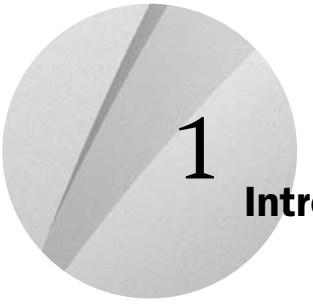

1 Introduction

Learning outcomes

In this chapter, you will learn how to

- outline key stages in the construction of econometric models;
- illustrate the principles of model building in real estate;
- explain the relationships and variables researchers most frequently model and forecast in the real estate market;
- broadly categorise quantitative and qualitative forecasting approaches;
- understand the objectives and usage of modelling and forecasting work; and
- compare the characteristics of real estate data with those of economic and financial data;
- you will also become acquainted with the use of econometrics software packages.

The focus of this book is econometric modelling and forecasting in the real estate field. The book tackles key themes in applied quantitative research in real estate and provides the basis for developing forecast models for this market. This chapter sets the scene for the book. It describes the rationale for this text and highlights the business areas in which real estate modelling is important. The econometric study of relationships in real estate and the forecasting process draw upon the general subjects of econometrics and economic forecasting. This chapter also touches on issues relating to the construction of general forecasting models with direct implications for real estate practice.

1.1 Motivation for this book

The complexity of the real estate market, its linkages to the economy and the importance of real estate in the credit and investment spheres have necessitated a closer study of the dynamics of the real estate market and the increasing use of quantitative analysis, to explore how adjustments take place within the market and to measure its relationship with the external environment. Researchers in both academia and industry are keen to identify systematic relationships in real estate and to formally study what shapes these relationships through time and across real estate sectors and locations, with the ultimate goal of forecasting the market. Quantitative work in real estate markets is now sizeable and has brought challenges. As real estate analysts are exposed to such work, there is an eagerness to understand the principles and to directly apply them in practice to inform decision making. A textbook treatment and application of econometric techniques to real estate is therefore appropriate. The present book aims to address this need by focusing on the key econometric methodologies that will facilitate quantitative modelling in the real estate market and help analysts to assess the empirical support for alternative a priori arguments and models.

In real estate courses at universities, modelling and forecasting analysis is now introduced. A number of real estate programmes have explicit streams in this subject area, and this component of the curriculum is expanding. The majority of these modules are conversion courses and are usually taken by students who do not have an economics or statistics background. Hence this book is intended to bring students with an interest in the quantitative analysis of the real estate market up to speed with the principles of econometric modelling and their application to real estate. The book provides structure to the development of these skills. Students will familiarise themselves with the most commonly used techniques in practice and will be well equipped to pursue the econometric analysis of real estate markets. The content of this book and the range of topics covered make it suitable for both undergraduate and postgraduate degrees.

The recognition of real estate as an asset class by the investment community is another motivation for this book, since it poses challenges to how analysis in real estate markets is conducted. Investors in other asset classes are accustomed to applying quantitative analysis to study market behaviour and they would like to see similar practices in the real estate market. This book illustrates to people who are not real estate industry analysts the range of techniques at their disposal to study relationships in this market. Forecasting is, of course, important for investment purposes. The methodologies we present in this book can all be used for forecasting. Through the key model

diagnostics and forecast evaluation tests we describe, an investment analyst is able to assess how good the models are.

We focus on the areas that really matter in real estate modelling and forecasting and that have not been addressed due to the lack of such a textbook. For example, forecast evaluation and judgemental forecasting are topics with limited treatment in the real estate context. The book also highlights more advanced techniques and illustrates how these can be used for forecasting; most existing studies stop a step short of actually moving into forecasting. We emphasise diagnostic checking, as the standards of rigour within the industry differ. A key objective of this book is to allow readers to select between specifications and to equip the researcher with primary tools to construct a model, assess it, use it to forecast and assess the forecasts. We also identified a need to illustrate forecasting in practice with a large number of practical examples and with an emphasis on forecast production. In addition, our objective is to show students and professionals alike the potential and limitations of econometric modelling and forecasting. This will make communication between the various units involved in the forecast process and between producers and users of forecasts more effective. The book discusses both econometric model building and forecasting. These two areas are elaborated in subsequent sections in this chapter.

The demand for real estate analysts with at least basic skills in modelling is growing. Producers of forecasts are a source for this demand, but so are users or consumers of forecasts. Having the ability to understand how a model was built, how well it explains relationships between variables and how well it forecasts is itself a valuable skill. There is no doubt that we will see more emphasis on the quantitative analysis of the real estate market globally, especially as more data become available.

1.2 What is econometrics?

The literal meaning of the word 'econometrics' is 'measurement in economics'. The first four letters of the word suggest, correctly, that the origins of econometrics are rooted in economics. The main techniques employed for studying economic problems are of equal importance in real estate applications, however. We can define real estate econometrics as the application of statistical techniques to problems in the real estate market. Econometrics applied to real estate is useful for testing alternative theories of market adjustments, for determining income and returns, for examining the effect on real estate markets of changes in economic conditions, for studying the

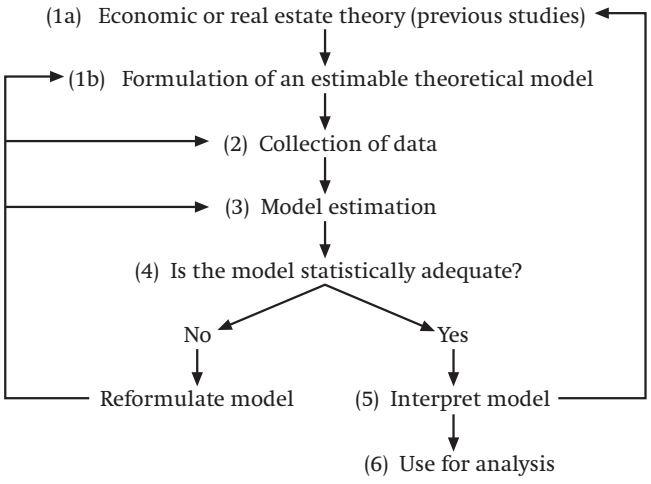

Figure 1.1 Steps involved in forming an econometric model

linkages of the real estate market with other investment markets and for investment decision making.

1.3 Steps in formulating an econometric model

Although there are of course many different ways to go about the process of model building, a logical and valid approach would be to follow the steps described in figure 1.1.

The steps involved in the model construction process are now listed and described. Further details on each stage are given in subsequent chapters of this book.

- *Steps 1a and 1b: general statement of the problem.* This will usually involve the formulation of a theoretical model, or intuition from real estate theory that two or more variables should be related to one another in a certain way. The model is unlikely to be able to completely capture every relevant real-world phenomenon, but it should present a sufficiently good approximation that it is useful for the purpose at hand.
- *Step 2: collection of data relevant to the model.* The real estate data required may be available through real estate firms or other data providers. The researcher may have to consult different sources of information depending on geography and sector. Government organisations may also hold real estate data.
- *Step 3: choice of estimation method relevant to the model proposed in step 1.* For example, is a single-equation or multiple-equation technique to be used?

- *Step 4: statistical evaluation of the model*. What assumptions were required to estimate the parameters of the model optimally? Were these assumptions satisfied by the data or the model? In addition, does the model adequately describe the data? If the answer is 'Yes', proceed to step 5; if not, go back to steps 1–3 and either reformulate the model, collect more data or select a different estimation technique that has less stringent requirements.
- *Step 5: evaluation of the model from a theoretical perspective*. Are the parameter estimates of the sizes and signs that the theory or intuition from step 1 suggested? If the answer is 'Yes', proceed to step 6; if not, again return to stages 1–3.
- *Step 6: use of model*. When a researcher is finally satisfied with the model, it can then be used for testing the theory specified in step 1, or for formulating forecasts or suggested courses of action. This suggested course of action might be for an investor to help reach a decision as to where and in which sector to buy or sell, for a developer to decide where and when to develop or for a lender wishing to underwrite risks from lending on real estate.

It is important to note that the process of building a robust empirical model is an iterative one, and it is certainly not an exact science. Often, the final preferred model may be very different from the one originally proposed, and need not be unique, in the sense that another researcher with the same data and the same initial theory could arrive at a different final specification.

1.4 Model building in real estate

Econometric models are driven by theory. Similarly, the building of econometric models for the real estate market requires us to have a good theoretical grasp of this market. Office, retail and industrial building structures are used for the production of services and goods. The demand for space is driven by the demand for goods and services (derived demand). Hence, in that respect, the market follows the principles of the factor of production market. Building construction is part of fixed capital investment, and therefore theories explaining fixed capital formation should be relevant for building construction. When real estate is seen as an asset class, general investment principles apply to this market. Real estate also comprises other characteristics that make the market unique, such as the impact of planning controls, the workings of the land market and institutional factors including the lease structure.

Apparently, there are several aspects of the market we can model utilising alternative theories. The particular characteristics of this market will affect model outcomes, and for this reason they should be well understood. There is a significant literature on the workings of the real estate market that should guide empirical modelling. The book does not intend to review this literature and the reader is referred to sources such as Ball, Lizieri and MacGregor (1998) and Di Pasquale and Wheaton (1996) and the references therein.

A simple framework of the real estate market is given by Keogh (1994). It breaks the market down into three major parts: the user or occupier market, the investment market and the development market. The three segments of the market interact. In each of the three components, demand and supply determine prices. In the occupier market, demand for space and the supply of buildings will affect metrics such as the vacancy rate, the rent level and the rent growth rate. Rent changes feed into both the investment and development markets. In the investment market, capital values and yields are established again by the demand and supply of investment interest in buildings. The investment market echoes trends in the occupier market but it also reflects wider asset market influences that determine the required rates of return. Both the occupier and investment markets send signals to the development market for new development, refurbishments, and so forth. The current and expected level of rents and building prices, along with other factors (e.g. land costs, borrowing costs), will determine the financial viability of supplying more space. The development market in turn supplies new space to the user and investment markets. Econometric analysis can be used to examine the relationships between the components in this framework, the adjustments within the components and the relationship of these components to influences outside the real estate market.

1.5 What do we model and forecast in real estate?

The discussion in this section focuses on the variables that are of most interest to real estate analysts. They represent all segments of the market and, hardly surprisingly, they are the focus of empirical modelling in the real estate market. There are, of course, more variables that are examined by analysts but the most common ones are briefly described below.

Demand variables

(1) *Take-up*. This is the amount of space taken up. It is not necessarily new demand, since the source could be firms already occupying premises in

the market (for example, vacating existing premises to move to a better specified building). Hence an occupier moving from an existing building into a newly completed building is recorded as 'take-up'. This variable is observable by real estate firms operating in the respective market and sector, especially in European markets.

(2) *Net absorption*, defined as the change in the occupied stock. Unlike take-up, it represents new demand, and as such it is appealing to investors and developers as a measure of demand strength in a market. This variable can be observed in some cases but, alternatively, it can be estimated from the vacancy rate, the stock and the occupied stock.

There exist other measures of demand, such as active demand (recording the number of enquiries for space), but this definition of demand is not as widely used as the previous two.

Supply variables

There are different definitions and measures of supply that analysts model. These measures depend on the level of aggregation or geographical coverage.

(1) *Stock*. This refers to the total amount of space in the market (both occupied and vacant). It is usually estimated by real estate firms or local government agencies.
(2) *Physical construction*. This is the amount of physical supply (in square metres or square feet). Data for physical construction are more common at the local level (city, metro). The completeness of the data set for this variable depends largely on the sector and location.
(3) *New orders*, new permits or value of building output. These series are encountered at the more aggregate level (say the national level), and they are usually compiled by government agencies.

Vacancy

Vacancy is either measured in physical terms (the amount of industrial space vacant in market A) or it is expressed as a percentage of total stock. These are measures usually produced by real estate consultancy firms.

Rents

There are different measures of rents, such as headline, effective, average, transaction and valuation-based rents. Transaction rents (either headline or average) are the levels achieved in transactions in the occupier market. The other source of rents is from valuations (to obtain measures such as the estimated rental values and sustainable rents). Valuation-based rent values

are much more common than rents obtained from transactions. Given the availability of valuation-based rents, which can be headline or average, this source of rent data is often used in empirical modelling. Effective rents are constructed to take into account rent concessions. In this book we also encounter the concept of equilibrium rents.

Performance variables

These variables describe the performance of the real estate asset for the investment market segment.

(1) *Income return*. This refers to net operating income over value (or value from the previous period). Net operating income, when not observable, can be derived or modelled using changes in the vacancy rate, rent changes and lease structure information.
(2) *Yields*. These can be estimated directly or derived from capital values and income information. The focus of real estate researchers is mainly on initial yields and equivalent yields. The initial yield is the current income divided by price; it can be net or gross depending on the market environment. The net yield is the gross yield net of operating costs. The gross initial yield is the gross rent divided by price. The equivalent yield is an overall measure that is used to capitalise both the current and future cash flows after the rent review.[1]
(3) *Capital growth*. This is the change in the capital value of a building. It can either be observed (investment transactions) or estimated from rent or net operating income and yields.
(4) *Total returns*. This is the sum of income and capital returns.

1.6 Model categorisation for real estate forecasting

Real estate forecasting is in many respects not that different from economic forecasting, and the techniques used are similar. We summarise forecast approaches that can be used in real estate in figure 1.2.

The left-hand panel of figure 1.2 summarises the statistical approaches that are available to construct models and to produce forecasts. These techniques occupy the majority of the discussion in this book. Both econometric and pure time series techniques are explained. The right-hand panel of figure 1.2 brings a different dimension to forecasting, representing the qualitative approach. We explicitly discuss these approaches to real estate

[1] For more on yield definitions, see Baum and Crosby (2008), Wyatt (2007) and Brown and Matysiak (2000).

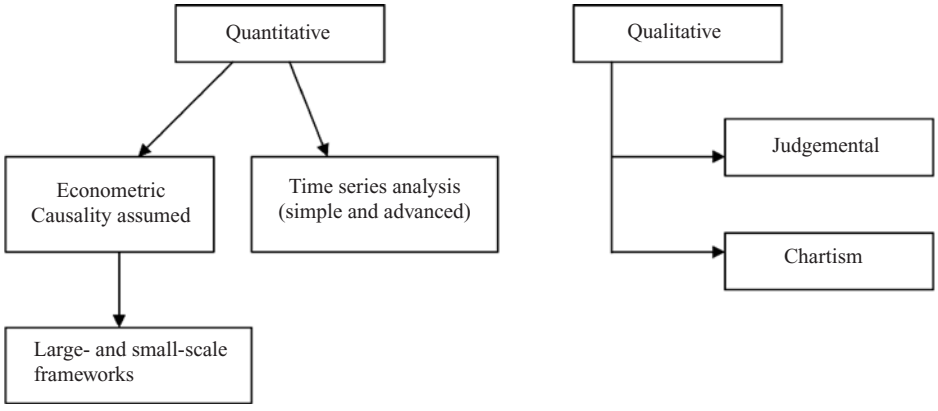

Figure 1.2
Summary of forecast approaches

forecasting, and this is the first textbook that makes a systematic attempt to bring the two approaches together in the real estate field. In economics, certain conditions may favour the one approach or the other, but in most cases the two can complement each other.

1.7 Why real estate forecasting?

Real estate forecasting has become a part of the larger process of business planning and strategic management. As in any industry, individuals in this market make decisions that affect the future performance of their business.

Investors in real estate, such as pension funds, insurance companies and real estate funds, will make allocations, which they might maintain for some time. They are therefore looking to forecast future asset performance across real estate sectors and locations. When investors and other participants take positions and make investments, they need to form a view and state their confidence in these decisions for their funders, banks, shareholders, etc. Investors need to know where rents, yields and prices will be within a predetermined time frame. Views about the future trajectory in rent growth are important to valuation departments. Will rent grow by the inflation rate or otherwise?

Real estate consultancies make plans about revenues based on forecasts for activity across their business lines. Leasing departments are interested in activity in the occupier markets as brokerage fees depend on the turnover in this segment. Using economic projections, they would like to know whether and to what extent firms are expected to expand or rationalise their space needs. Capital market departments are concerned with future events in the investment market and developments that might make real estate more attractive in relation to other assets. They would like to know what

future economic and real estate market conditions will mean for investment transactions.

Developers would like to have estimates for future demand, rents and prices. Investors with loan portfolios, including those secured on real estate, demand objectivity and transparency in the analysis of future trends. Scenario analysis concerning future rent and cash flows is also important.

The pressure from **other investment classes** is apparent. Sophisticated investors accustomed to formal modelling and forecasting techniques will make similar demands if they are to enter the real estate asset class. These investors put particular focus on systematic relationships and predictions based on fundamentals – that is, the customary drivers of the market. In addition, they may explore other forecasting approaches, such as time series modelling and cointegration analysis, that are now completely standard tools in mainstream financial econometrics. As the real estate field attracts interest from the wider investment community, the pressure to apply well-recognised and transparent techniques to analyse markets and forecast will increase. As an illustration, consider the advent of real estate derivatives. With a range of investors being involved, including investment banks, real estate forecasting needs to live up to the standards demanded by these market participants. Overall, real estate forecasting that adheres to best practices in economics and finance increases the plausibility of the real estate field in the wider investment community.

Risk departments should also be interested in the impact of uncertainty on forecasts of future outcomes, and this represents another reason for the increasing sophistication of modelling work in real estate. The sensitivity of the predictions to the inputs is of great interest to both the producer and the consumer of the forecasts. Studying the accuracy of the forecasts, the gains from different models and producing confidence boundaries make the forecast process more acceptable to risk managers. Investors in real estate accept the location-specific influences on the risk–return profile of real estate. Many would argue that the value of a particular building structure does not follow general market trends, but that it has unique features that immunise it from a downturn. Investors and risk managers may be sceptical and may not accept that market risk is not relevant and that systematic risk is absent. Therefore a forecast about the market accompanied by scenario analysis provides comfort to the risk manager and sets a benchmark for the assessment of how immune individual assets are.

The location, building and lease characteristics that determine value at the building level or even at the market level created a tendency for 'bottom-up' real estate forecasting. Even so, many participants, such as those