let's assume, for the sake of simplicity, that labour income is risk-free and independent of age. To simplify things even further, let's assume that an individual (or household) receives every year (from year 1 to year T) the same disposable labour income (income after tax and other cash payments), which we denote y. T represents the individual's lifetime horizon. The estimated value of human capital will be:

$$H = \frac{y}{(1+r)} + \frac{y}{(1+r)^2} + \ldots + \frac{y}{(1+r)^T} = \sum_{t=1}^{T} \frac{y}{(1+r)^t} \tag{1.2}$$

In words, the estimated value of human capital is the sum of discounted future labour income.

Review Question 1.2

Please take a moment to think about equation (1.2).

- How realistic is this specification and the estimates of the value of human capital that we would obtain by using it?

Equation (1.2) is unlikely to produce realistic estimates of the value of human capital. As we noted earlier, labour income is risky (meaning that y may vary over time), and labour income depends on age (so that H may change for the same individual as she becomes older).

The next reading, from Guiso and Sodini (2013), examines these issues in more detail.

In the reading the authors argue that the value of human capital depends on present and future labour income, age, and a discount factor. This is represented mathematically in equation (2.1) on page 1403. We reproduce that analysis here, but replace γ in the reading with y, for consistency with equation (1.2).

$$H_a = E_a \sum_{\tau=a}^{T} \beta^{\tau-a} y_\tau \tag{1.3}$$

How should we interpret equation (1.3)?

H_a is human capital, calculated for an individual at age a.

τ represents future time periods, running from the current age, a, to the last year of the individual's life, T.

T represents the last year of the life of an individual, and for this reason the maximum value that τ can reach is T.

β is a discount factor. It has a slightly different interpretation compared to the discount factor used in the bond valuation above. β is a constant, and is raised to the power of $\tau - a$ for each year involved in the summation in equation (1.3). We will demonstrate this with an example in a moment.

E_a is an expectation operator. The a subscript indicates that these are expectations formed at age a, of disposable income in future years. So the expectation of income in any future year can change with age.

In words, equation (1.3) states that the value of human capital is the expected sum of present and discounted future disposable labour income.

Suppose we are calculating human capital for someone aged 39. Then $a = 39$. The first terms in the summation would be

$$\begin{aligned} H_{39} &= E_{39} \sum_{\tau=39}^{T} \beta^{\tau-39} y_\tau \\ &= E_{39} \left\{ \beta^{39-39} y_{39} + \beta^{40-39} y_{40} + \beta^{41-39} y_{41} + \ldots \right\} \\ &= E_{39} \left\{ y_{39} + \beta y_{40} + \beta^2 y_{41} + \ldots \right\} \end{aligned} \tag{1.4}$$

In words, the estimate of human capital at age 39 is the expectation (formed at age 39) of this year's income, plus the income at age 40 (discounted once), plus the income at age 41 (discounted over two years), and so on.

If the discount rate is 5%, then

$$\beta = \frac{1}{(1+0.05)} = 0.952$$

And the income at age 41 would be discounted by

$$\beta^{\tau-a} = \beta^{41-39} = \beta^2 = \left(\frac{1}{1+0.05} \right)^2 = 0.907$$

We discount more heavily income we expect to receive further into the future.

Review Question 1.3

In this example, by how much would income at age 50 be discounted in the calculation of human capital (calculated at age 39)?

$$\beta^{\tau-a} = \beta^{50-39} = \beta^{11} = \left(\frac{1}{1+0.05} \right)^{11} = 0.585$$

Note also that if interest rates increase, the discount rate increases, the discount factor decreases, and the present value of future labour income decreases.

Review Question 1.4

Use equation (1.3) to estimate the value of your own human capital. What inputs will you need? What assumptions will you make about your labour income in future years? And interest rates?

For example, the median UK household disposable income in 2016 was £26,000 (ONS, n.d.). Consider a discount rate of 2% (the yield on 30-year government bonds in 2017 was approximately 2% (Bloomberg, n.d.)). If we assume there will be no change in income, or interest rates, if we ignore taxes, and any income or other cash benefits received after age 67, and if we continue the example and consider someone aged 39, then human capital estimated using equation (1.3) is

$$
\begin{aligned}
H_{39} &= E_{39} \sum_{\tau=39}^{67} \beta^{\tau-39} y_\tau \\
&= £26,000 + \frac{1}{1+0.02} £26,000 + \left(\frac{1}{1+0.02}\right)^2 £26,000 + \ldots + \left(\frac{1}{1+0.02}\right)^{28} £26,000 \\
&= £579,313
\end{aligned}
$$

Can you see how the value of human capital, despite being uncertain and non-tradable, might influence the general financial decisions of households, either as an explicit or an implicit factor in those decisions?

Study Note 1.1

Please note the typographic error in the formula for human capital in the next reading by Guiso and Sodini. In the summation they write $y_{\tau+a}$ instead of y_τ. In the analysis in the unit τ represents an age in the future and T is the age at which the household stops earning (or the end of their life). If instead τ denotes a particular number of years from the current age, the formula for human capital in the reading should have been written as

$$H_a = E_a \sum_{\tau=0}^{T} \beta^\tau y_{\tau+a} \tag{1.5}$$

and T is the expected number of years left for the life of that household.

Reading 1.1

Guiso & Sodini (2013) 'Household finance: An emerging field'. *Handbook of the Economics of Finance*.

Please now read Section 2.1 in Luigi Guiso and Paolo Sodini (2013) 'Household Finance: An Emerging Field', pages 1403–06.

Please give attention to Figure 1 and Figure 2, and the related discussion of these figures in the text. Make a note of the following issues:

- the relationship between level of education and how the value of human capital evolves during the life cycle
- the relationship between background risk and age. Note that background risk refers to any risk that cannot be traded or insured.

As a household ages, all other things being equal, the value of human capital decreases. Higher levels of education are associated with an increased value of human capital.

Figure 1 and Figure 2 on pages 1405–06 are based on data from the Survey of Consumer Finances (SCF) wave of 2007, The SCF is a survey based on US households which is conducted every three years by the Board of Governors of the Federal Reserve System. This survey covers a variety of aspects related to household finances, such as: level of education, use of credit or debit cards, loan applications, debt outstanding, planning horizon for saving and spending, types of (real and financial) assets held.

1.3 Household Tangible Assets

In this section you will consider the tangible assets held by households. You will first examine the characteristics that distinguish real and financial assets. You will then examine the types of financial assets held by households, and obtain a preliminary idea of the extent to which households invest in cash rather than more risky assets. You will then conduct a more thorough examination of the allocation of household wealth, between real assets and financial assets, and between the various types of financial asset. One objective of this analysis is to consider whether the allocation of wealth between the different types of assets is the same for all households, or if it varies across households. For example, we might ask whether poorer households (defined by gross financial wealth) hold the same proportion of their wealth in cash compared to households that have higher levels of wealth. Similarly, we might ask whether the more wealthy households hold a larger proportion of their wealth in risky assets (like company shares), compared to households that have lower levels of wealth.

1.3.1 Comparing real and financial assets

In this sub-section, we discuss briefly the main features of financial and real assets. These two classes of assets differ markedly along the following dimensions:

- liquidity
- ownership and degree of control over the asset
- degree of complexity.

Liquidity

Financial assets tend to be more liquid, especially those that are traded in regulated markets (for example, the NYSE). They are easy to value, and information on their current and past prices and performance is either publicly available or provided by commercial database providers. However, the degree of liquidity of financial assets can vary substantially depending on the size of the company, the type of market where they are traded (dealer market, call auction or continuous auction market, physical or electronic market), trading and listing rules, and other factors that may affect the trading volume for that financial asset.

Ownership and control

Financial assets can be defined as claims over the income generated by real assets. However, financial assets do not generally allow much control over these real assets. Let's consider in particular the case of common shares. Common shares confer voting rights to the owner of the shares. But control over the use of the real assets of the company can be weak, unless the shareholder holds a sufficient number of shares to influence the management of the company. For example, households that hold stocks are usually minority shareholders, and therefore they may not be able to monitor the management, even if their stocks enable them to have voting rights. Suppose you have bought 100 common shares of Company A, and Company A has a total number of common shares outstanding equal to 1,000,000: therefore you have very little influence over Company A's directors (monitoring costs may be too high). This separation between ownership of the financial assets and control of the real assets generating the income is usually referred to as an agency problem. The managers of a company may make decisions that suit their own objectives, which are not necessarily the objectives of shareholders. To align the incentives of the principal (the shareholder) and the agent (the manager), some companies use performance-based compensation contracts.

Complexity

Financial assets can be very complex and hard to understand, and households may not have the information or knowledge required to make informed investment decisions. This is true especially for complex contracts such as financial derivatives, that is, financial assets whose value depends on the value of an underlying asset (for example, a commodity such as oil or copper).

Table 1.1 summarises the differences between real and financial assets described above.

Table 1.1 Comparison between real and financial assets

	Real assets	Financial assets
Degree of liquidity	Usually low	Can be high
Degree of control over the asset owned	Usually high	Usually low
Degree of complexity	Usually low	Can be high

1.3.2 Household holdings of financial instruments

Households can hold financial assets such as:

- cash
- fixed income securities
- equity securities

- unit trusts/mutual funds, and other types of collective investment vehicles
- insurance
- loans (usually to friends and relatives)
- derivatives (for example, options, futures, Exchange Traded Funds – ETFs, or Exchange Traded Commodities – ETCs).[1]

The term cash can include coins and banknotes, but also transaction accounts (current, or chequing, accounts) and saving accounts, money market funds, and certificates of deposit. Fixed income securities comprise bonds, both zero-coupon bonds and coupon bonds. Equity securities are usually called 'stocks' or 'shares'. Derivatives such as ETF enable households to diversify their portfolios without buying many stocks or bonds individually.

Usually households hold financial instruments via banks or other financial intermediaries. For example, collective investment vehicles (CIVs), such as unit trusts (as they are known in the UK) or mutual funds (US) are financial institutions that perform the intermediation function by collecting funds from households (and other investors) and investing these funds in financial markets. Households obtain income from investing in unit trusts because they have a claim on a share of the assets comprised in the fund. Therefore they can benefit from an appreciation in the value of the fund assets and they may also receive a share of the income generated by the fund assets. If the assets are bonds, income will be in the form of interest payments. If the assets are equities, income will be in the form of dividends.

In general, the participation of households in financial markets tends to be limited. The total holdings of financial assets by the average household varies considerably between countries. The share of different types of financial assets in relation to the total financial wealth of households also varies between countries.

Exercise 1.1

Please examine the data on household financial assets at the website of the Organisation for Economic Cooperation and Development (OECD, 2017), available from: https://data.oecd.org/hha/household-financial-assets.htm

1. Which country has the lowest proportion of cash relative to total household financial assets? And the highest?
2. Which country has the lowest investment in pension funds relative to total household financial assets? And the highest?

For example, in 2015 the proportion of total household financial assets held as cash was 13.6% in the US and 78.9% in Turkey. The proportion of total

[1] For a definition of financial assets according to the OECD, as well as descriptive statistics, see: https://data.oecd.org/hha/household-financial-assets.htm

household financial assets invested in pension funds was 1.2% in Greece, and 60% in the Netherlands. Let us examine some of these patterns in more detail.

Kick, Onali, Ruprecht and Schaeck (henceforth, KORS, 2016), using data from the OECD, show that US households hold around 13.7% of their financial portfolio in currency and deposits (confirming the results from the above exercise). In contrast, for Japanese households the share of financial assets represented by currency and deposits is 54.3%. An important topic in the household finance literature is the participation of households in the stock market. KORS (2016) report that US households tend to hold a much higher proportion of their financial wealth in equities (43.4%) than Japanese households (10.8%). This finding suggests that institutional characteristics of a country, such as stock market development, as well as cultural differences, play an important role in shaping the preferences of households regarding the allocation of their financial assets.

The next reading analyses the composition of household tangible wealth for a cross-section of US households, with the data organised according to *deciles* of gross tangible wealth. What do we mean by deciles? To create the graphs in the reading the households are ranked according to gross tangible wealth. The first decile refers to the 10 per cent of households with the lowest values for gross tangible wealth. The second decile represents the next 10 per cent of households, and so on up to the tenth decile, which corresponds to the households with the highest levels of gross tangible wealth. In crude terms, the first decile represents the poorest households measured in terms of gross tangible wealth, and the tenth decile represents the wealthiest households.

Reading 1.2

Guiso & Sodini (2013) 'Household finance: An emerging field'. *Handbook of the Economics of Finance.*

1. Please read carefully the start of section 2.2 of Guiso and Sodini (2013), pages 1406–13, especially Figures 3 to 7, which are based on data from the SCF in 2007. The Appendix to the paper provides definitions, on pages 1514–15, of the elements displayed in the Figures, if some of them are unfamiliar to you.

   Make a note of the main findings reported in this section. In particular, focus on the following:
   - the relationship between total tangible wealth and the relative weights of real tangible wealth and financial tangible wealth
   - the relationship between the share of primary residence in real wealth and gross tangible wealth
   - what kind of assets poor households tend to hold
   - what category of households (poor, middle-class, or rich) are most likely to be affected by a house-price bubble, when it forms and if it bursts.
2. Please also read carefully section 2.2.3 of Guiso and Sodini (2013), pages 1413–17. This section focusses on the composition of financial wealth across the cross-section of households, with households again ranked according to total tangible wealth.

   Please note the following points:
   - the relationship between background risk and housing
   - the relationship between investor wealth and participation in financial assets, in particular participation in stocks.

Are you surprised by any of the findings reported in the readings from Guiso and Sodini (2013)? Considering the poorest households, for example, most of their tangible wealth is held in cash and motor vehicles, there is limited participation in other financial assets, and where there is, this tends to be concentrated in a limited number of assets. Residential assets, being fixed in nature, are unlikely to be used to balance wealth portfolios in response to macroeconomic and financial shocks, at least in the short term. The authors also suggest that the variability they observe across households in relation to the composition of financial portfolios (or heterogeneity) is in contrast to what theoretical models of risk preferences would suggest. You will examine preferences towards risk later in this unit.

1.4 Household Liabilities and Financial Crises

In this section you will examine how household liabilities can contribute to financial crises. The section first provides a brief introduction to the various types of household debt, and then analyses the mechanisms by which items such as home loans and credit cards could lead to the instability of financial systems.

1.4.1 Types of household debt

In this sub-section we briefly describe the main features of different types of household debt.

Mortgages are (long-term) loans to households, usually for the purpose of buying a home, and are secured by real estate assets. Properties constitute a very important asset for middle-class US residents, but participation rates (that is, the percentage of households holding real estate assets) tend to be very low for poor households. In other words, many poor households tend not to own any real estate asset.

Consumer debt is debt arising from deferred payment for purchases of consumption goods. It can refer to loans associated with purchases of durables such as vehicles, home appliances, and the like. Consumer debt can include financial instruments such as credit cards, payday loans, and other forms of short-term debt.

Credit cards are short-term financing instruments that are used for payments of goods and services. The payment occurs at the point of sale and the interest rate for borrowing tends to be much higher than for mortgages. However, interest is not charged until after (usually) a month from purchase, and no interest is charged if the balance is cleared before that time.

Payday loans are small and unsecured short-term loans that are meant to be repaid once the borrower’s payday is due (hence, the name ‘payday loans’). They are often mentioned in the media because of the very high interest rates charged on borrowers, and this has led to regulation in several countries that aims to improve disclosure of the loan terms to borrowers.

Student debt is debt raised to pay for education, usually Higher Education (HE). This type of debt is particularly important in Anglo-Saxon countries, where HE fees tend to be more expensive. In the UK and the US this type of loan is provided by the Student Loans Company (SLC) and Sallie Mae, respectively.

Reading 1.3

Please read section 2.3 'Liabilities' in Guiso and Sodini (2013), pages 1417–19. This short section examines the various types of household liabilities, using the same cross-section method, with households ranked according to gross tangible wealth.

Guiso & Sodini (2013) 'Household finance: An emerging field'. *Handbook of the Economics of Finance*.

1.4.2 Household liabilities and financial crises

The total debt of the economic agents of a country can be divided into public debt (also known as sovereign debt) and private debt. Household debt is a subset of private debt. Other components of private debt are as follows: corporate debt (debt issued by non-financial firms) and bank debt (debt issued by financial institutions).

The financial crisis of 2007–2009 started with defaults related to sub-prime mortgages in the United States, that is, mortgages granted to borrowers with a low credit rating. For these mortgages the probability that the borrower will default on their mortgage is higher than average. The crisis spread through financial markets and across national borders because of securitisation: payments relating to these mortgages were packaged together and sold in the form of mortgage-backed securities (MBS). These MBS were divided into Senior tranches, which had a first claim on cash flows from the mortgages; Mezzanine tranches had a secondary claim; and Equity tranches had a residual claim on the cash flows. Equity tranches were also repackaged in a similar way, into Senior, Mezzanine and Equity tranches. So it was possible for an investment bank to sell what looked like a secure MBS with a senior claim to cash flows, when in fact it was a senior claim to an equity tranche, on a sub-prime mortgage.

Many financial institutions bought these MBS because the credit rating agencies (Moody's, and Standard and Poor's) gave the securities relatively high credit ratings. These high credit ratings were partly due to faulty statistical models (Benmelech and Dlugosz, 2010) and to a conflict of interest between credit agencies and the investment banks (securitisers) that were proposing the structure of the mortgage pools (White, 2010).

The statistical models employed to assess the probability of default on MBS did not consider adequately the correlation in the defaults of mortgages and the exposure of the value of MBS to macroeconomic shocks. Since all borrowers in the US were subject to the macroeconomic shocks, the default correlation was much higher than that assumed by the rating models (Benmelech and Dlugosz, 2010). In effect, the ratings agencies estimated the probability of default of each MBS in isolation, without looking at the market as a whole.

The conflict of interest was a result of two features of the MBS rating business (White, 2010):

- The banks engaged in securitisation earn larger fees if the MBS is given a higher rating.
- The 'issuer pays' model implies that the credit agencies receive a fee from the investment banks engaged in securitisation, and the banks can threaten to move their securitisation business to another credit rating agency if the rating received is too low.

In the period leading up to 2007 house prices in the US increased significantly, due to a policy of low interest rates. However, once interest rates were increased, repayments on mortgages were not made, house prices fell, and householders defaulted on their mortgages. The value of the mortgage-backed securities collapsed. One of the consequences of this event was a widespread reduction in lending to households and firms by banks.

However, the problems related to sub-prime mortgages and MBS were part of a much bigger issue: household leverage increased sharply in the years leading to the crisis.

Mian and Sufi (2011) point out that from 2002 to 2007 the household debt-to-income ratio grew at a much higher pace than in the previous 25 years, due to favourable lending conditions. Mian and Sufi (2011) stress that this increase in leverage:

- was not accompanied by an increase in corporate leverage, and
- was due not only to new homebuyers, but also to existing home owners.

How and why did existing home owners increase their leverage?

Home owners in the US increased their leverage via *home equity-based borrowing*. A Home Equity Loan (HEL) allows a home owner to obtain money from a bank using the equity of their home as collateral. The loan amount depends on the value of the property, and home-owners exploited the strong increase in house prices, accompanied by low interest rates, in 2002–2007 to increase their leverage. As the next reading shows, these loans were not necessarily used to purchase properties, or to pay down existing consumer debt, but rather to fund purchases of consumer goods. Because of the crisis, and the consequent drop in house prices, many home owners that borrowed aggressively using HEL defaulted. This played an important role in the contraction in economic activity during the crisis. In particular, Mian and Sufi (2011) suggest that defaults relating to HEL represented 39% of total defaults in the US during the crisis.

Reading 1.4

Mian & Sufi (2011) 'House prices, home equity-based borrowing, and the US household leverage crisis'. *American Economic Review.*

Please read the paper by Mian and Sufi (2011), especially the introductory section, pages 1–6, and the Conclusion section on page 30. Figures 1 to 3, towards the end of the document, are also interesting. You should concentrate on the questions the authors are attempting to answer, and their main findings.

Make a note about the following issues examined in the paper:

- the main reason for US homeowners to use HEL, according to the findings of the paper
- the relationship between housing supply elasticity and house prices
- the relationship between the increase in household debt from 2002 to 2006 and HEL.

In the paper MSA refers to metropolitan statistical area.

1.5 Household Risk Preferences

So far in this unit you have examined patterns of household investments in tangible assets, including holdings of risky and less risky financial assets. In this section you will develop a deeper understanding of the factors that influence the way households allocate their wealth. You will consider household preferences regarding risk, and examine the methods available to observe and estimate these preferences.

1.5.1 Risk-averse, risk-neutral, and risk-loving investors

First, we make a distinction between investors who are averse (or who avoid) risk, investors who are neutral to risk, and investors who love or prefer risk. A risk lover is a person who will gamble even when a mathematical calculation shows the odds are unfavourable. A person who is risk averse would require very favourable odds to make a bet. A risk neutral person is concerned that they, on average, make a profit, not whether any particular bets are successful (Rutherford, 2012).

To demonstrate the difference between risk-neutral, risk-averse, and risk-loving investors, we can use an example where individuals are faced with choosing between two scenarios: a scenario involving a certain outcome, and a scenario involving a gamble. By gamble, we mean a choice which involves uncertain outcomes.

For example, imagine a friend presents you with a lottery ticket which has the following possible outcomes:

- there is an 80% probability that you will not win any money
- the probability of winning £100 is 10%
- the probability of winning £200 is 7%
- the probability of winning £700 is 3%

At what price would you be willing to sell this ticket?

In this case, the expected monetary value (EMV) of the gamble, or the expected value of the possible outcomes of the gamble, expressed in monetary terms is:

$$EMV = 0 \times 0.8 + 100 \times 0.10 + 200 \times 0.07 + 700 \times 0.03 = £45$$

This is the sum of the values in each possible outcome, with each value weighted by the probability of the outcome occurring.

If you are risk neutral, you would be willing to sell this ticket for £45. You are equally happy to receive £45 with certainty, or be exposed to the risks of the gamble which provides an expected value of £45. If this is the case, for you the Certainty Equivalent (CE), or the certain amount that is equally preferred to the gamble is £45.

If you are risk averse, on the other hand, you will ask for a price lower than £45. Why is that? If you are risk averse you would rather receive a lower sum of money, with certainty, than be exposed to the risk involved in the gamble, even if this means you deny yourself the possibility of winning £100, £200, or £700.

Finally, if you are risk loving, you will ask for a price higher than £45 to sell the ticket. You would require higher compensation to give up the possibility of earning £100, £200, or £700 (or nothing).

Another way of looking at this is to ask what is the premium you require to compensate you for the perceived risk? The risk premium (RP) is:

$$RP = EMV - CE \tag{1.6}$$

In this case:

- Risk-averse households require compensation for risk, so $RP > 0$ (for example, if $CE = 30$, then $RP = 45 - 30 = 15$);
- Risk-neutral households are indifferent between risk and certainty, $RP = 0$ ($CE = 45$, $RP = 45 - 45 = 0$);
- Risk-loving (or risk-seeking) households actually like risk, and in a sense need to be compensated for certainty, so $RP < 0$ (for example, if $CE = 50$, then $RP = 45 - 50 = -5$).

Utility functions

To understand how risk preferences can influence investment decisions we need a way to model risk preferences more analytically. This involves specifying functional forms for the preferences. These functional forms should be usable and realistic, but they will also require some simplifying assumptions. If you have studied Economics or Finance then you will already be familiar with utility functions, and the concept of marginal utility. Utility is the satisfaction derived from an activity (Rutherford, 2012), which can be consumption, or wealth, or income. Marginal utility is the amount of satisfaction obtained from one additional unit of the activity.

Figure 1.1 shows examples of utility functions, with respect to wealth, for three hypothetical households: a risk-averse household, a risk-neutral household, and a risk-seeking household. Figure 1.2 shows the corresponding marginal utility functions. The data generating the graphs is shown in Table 1.2.

Figure 1.1 Utility functions of wealth

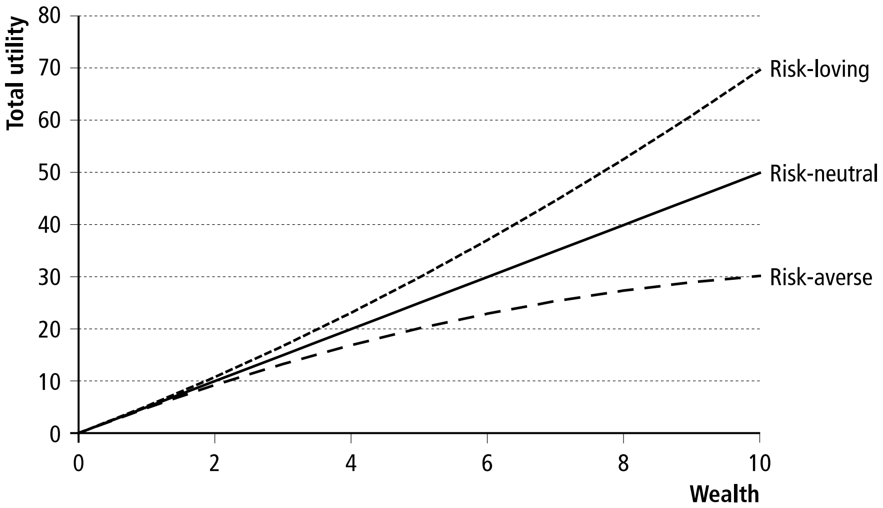


Figure 1.2 Marginal utility functions of wealth

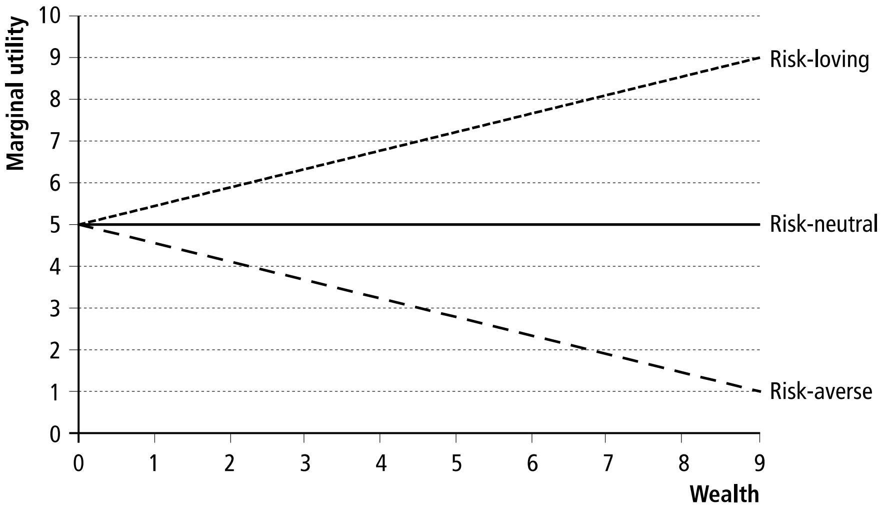


Table 1.2 Wealth, utility, marginal utility, and risk preferences

	Risk neutral		Risk averse		Risk loving	
Wealth	Total Utility	Marginal Utility	Total Utility	Marginal Utility	Total Utility	Marginal Utility
0	0		0		0	
1	5	5	4.8	4.8	5.2	5.2
2	10	5	9.2	4.4	10.8	5.6
3	15	5	13.2	4	16.8	6
4	20	5	16.8	3.6	23.2	6.4
5	25	5	20	3.2	30	6.8
6	30	5	22.8	2.8	37.2	7.2
7	35	5	25.2	2.4	44.8	7.6
8	40	5	27.2	2	52.8	8

9	45	5	28.8	1.6	61.2	8.4
10	50	5	30	1.2	70	8.8

Study Note 1.2

Figures 1.1 and 1.2 are generated according to the following functions for $u(w)$, where w is wealth and $u(w)$ is the utility of wealth. For the risk-neutral household the utility function is

$$u(w) = 5w \tag{1.7}$$

This function is linear in wealth: if wealth increases by 1 unit, utility increases by 5 units.

For the risk-averse household the utility function in Figure 1.1 is generated by the quadratic function

$$u(w) = 5w - 0.2w^2 \tag{1.8}$$

This function suggests that utility increases as wealth increases, but not by as much as for the risk-neutral household. For a one-unit increase in wealth, total utility increases by

$$\frac{du(w)}{dw} = 5 - 0.4w \tag{1.9}$$

For the risk-loving household the utility function in Figure 1.1 is

$$u(w) = 5w + 0.2w^2 \tag{1.10}$$

This function is also quadratic, and utility increases as wealth increases, but by more than for the risk-neutral household. For a one-unit increase in wealth, total utility increases by

$$\frac{du(w)}{dw} = 5 + 0.4w \tag{1.11}$$

Quadratic utility functions have the advantage that they are relatively easy to understand. However, for some ranges of wealth they may be unrealistic. In particular, they do not necessarily increase monotonically with wealth. As you can see for the total utility function for the risk-averse household in Figure 1.1, utility increases as wealth increases up to a maximum point (reached at $w = 12.5$), and for levels of wealth above this point, utility decreases.

From Figure 1.1 you can see that risk-neutral households have linear utility functions of wealth. In Figure 1.2 the marginal utility for risk-neutral households (that is, the first derivative of the utility function) is constant. Risk-averse households have concave utility functions (in particular, we have used quadratic functions), and decreasing marginal utility functions. By concave we mean that the function curves towards the horizontal axis as wealth increases (as wealth increases, the slope of the total utility function becomes less steep). Risk-seeking households have convex utility functions, and increasing marginal utility functions. By convex, we mean the function curves away from the horizontal axis as wealth increases.

For risk-averse households, the curvature of the utility function is related to the level of risk aversion. The higher the curvature, the more risk averse the household is.

Review Question 1.5

Please take a moment to think about the concepts of risk-neutral, risk-averse, and risk-loving households. Also consider the depictions of total utility and marginal utility, with respect to wealth, shown in Figures 1.1 and 1.2.

For example, do you consider yourself to be neutral with respect to risk, averse to risk, or are you a risk seeker? Do you think the utility functions shown here adequately and realistically capture the notions of risk aversion, risk neutrality, and risk loving? And can you imagine how these functions might be useful for modelling household financial decisions?

1.5.2 Risk aversion and portfolio allocation

In Unit 2 you will examine how households allocate their wealth between risk-free assets and a portfolio of risky assets. In the remainder of this unit you will consider how risk preferences affect the decision to allocate investments between risky assets and assets that are considered to be risk-free. And you will examine the methods available to quantify households' risk preferences. These sections make use of a number of results from economic and finance theory. You need to be able to understand, interpret and apply these results, but they are studied in more detail in the modules *Corporate Finance* and *Risk Management: Principles and Applications*.

As you have seen, a household's preferences towards risk will determine the kind of premium they require to hold a risky asset – the risk premium. A fundamental theorem of classical financial economics theory states that, as long as certain assumptions are satisfied[2], the optimal combination of risky assets (the risky portfolio) for an investor is actually independent of the investor's preferences towards risk and return. However, the degree of risk aversion of an individual affects the allocation between a risk-free asset and the risky portfolio. The risky portfolio is also known in the literature as the 'market portfolio'.

You may already be familiar with the Capital Asset Pricing Model (CAPM), which relates the risk premium on an individual risky asset to the risk premium on the market:

$$E\left(R_j\right) = R_F + \beta_j\left[E\left(R_M\right) - R_F\right] \tag{1.12}$$

In equation (1.12):

$E\left(R_j\right)$ is the expected return on security j

[2] These assumptions are as follows: absence of inflation, taxes and other transaction costs; investors can borrow and lend at the risk-free rate; assets are infinitely divisible; investors are price-takers and risk-averse; investors have homogenous expectations in terms of mean and covariance matrix of security returns; investors have the same one-period investment horizon; capital markets are in equilibrium.

R_F is the return on a risk-free security

β_j is the beta for company *j*, and measures how the return of security *j* varies with the market return

$E(R_M)$ is the expected return on the market portfolio

$E(R_M) - R_F$ is the equity market risk premium, also called simply the risk premium or market excess return.

In words, the capital asset pricing model says that the expected return on a security is equal to the risk-free rate, plus the systematic risk of the security (measured by the security's beta coefficient), multiplied by the equity market risk premium.

Guiso and Sodini (2013: 1425–26) denote $\left[E(R_M) - R_F\right]$ as Er_i^e.

The subscript *i* refers to a particular investor, in the same way as *j* above refers to a particular security. In theory, the expected risk premium may differ for different investors. However, if we assume that all investors have the same expectations with respect to the distribution of future returns, we can write:

$$Er^e = \left[E(R_M) - R_F\right] \tag{1.13}$$

Differences in portfolio allocations across households depend on their risk attitudes: households that are more risk averse will tend to invest a larger proportion of their wealth in the risk-free asset. Vice versa, households that are less risk averse will tend to invest a larger proportion of their wealth in the market portfolio. A key issue in the household finance literature is the relationship between wealth and degree of risk aversion. In section 1.5.1 you considered the differences between the utility function of risk-averse, risk-neutral, and risk-loving investors. However, risk-averse investors can display different attitudes to risk, as their wealth changes.

Is it possible to provide more precise definitions of risk aversion, which would enable us to predict household's attitudes to risk as their wealth increased, and also enable us to estimate measures of household risk preferences? We start by making a distinction between relative risk aversion and absolute risk aversion.

Relative risk aversion refers to the proportion of the household's wealth held in a risky portfolio (and the proportion held in a risk-free asset). If, for example, a household has constant relative risk aversion, then as their wealth increases, they would choose to hold a constant proportion of their wealth in a risky portfolio (and a constant proportion in a risk-free asset).

Absolute risk aversion refers to the absolute (or dollar) amount of a household's wealth held in a risky portfolio. So, if a household has constant absolute risk aversion, as their wealth increases they would hold a constant value in a risky portfolio.

You saw earlier that risk aversion can be represented graphically by the shape of the utility function. The precise definition of the measures of relative and absolute risk aversion derive from the measure of concavity of the utility function.

The coefficient of relative risk aversion (also named the Arrow-Pratt measure of risk aversion) can be formally defined as follows:

$$\gamma = \frac{-wu''(w)}{u'(w)} \tag{1.14}$$

where:

w is the level of wealth

$u\ (w)$ is the utility function of wealth

$u'(w)$ is the first derivative of the utility function

$u''(w)$ is the second derivative of the utility function.

What does equation (1.14) mean? The first derivative of a function is the slope of the function. In the three utility functions shown in Figure 1.1 the slope is positive (over the range of w displayed): for an additional unit of wealth, total utility increases. The second derivative measures what happens to the slope, for an additional unit of wealth.

Review Question 1.6

What happens to the slope of the utility function for the risk-averse household in Figure 1.1 as wealth increases?

For the risk-averse household in Figure 1.1 the slope of the total utility function decreases as wealth increases – the function becomes less steep. Equivalently, you can see in Figure 1.2 that the marginal utility of wealth declines as wealth increases. So for risk-averse households we have

$$u'(w) > 0 \qquad \text{and} \qquad u''(w) < 0 \qquad \text{so} \qquad \frac{-wu''(w)}{u'(w)} > 0$$

The coefficient of relative risk aversion is positive for risk-averse households.

Review Question 1.7

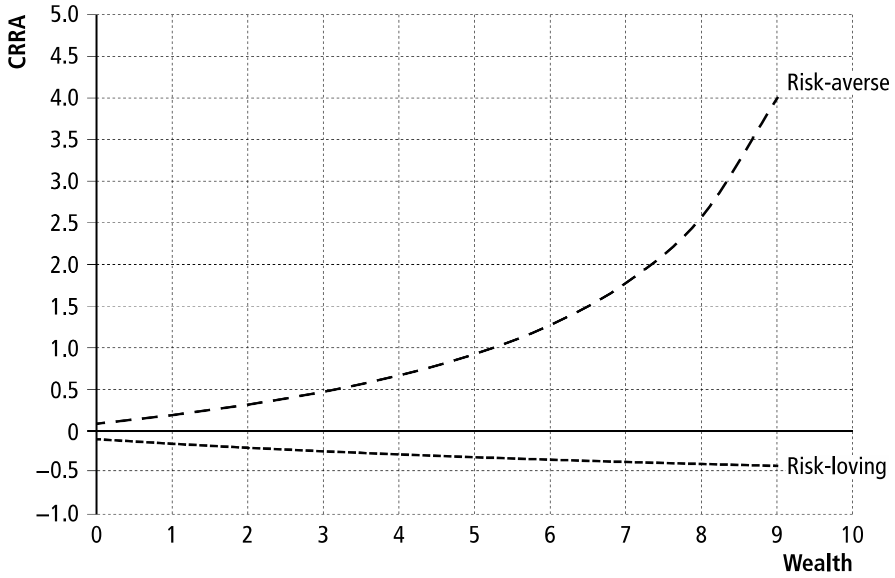
And what happens to the slope of the utility function for the risk-loving household in Figure 1.1 as wealth increases?

For the risk-loving household the slope of the total utility function increases as wealth increases. So for risk-loving households we have

$$u'(w) > 0 \qquad \text{and} \qquad u''(w) > 0 \qquad \text{so} \qquad \frac{-wu''(w)}{u'(w)} < 0$$

The coefficient of relative risk aversion is negative for risk-loving households. Figure 1.3 plots the coefficient of relative risk aversion for the utility functions of the risk-averse and risk-loving households shown in Figure 1.1.

Figure 1.3 Coefficient of relative risk aversion



As predicted, the coefficient of relative risk aversion is positive for the risk-averse households. It also increases as wealth increases. This is another consequence of using a quadratic utility function.

Review Question 1.8

What will be the coefficient of relative risk aversion for risk-neutral households?

Risk-neutral households are not averse to risk, and neither do they seek risk. The coefficient of relative risk aversion is zero. Formally, the second derivative of the utility function is zero – the slope of the utility function does not change as wealth changes.

The coefficient of absolute risk aversion is

$$A = \frac{-u''(w)}{u'(w)} = \frac{\gamma}{w} \tag{1.15}$$

Therefore, given a particular coefficient of absolute risk aversion, A, we can obtain the coefficient of relative risk aversion, γ, by multiplying A by the level of wealth, w. Vice versa, given a particular coefficient of relative risk aversion, γ, we can obtain A by dividing by w.

In theory, nothing prevents investors from being risk-neutral or even risk-loving. In fact, many theoretical models in the economics literature consider risk-neutral investors.

As noted above, if the utility functions of individuals display constant relative risk aversion (CRRA), the risky proportion of their portfolios should be unrelated to their wealth. In other words, if poor households invest 20%

of their total wealth in risky assets, and 80% of their wealth in risk-free assets, rich households should do the same.

Review Question 1.9

Consider the following scenario.

- The poorest households hold 80% of their portfolio in the risk-free asset and 20% in risky assets.
- Middle-class households hold 50% of their portfolio in the risk-free asset and 50% in risky assets.
- The richest households hold 20% of their portfolio in the risk-free asset and 80% in risky assets.

Do these households display constant relative risk aversion?

In this case, we would say that households have utility functions with decreasing relative risk aversion (DRRA): as their wealth increases, they are willing to allocate a larger portion of their wealth in risky assets. If we observed the opposite pattern, that richer households tended to invest a larger proportion of their wealth in the risk-free asset than poorer households, then household preferences would display increasing relative risk aversion (IRRA).

1.5.3 Measuring risk aversion among households

Can we say whether households are risk averse, or whether their utility functions are consistent with CRRA, IRRA, or DRRA? These are empirical questions: we cannot establish *a priori* what type of utility functions households have, and to answer this question we need to implement a statistical analysis of data related to households' financial choices.

How can we empirically measure the degree of risk aversion of households? There are two methods to infer the degree of risk aversion of households:

- the revealed risk preference approach
- the elicited risk preference approach.

The revealed risk preference approach is based on data related to *actual* investor behaviour, such as stock market returns. The elicited risk preference approach is based on surveys or experiments.

The elicited risk preference approach suffers from several drawbacks. For example, in surveys there is the possibility that people may lie or report wrong information accidentally. Experiments can also be problematic, because during the lab session people are usually given small amounts of money to play with. Therefore, they may behave differently when large sums of *their own money* are at stake[3]. However, researchers are aware of

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[3] Monetary incentives are considered very important in experimental economics. However, in the psychology literature researchers argue that monetary incentives can lead to poor performance of the experiment because they can undermine the intrinsic motivation to

these issues and can try to address them (for example, by increasing the stakes in lab experiments). Moreover, even the revealed risk preference approach can lead to measurement errors due to the need to make some assumptions. For example, using SCF data to determine the level of risk aversion of US households requires making assumptions about the composition of the risky portfolio held by households.

1.5.4 The revealed risk preference approach

The revealed risk preference approach is based on a method called 'calibration'. This process works as follows. Imagine that you believe a particular economic model governs the relationship between two or more economic variables. For example, in the CAPM the expected return on a security is related to the expected return on the market portfolio, as in equation (1.12) above.

To calibrate the model, we seek to find the model parameters that produce the best fit to the actual data. You will see that Guiso and Sodini (2013: 1426) employ the formula

$$\gamma_i = \frac{Er_i^e}{\omega_i \sigma_i^2} = \frac{\left[E\left(R_M\right) - R_F\right]}{\omega_i \sigma_i^2} \tag{1.16}$$

where:

ω_i is the optimal weight for investor *i* in risky assets

σ_i is the volatility of returns on risky assets

γ_i is the coefficient of relative risk aversion, that is, the variable we intend to measure.

To estimate γ_i Guiso and Sodini (2013) assume that Er_i^e and σ_i are the same for all investors. These two variables are easily observable from historical stock market prices. The historical expected risk premium is 6.2% and estimated volatility of returns is 20%. So two out of the three variables on the right-hand side of equation (1.16) are easily retrieved. What about the proportion of financial wealth held in risky assets, ω_i?

Data on this variable is available in the SCF database for the US. In particular, this database allows us to capture variation in the proportion of financial wealth held in risky assets across different households (therefore, it is *not* the same for all households).

Once we compute ω_i for all households in the database, we can estimate the respective measure of risk aversion, γ_i. The distribution of the estimated coefficient of relative risk aversion is reported in Table 3 of Guiso and Sodini (2013), which is in the next reading. For example, if the risky assets account

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perform certain tasks required in the experiment, and can also lead to an excess of effort (Meloy, Russo and Miller, 2006).

for 10% of the overall household portfolio, we will have an estimated coefficient of relative risk aversion equal to 15.5:

$$\gamma_i = \frac{Er_i^e}{\omega_i \sigma_i^2} = \frac{0.062}{0.1 \times 0.2^2} = 15.5$$

1.5.5 The elicited risk preference approach

The elicited risk preference approach is based on laboratory or field experiments as well as household surveys. Both qualitative and quantitative indicators can be used to estimate the coefficient of risk aversion.

In the case of *qualitative indicators*, the questions require the respondents to choose between two or more alternative sentences describing their attitude to risk, or to give a 'grade' (*eg* from one to ten) to describe how comfortable they feel taking risk.

For example, a researcher may ask a question which requires a binary choice based on two different definitions of risk: one that is likely to be chosen by more risk-averse households, and one that is likely to be chosen by more risk-tolerant households. The first sentence could describe risk as a source of potential financial losses, and the second sentence could describe risk as a source of potential financial gains. Respondents that are more risk averse should choose the first sentence, and respondents that are more tolerant of risk should choose the second sentence. Therefore, the overall proportion of respondents choosing the first sentence is likely to be higher than 50% if households tend to be risk averse.

As reported in section 3.1.2 of Guiso and Sodini (2013), a possible question asking the respondent to provide a 'grade' could be: 'How much do you feel prepared to take on financial risk?'. Assume that the available grades are: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10. In this case, we would expect 5 to be the grade most frequently chosen by respondents. However, this question talks about risk only. What happens if the respondents are told that a higher level of financial risk may lead to a higher expected return? One of the questions in the SCF attempts to elicit the degree to which households are willing to take on a higher level of financial risk if expected return increases with financial risk. Even in this case, it appears that most respondents would prefer average or no financial risk, supporting the view that individuals tend to be risk averse.

Quantitative indicators assume that households are utility maximisers: they choose the alternative which ensures that their utility of wealth is as high as possible. To elicit the degree of risk aversion, a researcher can ask the respondents to choose between scenarios, similar to the lottery ticket example presented in section 1.5.1.

Note that you can identify a respondent's risk premium by asking what price they would be willing to *pay* for the lottery ticket, rather than the price at which they are willing to sell it. A similar case is considered in Guiso and

Paiella (2008), who use data from Survey of Household Income and Wealth (SHIW, Bank of Italy, 1995).

In this case, instead of a lottery ticket the question involves a security which needs to be bought at a particular price. The respondents are told that buying the security will lead to two potential outcomes: a gain of €5,000 or a loss of all the capital invested (that is, the price you are willing to pay). Both outcomes (win or lose) have equal probability (50%). Therefore, in this case the expected monetary value is

$$EMV = 0.5 \times 5,000 + 0.5 \times (-P) = 0.5(5,000 - P)$$

where P is the price the respondent is willing to pay for the security. Note that if you do not buy the security, you do not receive any money, and therefore the certainty equivalent $CE = 0$. Therefore, in this case

$$RP = EMV - 0 = EMV$$

Imagine you are willing to pay €5,000 for the security. In this case

$$EMV = 0.5(€5,000 - €5,000) = 0 \text{ and } RP = EMV - CE = 0 - 0 = 0$$

In this case you are risk-neutral.

Suppose instead you are willing to pay more than €5,000. If, for example, you are willing to pay €5,500, then

$$RP = EMV = 0.5(€5,000 - €5,500) = -€250$$

A negative risk premium suggests you are risk-loving.

Finally, suppose instead you are willing to pay less than €5,000. For example, suppose you are prepared to pay €4,500. Then

$$RP = EMV = 0.5(€5,000 - €4,500) = €250$$

The risk premium is positive; therefore you are risk-averse.[4]

Once you have obtained CE for each household, you need to make assumptions about their utility function to retrieve their level of absolute risk aversion. If you have information on the household's wealth, you can then retrieve the coefficient of relative risk aversion, denoted above as γ_i, by multiplying the coefficient of absolute risk aversion by total wealth.

An alternative way of eliciting the degree of risk aversion using quantitative indicators is to ask respondents to choose between keeping their current job (and related salary) for their entire working life, and a gamble involving

[4] Note that the question asked in this survey is a bit ambiguous. Some respondents may have interpreted the question as follows: if I win, I will still lose the price of the security, P. This is one of the main problems with the elicited risk preference approach: some respondents may not understand the question correctly, or the question may be open to different interpretations.

uncertain labour income (which could be either higher or lower than their current salary).

Quantitative measures of risk aversion such as those described above may be biased because individuals tend to be less risk averse when they have to choose among hypothetical scenarios: people may be less inclined to choose alternatives that may lead to losing large amounts of real money.

1.5.6 Determinants of household risk preferences

While households tend to be risk averse, there is a lot of diversity in their risk attitudes. How can we explain this finding? What are the factors underlying different degrees of risk aversion among households? These are the questions we seek to answer in this sub-section.

As you saw in the reading in section 1.3.2, a potential explanatory factor for risk preferences is wealth, in particular financial wealth. It seems plausible that individuals tend to increase the amount of money they are willing to invest in risky assets as their wealth increases. For example, if you happen to win £1 million in a lottery, it is likely you will invest part of that money in risky assets. However, it is unclear if the *percentage* of wealth households are willing to invest in risky assets also changes as wealth increases. For example, individuals may display utility functions with constant relative risk aversion, meaning that the percentage of wealth invested in risky assets does not change as wealth increases. In other words, individuals with CRRA do not increase the portfolio share assigned to risky assets if their wealth increases, and likewise they do not decrease the share of their portfolio assigned to risky assets if their wealth decreases.

A simple way of estimating the role of financial wealth in shaping risk preferences is to consider the following equation:

$$\gamma_i = \frac{\lambda_i}{W_i^{\eta}} \tag{1.17}$$

where:

- γ_i is, as before, the coefficient of relative risk aversion
- λ_i is an individual 'fixed effect' capturing individual characteristics that we cannot observe in the data (for example, you may not have data on the level of intellectual ability of each household)
- W_i is financial wealth
- η is a parameter influencing the effect of wealth on relative risk aversion.

The key parameter of interest here is η. In particular, if $\eta = 0$, then $W_i^{\eta} = 1$, and risk aversion does not change with wealth. If $\eta > 0$, then as financial wealth increases, the coefficient of risk aversion decreases, and households display utility functions with diminishing relative risk aversion. For example, consider $\eta = 0.5$ and $\lambda_i = 1$. If $W_i = 0.6$,

$$\gamma_i = \frac{1}{0.6^{0.5}} = 1.291$$

Now assume wealth doubles. Then

$$\gamma_i = \frac{1}{1.2^{0.5}} = 0.913$$

With this specification, as wealth increases, the degree of relative risk aversion decreases.

Other factors that may affect household risk preferences are:

- background risk
- borrowing or credit restraints
- consumption commitments
- demographics
- past experiences
- IQ, personality, and genetic factors.

As you saw earlier in the unit, background risk refers to any kind of risk that cannot be insured or traded. Therefore households cannot reduce background risk by, for example, diversifying their asset portfolio. Households with a higher degree of background risk may be less willing to take on some other type of financial risk.

Borrowing or credit constraints refer to the possibility that some households may be unable to borrow funds in the future. Borrowing constraints may lead to a higher degree of risk aversion and a smaller allocation of risky assets in their financial portfolio. For example, imagine that in the future a household's unexpected medical expenses can be covered either by selling financial assets, which can include both risk-free and risky financial assets, or by borrowing funds from a bank. If the household expects that they will not be able to borrow from a bank in the future (perhaps because they are already highly leveraged), they can only rely on their financial assets. In this case, they are more likely to reduce the size of the risky allocation in their financial portfolio. Typically, this means that they are more likely to hold their financial assets as cash or invest in risk-free bonds, and less likely to invest in stocks. On the contrary, if a household does not face borrowing constraints, they may be more willing to increase the share of their financial portfolio invested in risky assets.

Regarding consumption commitments, many households buy durable goods (for example, cars) that imply future repayments. Households with such future financial commitments are more likely to be more prudent in their portfolio choices, because they need to ensure that they will have the cash needed to make these payments in the future.

Characteristics such as gender, age, and education are likely to affect the degree of risk aversion of a household. The research in this area has identified some regularities based on age and gender. For example, experimental research shows that men tend to be less risk averse than women (among others, Holt and Laury, 2002; and Fehr-Duda, Gennaro and Shubert, 2006) and younger people tend to be less risk averse than older people (among others, Dohmen *et al*, 2011). Guiso and Paiella (2008) also find that risk aversion and age are positively correlated using survey data from the Bank of Italy. However, the evidence for some of these demographic traits is mixed. In particular, while more educated individuals tend to be less risk averse, a recent empirical study based on the Swedish Twin Registry finds that the degree of financial risk taken by households is uncorrelated with the level of education of an individual (Calvet and Sodini, 2014).

Past experiences can also influence household attitude to risk. Households tend to have a smaller share of their financial portfolio invested in stocks if in the past the stock market was under-performing. This empirical finding is plausibly linked to the reaction of individuals to traumatic experiences. For example, being bitten by a dog as a child can make an individual more inclined to distrust dogs.

Finally, some researchers have examined links between risk aversion and IQ, personality, and genetic factors. Laboratory studies examining the IQ and risk aversion of students have provided evidence that individuals with a higher IQ tend to be less risk averse when making financial decisions. Regarding personality, people who are more anxious or depressed tend to display a higher degree of risk aversion. Finally, the empirical studies involving twins also allow researchers to examine the extent to which risk aversion of an individual depends on genetic features.

Empirical studies also suggest that the degree of risk aversion can change over time for the same household. For example, the 2007–09 financial crisis led to an increase in the degree of risk aversion.

Please note that in the next reading from Guiso and Sodini (2013) the authors use the term 'risky share' to mean the proportion of a household's financial wealth (or of their overall financial portfolio) that is invested in risky assets. In the reading 'risky share' does not mean the share or stock of a particular company.

Reading 1.5

Guiso & Sodini (2013) 'Household finance: An emerging field'. *Handbook of the Economics of Finance*.

Please read carefully the start of section 3 and section 3.1 in Guiso and Sodini (2013), pages 1424–32. Make a note of the following important points:

- What does the proportion of financial wealth invested in risky assets for US households reveal about the coefficient of relative risk aversion?
- The main characteristics of qualitative and quantitative measures of elicited risk aversion, in particular with respect to their predictive power of observed financial choices.

Also please read section 3.2 in Guiso and Sodini (2013). Make a note of the following:

- How can you determine the wealth elasticity of the average portfolio's risky allocation using a revealed risk preference approach?
- Why do panel data models help allow for unobservable factors when investigating the impact of financial wealth on the degree of risk aversion?

- What is the main advantage of using data on portfolios held by twins to measure the elasticity of the proportion of wealth invested in risky assets with respect to financial wealth?

Earlier in the unit you saw how preferences can be revealed if we use the relation

$$\gamma_i = \frac{Er_i^e}{\omega_i \sigma_i^2} \tag{1.18}$$

If we assume that the expected risk premium and the volatility of returns on the risky portfolio are the same for all individuals, and we use historical values for these measures, then the only variable changing across households on the right-hand side of this equation is the proportion of financial wealth held in risky assets. Table 3 in the reading shows the distribution of the coefficient of relative risk aversion revealed by this method. The percentiles in Table 3 refer to the revealed coefficient of relative risk aversion (and not to the percentiles or deciles of gross tangible wealth used to organise the data in Figures 3 through 15 in the readings).

You will have seen from Table 3 that this method reveals a wide range of values, from 1.6 for the one per cent of households with the lowest aversion to risk (and by implication, the highest proportion of financial wealth invested in the risky portfolio); to 136.4 for the one per cent of households with the highest aversion to risk (and by implication, the lowest proportion of financial wealth invested in the risky portfolio); and a median value of 3.5.

To reinforce and test your understanding of preferences towards risk, and risk aversion, please answer the following question.

Review Question 1.10

Suppose households have a logarithmic utility function with respect to wealth

$$u(w) = \ln(w) \tag{1.19}$$

where $\ln$ is the natural logarithm. What is the Arrow-Pratt coefficient of relative risk aversion? Comment on your result.

Tip 1.1

For the function $y = \ln(x)$ (1.20)

the first derivative of y with respect to x is $y'(x) = \frac{1}{x}$ (1.21)

and the second derivative is $y''(x) = \frac{-1}{x^2}$ (1.22)

The coefficient of relative risk aversion is

$$\gamma = \frac{-wu''(w)}{u'(w)} \tag{1.14}$$

For the logarithmic utility function this is

$$\gamma = \frac{-w\left(-1/w^2\right)}{1/w} = -w^2\left(\frac{-1}{w^2}\right) = 1$$

The logarithmic utility function is concave, and demonstrates risk aversion. The logarithmic utility function also has the property of constant relative risk aversion. Figure 1.4 shows a logarithmic utility function, and Figure 1.5 shows the corresponding marginal utility function.

Figure 1.4 Logarithmic utility function – total utility

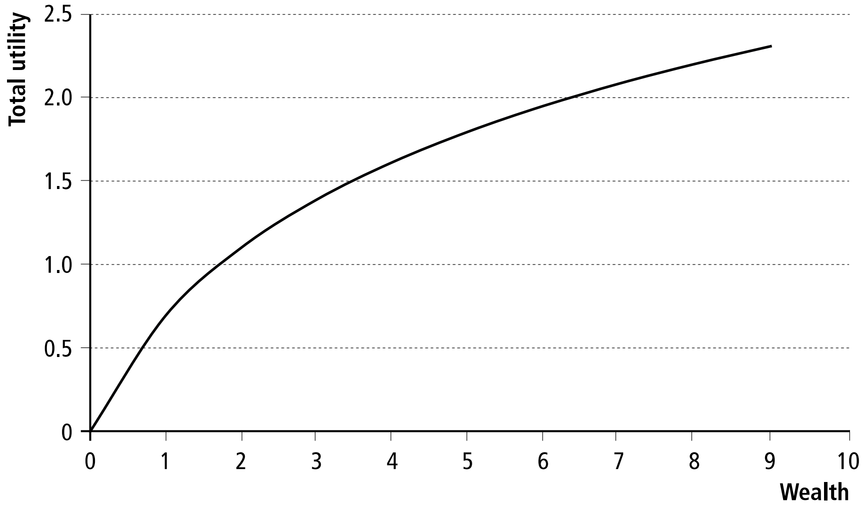
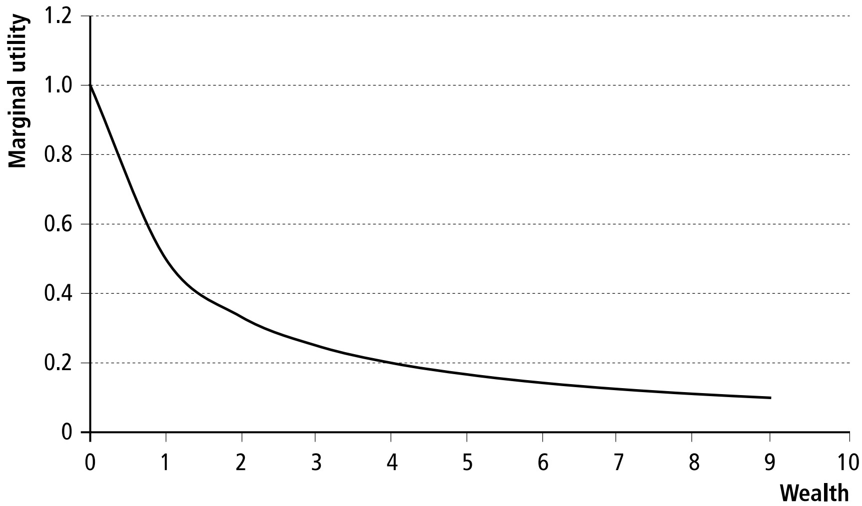


Figure 1.5 Logarithmic utility – marginal utility



1.6 Conclusion

In this unit you have studied the key features of household assets and liabilities, and how attitudes towards risk can affect household portfolio choices.

You began by considering human capital. Human capital is a type of asset that is hard to value because it is intangible and non-tradable. You saw that it is possible to estimate the value of human capital by discounting the expected values of labour income that will be received in future years. Human capital is risky, because future labour income may increase or decrease unexpectedly. In addition, you saw how human capital depends on demographic characteristics such as age and the level of education of the household. However, for most households, labour income is likely to constitute the largest source of income over their lifetime. Also, for many households human capital is likely to constitute the most significant form of wealth they will possess. So, although human capital is intangible, it is still likely to influence household decisions relating to borrowing, saving and investment. Also, as the household ages, the division of total wealth between intangible wealth and tangible wealth will also evolve, which has implications for the financial decisions made by each household.

You also considered household tangible assets, including real assets (such as housing) and financial assets (for example, stocks and bonds). Financial assets tend to be more liquid than real assets, but they do not allow direct control over the assets that generate income. In fact, households tend to be minority shareholders or small bond-holders of companies. Therefore, they cannot influence effectively the management of these companies. Financial assets, in particular those whose value derives from the value of another asset (financial derivatives), can have very complex payoff structures: it is hard to understand under what circumstances these assets may generate positive or negative cash flows for the household. The composition of household portfolios can be very diverse. Cultural factors, as well as demographic and institutional factors (such as stock market development) can affect the way households allocate their wealth in different types of assets. In this section you also analysed the allocation of household wealth between real assets and financial assets, and between different types of financial assets. In particular, you saw how this allocation varied between households, depending on the amount of total tangible wealth the households possess.

In section 1.4 you examined household liabilities, and the circumstances in which household leverage can affect economic activity and the stability of the financial system. You considered the main types of liabilities, such as mortgages, credit cards, and student loans. In Unit 4 you will explore in greater depth the features of some of these financial instruments.

Section 1.5 introduced the concept of household risk preferences. You examined the concepts of relative risk aversion and absolute risk aversion, and assessed how researchers can measure risk aversion using the revealed risk preference approach and the elicited risk preference approach. You will reinforce and develop your understanding of risk preferences in Unit 2, where you will investigate in greater depth how households allocate their wealth in their portfolio, and under what circumstances they decide to change the composition of their portfolio (known as portfolio rebalancing).

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