# Table of contents

1. Introduction ........................................................................................................ - 4 -
2. Economic model: Basic concepts .................................................................. - 5 -
   2.1 Introduction ................................................................................................. - 5 -
   2.2 What is a model? ....................................................................................... - 5 -
   2.3 An economic model .................................................................................. - 6 -
   2.4 Demand, supply and elasticity ............................................................... - 7 -
      2.4.1 Demand and supply ........................................................................ - 7 -
      2.4.2 Price elasticity ............................................................................... - 8 -
      2.4.3 Income elasticity of demand ........................................................ - 10 -
      2.4.4 Joint effect of elasticities .............................................................. - 10 -
3. The Affordability Model .................................................................................. - 12 -
   3.1 Introduction ................................................................................................... - 12 -
   3.2 Model structure ........................................................................................... - 12 -
   3.3 Key variables, elasticities and assumptions .......................................... - 15 -
      3.3.1 Key variables and their influences ............................................. - 15 -
      3.3.2 Key elasticities ............................................................................ - 15 -
      3.3.3 Key assumptions .......................................................................... - 16 -
   3.4 Data inputs ................................................................................................... - 17 -
4. Modules of the Affordability model ................................................................. - 18 -
   4.1 Introduction ................................................................................................... - 18 -
   4.2 House Prices ............................................................................................... - 18 -
      4.2.1 The measure of house prices ....................................................... - 18 -
      4.2.2 Determinants of house price ....................................................... - 18 -
      4.2.3 Ripple effect ............................................................................... - 20 -
      4.2.4 Short and long term effects ......................................................... - 20 -
   4.3 Tenure Choice .............................................................................................. - 22 -
   4.4 Household formation .................................................................................. - 25 -
   4.5 Inter-regional migration ............................................................................ - 26 -
   4.6 International Migration ............................................................................... - 27 -
   4.7 Demolitions and Vacancies ....................................................................... - 29 -
   4.8 Effective housing stock ............................................................................. - 30 -
   4.9 Right to buy and Second homes ............................................................. - 32 -
      4.9.1 Right to buy .................................................................................. - 32 -
      4.9.2 Second homes ............................................................................ - 32 -
5. Conclusion ......................................................................................................... - 33 -
References ............................................................................................................ - 35 -
List of figures

Figure 2-1. Demand curves ................................................................. - 9 -
Figure 2-2 Market equilibrium .......................................................... - 10 -
Figure 2-3 Price elasticity of demand ............................................... - 11 -
Figure 3-1. Flow Chart of the Model ............................................... - 14 -
1 Introduction

The Barker Review of Housing Supply (Barker, 2004) has become one of the most important documents for housing policy in recent years and the Government quickly adopted many of its recommendations. One of the important recommendations was to understand affordability at national and regional levels.

A team of economists led by Professor Geoff Meen from the University of Reading were asked to derive an appropriate methodology whereby national affordability targets could be translated into regional housing targets. This methodology had to be consistent across the regions. Therefore, regional targets had to reflect the national target and changes in house prices and migration flows in one region, for example, had to be consistent with changes in other regions. The central indicator of affordability in the project was the ratio of lower quartile house prices to lower quartile incomes. The modelling project was designed to quantify, at a regional scale, the relationship between affordability and new construction. NHPAU also uses the model for policy analysis, simulation of scenarios relating to various supply levels and resulting affordability.

Details of the model were published in Allmendinger et al (2005). The results used in this publication are from a more recent version of the model, where the basic structure remains the same with additional improvements. These improvements have been published in various separate papers and government reports (see for example, Meen and Andrew, 2007 and Meen et al, 2008). However, the published material can not be of practical help to specialists at regional planning bodies using the model.

This guide brings together the latest developments of the Affordability model, presenting them in the form accessible to non-technical audience using the model. NHPAU has produced this guide in accordance with its remit, which covers engagement with the regional spatial strategy process; delivering new research on the affordability problem; and providing support to the regional partners, including helping them meet the requirement in PPS3 to consider affordability when developing housing plans. Having started to deliver on the first two elements of this programme, this guide contributes to the progress in providing more support for the regional partners. It has been used during the NHPAU training sessions relating to housing economics and the operation of the model. This guide is still in draft form and additional details on the recent developments on the model will be added soon.

The structure of the guide is as follows. It starts with the introduction of basic concepts relating to models in general and economic models in particular. It then focuses on the affordability model itself and presents its structure, key relationships and assumptions. Lastly, the attention turns to the details of the model and each of its modules is considered in turn. The concluding chapter summarises the main features and implications of the Affordability model.
2 Economic model: Basic concepts

2.1 Introduction

This chapter introduces a number of concepts relating to models in general. First, a definition of a model is provided and then, this general term is described with regard to economic models and their types. The chapter ends with the explanation of the basic concepts of demand, supply and elasticity.

2.2 What is a model?

A model is a construct that represents the processes of interest by a set of variables and a set of quantitative relationships between them. In general terms, a model is a representation of a real phenomenon, system, or procedure. This phenomenon (system, procedure) can be, for example, the movement of the planets in the solar system; the climate of planet Earth; the geography of a country; the functioning of a town or city; the global or national economy; the functioning of a particular market, like for example, the housing market; the human body; etc.

Real systems are usually so complex that we can only study them through a simplified representation, or in other words, a model. Inevitably a model leaves some things out while it simplifies or generalises others. It is a compromise between what is real and what can be used. A good model must be a realistic representation of the real world, capturing the main characteristics of the phenomenon, system or procedure in question, with “sufficient” accuracy and detail. At the same time, this must be done in a simple and manageable way, which enables one to draw useful conclusions about the real world.

What should the model contain, and what should it not, in order to represent the relationship in question? Generally speaking, this depends on the particular question the modellers seek to answer and on their ability to identify what information is most important for answering it. Consider for example a map - the model most people are familiar with. A map of a country will usually show the shape of that country, the country’s neighbours, the main cities and towns, the main road and rail networks, and significant features of the country’s natural geography, like rivers and mountains. It will not show for example the streets of a particular city. This will be the object of a local map, which aims to provide exactly this piece of information. And even this local map will probably not show how the residential areas are built up. This will be the objective of a more detailed map, provided perhaps by the Land Registry. And this will not show the colour of the front door of a particular property, or whether that property has central heating or not. In each case, the important question is what a map is for and what information is important for that purpose.
Another example is the model of a town, used by town planners. As the objective of town planners is the efficient functioning of settlements, this is the kind of information they include in their models. For example, town models show the landscape, roads and transport networks, the use of land, etc, while they don’t show details about particular buildings. A civil engineer’s model on the other hand will show the structure of a building and ignore the town. And even that model will not show, for example, what kind of taps are installed in the bathroom. As with the map example, the ultimate question is what the model is for and what information is important.

2.3 An economic model

An economic model is a simplified framework designed to illustrate complex economic processes. A model can be of various types, as the above examples of the map and the town model illustrate. Economic models are usually of two types: A *diagrammatic* model describes the forces of the economy with diagrams and flow charts. An *algebraic* model describes the relations between economic variables in terms of algebraic equations.

The functioning of the global or national economy is no less complex than the functioning of a town or of the landscape of a country, as in the above examples. In general, to fully describe an economy is to describe the behaviour of each individual and each organisation in each market, sub-market, or sub-sub---sub-market. Furthermore, each individual’s behaviour in each (sub) market affects (albeit marginally) the equilibrium in that market and through it the behaviour of all other individuals in all other markets. Although this effect is usually negligible, it illustrates the complexity of the economy and the challenges faced by every economic model.

Similarly to the previous examples, an economic model consists of broad generalisations and omissions, depending on the particular questions it aims to answer and information that is important for these questions. Some degree of *aggregation* is always required. It is up to the skill of the modeller to identify, using both empirical evidence and knowledge of the economic theory, which aggregation or simplification is unlikely to have a significant effect on the result and which might have a significant effect and therefore should be analysed in more detail.

For example, a *macroeconomic* model focuses on aggregate economic variables like GDP, consumption, investment, employment, the general level of prices and interest rates, etc. It therefore includes the relations between these variables, but it doesn’t deal in detail with matters like the output of particular sectors of the economy, or the relative prices of different goods and services, or the structure of interest rates. This is not because these matters don’t affect the aggregate economic variables, but because including every sector and sub-sector will make the model too complex to use and interpret its findings. A macroeconomic model will for example focus on a “representative” price index instead of the price of each product or service in the economy. More complex models might single out the prices of commodities which have
a relatively significant influence on the aggregate economy (for example oil) and use an index for the others.

A *microeconomic* model on the other hand focuses on questions regarding a particular market or on economic relationships representing the behaviour of individual agents. These questions include, for example, the demand and supply for different financial products, or for a particular commodity. Taking the latter as an example, it depends on the price of this commodity in relation to other prices, the national income, and probably many other factors.

Another distinction made in economics is that between exogenous and endogenous factors. In a model representing house prices as a function of housing supply and housing demand, households’ income (a determinant of housing demand) will be treated as an *exogenous* factor, while the number of households (another determinant of housing demand) will be treated as an *endogenous* factor because not only will house prices depend on the number of households but the ability to form a household depends on the level of house prices. Taking a model of the commodity’s market as an example of a micro-model, the commodity’s price will be seen as *endogenous* because it is determined within the system but the national income will be seen as *exogenous* because it is determined outside of the system. This is not because the market for the commodity has no effect on the national income, but because this effect is probably marginal, while the national income depends on many other factors which cannot all be included in the model.

A more complex model might also treat the prices of similar commodities as endogenous and study the markets of a group of commodities simultaneously. Or it might distinguish between (broad) categories of consumers. Yet even the most complex model can not go down to the level of each individual consumer, or include every relevant or not so relevant (sub) market.

### 2.4 Demand, supply and elasticity

#### 2.4.1 Demand and supply

The *demand* for a particular good or service is how much of it the buyers wish to acquire *and they are prepared to pay for*, *given the price*. Therefore, demand is not a general “wish” to possess something, but the willingness to actually buy it, at a particular price. An implication is that the demand is different for different price levels. Another implication is that the “demand” is not the same as “need”: The first is how people behave in the market; the latter is the level of consumption the society considers necessary.

The *supply* is how much of a particular good or service is available in the market, *at a particular price*. Similarly to demand, supply is different at different price levels. When the demand exceeds the supply, the producers (suppliers) are able to increase their selling price, knowing that there is sufficient demand in the market. If in contrast the supply exceeds the demand, the consumers are able to negotiate lower prices, as the producers compete for business. Eventually *market equilibrium* is achieved, at a price level where
there is neither excess supply nor excess demand and hence neither side can adjust the price away from the equilibrium.

The notion of equilibrium usually relates to long-term relationships. Long-run equilibrium implies relationships to which any system returns after a shock or another short-term disturbance to one of its parts. So in the short run, the system may be out of equilibrium. The speed of adjustment to changes and return to the long-run equilibrium vary depending on which element of the system suffered a shock and which adjustment mechanism was activated. For example, since prices do not clear housing markets immediately markets can remain in disequilibrium for considerable periods of time.

In order to understand what determines the house price, one needs to understand what determines the supply and the demand for housing services. This is discussed next. Before that, however, a few things need to be clarified. Firstly, the discussion is about the supply and demand of housing services, rather than a simple count of housing units. Secondly, supply and demand are not strictly limited to the people who actively seek to sell or to buy a property; homeowners who are happy in their properties and do not wish to move are in a way both suppliers and consumers. They are not willing to move under the current market conditions. Their choices might well be different under different market conditions and this is very important for the market. In effect this means that “supply” is the total housing stock of the economy.

The demand (consumption) for a particular good or service depends on various factors, like its market price, the prices of complement or substitute goods or services, and the consumers’ income. In general, the higher the price of a good (or service) the lower its demand (the consumers buy less of it). The higher the prices of substitute goods, the higher the demand for the first good, as the consumers substitute between the two. In contrast, the higher the price of complement goods the lower the demand for the first good, as it is consumed together with the complement goods. Finally, the higher the consumers’ income the higher their demand, as they can now afford more (with the exception of inferior goods, which are consumed when income is low and people substitute away from as their incomes increase).

### 2.4.2 Price elasticity

In general, the elasticity measures the percentage change of one variable as a result of the percentage change in another. Although it is useful to know in which direction the demand for and supply of a commodity (or service) will move as a result of changes to prices or incomes, it is much more useful to know by how much.

For example, if the price of cinema tickets increases will people spend more or less money on the cinema? The answer to this question is not straightforward. On the one hand, higher prices imply higher expenditure. Yet higher prices will also deter people from going to the cinema, which implies lower expenditure. Which side does the balance lean to? This depends on the
degree to which the higher prices deter the consumers. Technically this is known as the price elasticity of demand and it is defined as the percentage change in demand that is caused by a 1% change in the price. So the expression “the price elasticity of demand is X” means that if the price increases (falls) by 1% the demand will fall (increase) by X%.

If the price elasticity is equal to minus 1 (1% increase in the price reduces the demand by 1%) then the net effect of the price increase on expenditure will be zero; the drop in demand exactly offsets the higher price. If the price elasticity of the demand for the cinema is higher than 1 then 1% increase in the price reduces the demand by more than 1%. In that case it is said that the demand is price elastic. If on the other hand the demand is price inelastic then 1% increase in the price reduces the demand by less than 1%. As a result, people will spend a higher proportion of their income on the cinema. The following figure shows two demand functions, one (b) more elastic than another (a).

Figure 2-1. Demand curves

![Demand curves](image)

The P-axis shows the price while the Q-axis shows the demanded quantity. The demand function shown by curve a is inelastic; relatively large changes in the price have limited effects on the demanded quantity. The function shown by curve b on the other hand is elastic; relatively small price changes have significant effects on the demanded quantity.

Similarly to the price elasticity of demand, the price elasticity of supply describes how the supply of a good is affected by a price change. Using the above example of the cinema, a higher ticket price would encourage the cinema manager to have more performances, or in other words, to increase the supply. By how much? This depends on the price elasticity of supply. If the cinema manager does not respond at all to the higher ticket price (for example, if the cinema already works at full capacity and it is not possible to increase the capacity), then the elasticity is 0 and the supply is completely inelastic.

What effects will an increase in the price for cinema tickets have on the demand for DVD rentals and on the demand for pop-corn? To answer this question one needs the cross elasticity of demand. The cross elasticity of demand measures how changes in the price of one good affect the demand for another. A negative cross elasticity of good B with respect to good A implies that a higher price of good A reduces the demand for B. This is the case of complement goods, that is, goods which the consumers consume more or less together. On the other hand, a positive value of the cross
elasticity implies that a higher price of good A increases the demand for B. This is the case of substitute goods, that is, goods for which an increase (or fall) in demand for one leads to a fall (or increase) in demand for the other.

2.4.3 Income elasticity of demand

Apart from the price elasticity of demand or supply, other elasticities are also important. For example, if people’s income increase will they spend a higher proportion of their income on the cinema, or not? This depends on the income elasticity of demand. Similarly to the price elasticity above, it refers to the percentage change of the demand, as a result of a 1% change in income. So if the income elasticity of demand for the cinema is X, the demand will increase by X% if the income increases by 1%. A negative income elasticity implies that the consumption of a particular good actually falls when people’s income increases. This is an inferior good, i.e. a good which is a cheap substitute for another (usually of better quality), and consumed instead of it only because it is cheaper. An income elasticity higher than 1 implies that as people’s income increases they spend a larger part of it on that particular good. That is a luxury good. Finally, an income elasticity between 0 and 1 implies that as people’s income increases they spend more on that particular good, but a smaller proportion of their income. This is the case of a necessity good.

2.4.4 Joint effect of elasticities

It is finally useful to briefly discuss the joint effect of all three elasticities: the price elasticities of demand and supply and the income elasticity of demand. In a market equilibrium the quantity demanded and the quantity supplied are equal and the mechanism that makes them equal is exactly the price. An increase in income will increase the demand. The size of that increase will depend on the income elasticity. But then the demand will exceed the supply and the price will need to adjust (increase) to restore the equilibrium between the two. What will the new equilibrium be? This depends on the two price elasticities (of demand and of supply), as can be demonstrated with the help of the following two figures.

Figure 2-2 Market equilibrium
Initially the demand function is as shown by curve a. When the income increases more quantity is demanded for any given price. Diagrammatically this can be described as a shift of curve a to the position shown by b. And the higher the income elasticity, the further away curve b will be. How does this shift in demand affect the market equilibrium? For a given price elasticity of demand, and a given income elasticity of demand this depends on the elasticity of the supply. Three alternative supply functions are considered, shown by the curves S₁, S₂ and S₃. S₁ is a totally inelastic supply function – the price has no effect on supply. S₃ on the other hand is a totally elastic function – a price change has a practically infinite effect on supply. Finally, S₂ is an intermediate case of positive but not infinite supply elasticity.

The initial equilibrium (point K) is given by the combination of price and quantity where the demand and supply curves intercept. As the demand moves from the position a to b there is excess demand. With elastic supply (S₃), the excess demand is fully accommodated with increased supply, without any effect on the price (point N). With inelastic supply (S₁) the quantity is the same in the new equilibrium (point L); the supply does not respond to the increased demand and the effect is fully transferred to a price increase. Finally, when the elasticity of the supply is between the two extremes (S₂), a part of the demand shift is transferred to a higher price. This in turn stimulates a higher supply (point M). In general, for a given price elasticity of demand and a given income elasticity of demand, the more elastic the supply the less the effect on the equilibrium price and the larger the effect on the equilibrium quantity.

It has to be mentioned that price elasticity may depend on the time horizon. For example, the short-run price elasticity of supply is lower than the long-run price elasticity of supply because housing output needs time to adjust to changes in house price.

The price elasticity of demand is considered next with the help of Figure 2.3.

Figure 2-3 Price elasticity of demand
The supply function is given by curve S, while two alternative demand functions are assumed of which the one (a) is inelastic and the other (b) is elastic. The equilibrium price and quantity for both demand curves is given by point K. An income increase shifts a and b outwards (because people demand larger quantities for any given price), to locuses c and d respectively. And as explained above, the higher the income elasticity of demand, the further away the new demand curves will be. But now the demand exceeds the supply and an adjustment is required. In particular, the price increases, discouraging demand and encouraging supply. The new equilibrium is given by points L and M for the demand functions d and c respectively. As can be seen, the new quantity is higher when demand is inelastic.

3 The Affordability Model

3.1 Introduction

The Affordability model is an econometric model developed to relate affordability to housing supply. It is designed to look at the medium to long-term. This is because affordability is a long-term problem. Where changes to the system affect its structure, the long-run equilibrium will change. An example of such structural change is deregulation of the mortgage market in the early-1980s in the UK. Although accounting for structural changes is difficult, the model attempts to allow for them as far as possible. This chapter provides an overview of the Affordability model. It describes its structure, key features and assumptions and the data used.

3.2 Model structure

The model consists of three interrelated blocks:
- demographic;
- housing;
- labour market.

These blocks are constructed for all of the English Government Office Regions, including London. The regions are linked, primarily through migration flows and through relative house price movements. But, in addition, the model takes into account spatial contiguity. For example, earnings in any region are related to earnings in contiguous regions. Commuting flows would be expected to produce earnings contiguity even in the absence of migration. In the context of the house price equations, a ripple effect provides another example of spatial relationships between areas that can be captured by including contiguity terms into the equations.

The model captures the relationship between housing supply and affordability through the interplay of demographic trends, incomes, the labour market and
the housing market. The results from the model are housing decisions determined by market processes.

A simplified flow chart of the model is presented in Figure 1. In the figure, the econometric relationships in the model are primarily given on the left-hand side. The right-hand side indicates the central aggregate outcomes. Whilst the arrows indicate the primary direction of the actions, in some cases there can be a two-way effect.
Figure 3-1. Flow Chart of the Model

Population (t-1) + (Births-Deaths) + International Migration

Inter-regional Migration

Population of type (i)

Households of type (j)

Probability (individual of type (i) forms household type (j)): International and Domestic

Probability (household of type (j) is in each of the 3 tenures)

Number of owning households
Number of private renters
Number of social renters

Demand for housing services by owners

House prices

Supply of owner-occupier housing services

House prices

Rents

Vacancies, demolitions, second homes

Earnings

AFFORDABILITY
3.3 Key variables, elasticities and assumptions

3.3.1 Key variables and their influences
There are exogenous and endogenous variables in the model. Key exogenous variables include:

- births/deaths;
- mortgage rates;
- consumers’ expenditure deflator;
- official household projections (the model also produces its own endogenous household projections).

These variables enter key equations in the model, as summarised below.

<table>
<thead>
<tr>
<th>Key Equations</th>
<th>Influenced by</th>
</tr>
</thead>
<tbody>
<tr>
<td>House prices</td>
<td>Number of households, the stock of dwellings, real earnings, interest rates.</td>
</tr>
<tr>
<td>Household Formation</td>
<td>Marital status, age, gender, children, real housing costs, real incomes, previous household status.</td>
</tr>
<tr>
<td>Tenure</td>
<td>Tenure costs, real incomes, credit conditions, previous tenure, marital status, age, children, gender.</td>
</tr>
<tr>
<td>Inter-regional Migration</td>
<td>Relative house prices, housing availability, relative earnings, unemployment.</td>
</tr>
</tbody>
</table>

3.3.2 Key elasticities
Although the model is very large, in practice, the properties of the model are determined by a small number of key equations and elasticities. As was explained above, elasticities measure the responsiveness of one variable with respect to changes in another variable.

The key elasticities in the model are presented below:

- **Income Elasticity**: The elasticity of house prices with respect to real incomes is approximately 2.0. In other words, a 1% rise in real incomes would increase house prices by 2%, holding all other influences constant. This elasticity is determined by the income elasticity of demand and the price elasticity of demand. Since the income elasticity of demand is 1 the 1% increase in income increases the demand by 1%. Since the supply is fixed in the short-term, the adjustment comes from changes in price: the price will increase in order to reduce the demand to its initial level and restore market equilibrium. The required price increase depends on the price elasticity of demand, which is -0.5. Hence, to offset the 1% increase of demand the price will eventually increase by 2%.

- **Interest Rate Elasticity**: If interest rates rise by one per cent, house prices will fall. This fall will differ across the regions, e.g. in London the
fall in prices in the second year will be approximately 6%, in the Midlands 3% and in the North 1%.

- **Housing Stock Elasticity**: The long-run elasticity of house prices with respect to the housing stock is estimated as -2. That is if housing stock increases by 1%, house prices will fall by about 2%.

- **Elasticity of house price with respect to Household formation**: If the number of households increases by 1%, then house prices will increase by about 2%.

### 3.3.3 Key assumptions

The key assumptions in the model are as follows.

- **Average earnings and inflation**: In the long run, at the national level, average earnings, which are used as a proxy for household income, are assumed to grow by 5% per annum in nominal terms. The model assumes a percentage change in the consumers’ expenditure deflator (or inflation) of 2.5% per annum in the long run. Thus earnings in real terms are expected to grow by 2.5% over the projection period. This assumption is in line with historical data. In the short-run, average earnings fluctuate around their long-run average and this explains why this assumption varies. Regional earnings growth rates are endogenously determined within the model based on the national level. Therefore, similarly to the assumption regarding the national earnings growth, this assumption also varies in the short run.

- **Mortgage interest rates**: Are assumed to be fixed at 5.75% in the long-run. But again, in the short-run, this assumption varies. Mortgage rates are an important element of the user costs of housing. They impact on house prices directly (through interest payments) and indirectly (through their impact on household formation and tenure choice). Mortgage rates are also used to calculate regional migration inflows and outflows. At higher interest rates, economic activity is lower and overall mobility falls.

- **The distribution of new build housing types**: Determines effective stock, is assumed to remain the same as in existing stock.

- **An income multiple constrain for mortgage approvals**: Varies regionally, being lower in the North West, North East and Yorkshire & Humberside and higher in London, the East and South East. This is based on past data.

- **A loan to value ratio**: Influencing a deposit constraint in mortgage approvals, also varies regionally, being lower in the South and higher in the North. This also is based on past data.

---

1 The growth in real household disposable income has averaged approximately 2.5% per annum over a long run period (2.67% since 1971; 2.63% since 1981; 2.58% since 1991; 2.44% since 2001)

2 It has to be noted that the long-run assumptions are varied between scenarios.
### 3.4 Data inputs

The data used in the model come mainly from ONS and DCLG. Each region in the model has 13 excel worksheets. The sources of data used in each worksheet are presented below.

<table>
<thead>
<tr>
<th>Worksheets in the Model</th>
<th>Data</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summary</strong></td>
<td>Private Starts</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Lower Quartile Earnings</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Lower Quartile House Prices</td>
<td>DCLG</td>
</tr>
<tr>
<td><strong>International Migration</strong></td>
<td>Gross Inflows and Outflows</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>National Proportions by Age</td>
<td>ONS</td>
</tr>
<tr>
<td><strong>Interregional Migration</strong></td>
<td>Gross Inflows and Outflows</td>
<td>ONS</td>
</tr>
<tr>
<td><strong>Natural Population Increase</strong></td>
<td>Conception Rates</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Total live births</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Conception / Birth ratio</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Male/Female Death Rates</td>
<td>DCLG</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Male/Female population</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Male/Female population</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Male/Female population</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Dependent Children Rate</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Couple Rate</td>
<td>ONS</td>
</tr>
<tr>
<td><strong>House</strong></td>
<td>Right to Buy Discount</td>
<td>DCLG</td>
</tr>
<tr>
<td><strong>Tenure</strong></td>
<td>Right to Buy Sales</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Total Demands for Each Tenure</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Total Supply for Each Tenure</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Stocks by Age</td>
<td>DCLG</td>
</tr>
<tr>
<td><strong>Housing Stock</strong></td>
<td>Stock by Tenure</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Effective Stock</td>
<td>Model calculation</td>
</tr>
<tr>
<td><strong>Working Variables to calculate employment status probabilities</strong></td>
<td>Model calculation estimated from LFS data</td>
<td></td>
</tr>
<tr>
<td><strong>Employment Status Probabilities</strong></td>
<td>Model calculation</td>
<td></td>
</tr>
<tr>
<td><strong>Earnings</strong></td>
<td>Model calculation</td>
<td></td>
</tr>
<tr>
<td><strong>Labour</strong></td>
<td>Average Full-Time Earnings</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Lower Quartile Earnings</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Median Earnings</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Unemployment Rate</td>
<td>ONS</td>
</tr>
<tr>
<td><strong>Prices</strong></td>
<td>Regional House Price</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>National House Price</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Mortgage Interest Rate</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Regional Owner-Occupier Housing Stock</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Consumers Expenditure Deflator</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Private Starts, 2000</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Median Regional House Price</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Private Completions</td>
<td>DCLG</td>
</tr>
<tr>
<td></td>
<td>Unemployment (England)</td>
<td>ONS</td>
</tr>
<tr>
<td></td>
<td>Lower Quartile House Prices</td>
<td>DCLG</td>
</tr>
</tbody>
</table>
4 Modules of the Affordability model

4.1 Introduction

Previous chapters introduced the concept of a model and provided an overview of the Affordability model, presenting its structure, key relationships and assumptions. This chapter looks into the modules of the Affordability model, for each of them explaining how they fit in the overall structure of the model, what relationship they focus on and how the results should be interpreted. The chapter starts with the house price module, moving on to the modules relating to housing demand (such as household formation, tenure choice, migration) and housing supply (such as effective housing stock, demolitions and vacancies and second homes).

4.2 House Prices

4.2.1 The measure of house prices

As each property commands a unique price in the market, the model works with a “representative”, or more formally “mix adjusted” house price for each region. This implies that if, for example, the new housing supply is on the average of lower quality than the existing stock (for example, smaller), this will shift the median and lower quartile down the quality ladder. It is for this reason that the use of mix adjusted prices is more appropriate for affordability analysis. When compared to earnings, the price equations effectively answer the following question: How affordable is a dwelling of a particular type? If the policy objective is to enable people to afford a dwelling with a minimum level of amenities, rather than just to accommodate them into “anything that has a roof”, this is a more appropriate question and the mixed adjusted price is a more appropriate house price to use. The median and lower quartile prices for each region are proportional to this price. More about housing quality is provided in section 4.8.

4.2.2 Determinants of house price

The price equations in the Affordability model depend on the following factors:

1) Housing supply, measured in housing services that the effective housing stock provides (see section 4.8). This is the sum of the private and social effective housing stock, with the supply of social housing discounted. The reason is that empirical studies have shown that the effect of the social stock on house prices is in the range of 30-50% of the effect of the private stock.

2) The general price level, expressed by the consumers’ expenditure deflator. It is used in order to convert nominal variables into real terms, providing a common base for comparisons over time.

3) The stock market index, deflated by the general price level

4) The number of households.

5) The real average earnings, again deflated by the price index.

6) The user cost of capital. This is the sum of the mortgage interest rate; the council tax and stamp duty; a constant term, representing other housing
7) An index of credit market conditions, reflecting the fact that the purchase of houses is to a large extent financed with mortgages, the provision and the terms of which are affected by the conditions in the credit market. The user cost of capital also includes a term for possible restrictions in mortgage borrowing. This term reflects the fact that the purchase of houses is to a large extent financed with mortgages, the provision and the terms of which are affected by the conditions in the credit market.

8) Regional unemployment relative to the unemployment level in a contiguous region.
9) Spatial lags of some of the above variables, that is, direct effects from one region to another. For example, the earnings of London affect the house prices in the South East and East.
10) Last year’s price level, reflecting the fact that house prices respond to changes in the market fundamentals only gradually.
11) Time lags of some of the above variables, reflecting the fact that the effect of some of them lasts for more than one year.

Of course the above effects are not equally strong in all regions. For example, the stock market index is significant only in London. Another example is the mortgage interest rates; their effect is stronger in the Southern regions than in the Northern. It must also be emphasised that house prices feed back to some of the above variables, either directly or indirectly. For example, household formation is affected by house prices. Spatial lags (item 9) are the result of interdependency between the regions. For example, as people can work in one region and live in another, the labour market conditions in the first region affect the housing demand in the latter.

The current version of house price equations differs from an earlier version but key properties are not very different. In particular, the recent version:
   a) Also used the above listed factors of housing supply, general price level, number of households, real earnings and last year’s price level (factors 1, 2, 4, 5, and 10).
   b) Used time lags of the other variables too (factor 11), although in a simpler structure.
   c) Used the mortgage interest rate, instead of the user cost of capital. Yet with the council tax and stamp duty assumed constant (as the model does), the two are essentially the same.
   d) Did not use the stock market index (which as discussed is significant only in London), the credit market conditions, or regional unemployment (factors 3, 7 and 8).
   e) Had contiguity effects which were much simpler, with the house prices in the South East affecting the prices in the West Midlands, East Midlands, North West and North East, and the prices in the East Midlands affecting the prices in Yorkshire & Humberside.
4.2.3 Ripple effect

The model assumes a ripple effect to be operative in the housing market through prices. In theory, a ripple effect could originate in any region of a country. For the UK, it is assumed to start in London and the South East. Meen (1999) defines the ripple effect as ‘The propensity for house prices to rise first in the south-east of the country during an upswing and to gradually spread out to the rest of the country over time’. Wood (2003) provides reasons for the effect:

- the housing demand and supply responses to a national economic shock may be faster in some regions than others,
- the ripple-out in the determinants of housing demand, such as incomes or employment, would also lead to a similar ripple in house prices, where London and the South East are argued to lead the economic cycle,
- these two channels could be complemented by demand-driven links between the regional housing markets, such as migration, commuting, investment flows and the way expectations of capital gains are formed,
- if the housing demand and housing prices in the South East were raised by an economic shock in that region, expectations of house prices and capital gains in other regions may rise in anticipation of a ripple-out in incomes and employment and of increased migration and investment flows.

In the house price equations, the ripple effect in prices is considered to account for the spatial relationships between regions. To generate a ripple effect, the relative house price (that is the own region prices relative to those in the South) is included in price equations, excluding equations for London and the South East. In the earlier version of the model, the ripple effect is argued to have captured the impact of second home ownerships across regions (Meen et al 2005: 22). One factor for the differences in the affordability ratio across regions is due to this effect. For instance, due to the ripple effect the North lagged behind the South and the Midlands in the early-1990s and as house prices were rising in the North but falling in the South the affordability ratio rose in the North whilst it was falling in the South (p.52, Meen et al 2005: 52).

4.2.4 Short and long term effects

House prices respond to changes in the market fundamentals only gradually, as implied by the presence of last year’s price in the price equation (item 10). For example, the price equation for the South East is

\[
\frac{P_t}{D_t} = \left( \frac{P_{t-1}}{D_{t-1}} \right)^{0.718} \left( \frac{E_{t-1} \cdot E^{GL}_{t-1}}{D^{2}_{t-1}} \right) \left( \frac{S_{t-1}}{H_{t-1}} \right)^2 \cdot \exp(-0.0203 \cdot U_t)
\]

where

\( P_t \) = nominal house price index
\[ D_t = \text{consumers’ expenditure deflator} \]
\[ S_t = \text{effective housing stock} \]
\[ H_t = \text{number of households (including holiday homes)} \]
\[ E_t = \text{average earnings (the index GL stands for earnings in London)} \]
\[ U_t = \text{user cost of capital} \]
\[ r_t = \text{mortgage interest rate} \]
\[ T_t^C = \text{council tax (as a percent of the property value)} \]
\[ T_t^S = \text{stamp duty (as a percent of the property value)} \]

The subscript \( t \) denotes time period.

\[ MRAT_t = \text{Excessive mortgage demand (as a percent of the mortgage supply)} \]

the subscript \( t \) denotes time period.

\[ U_t \text{ is in turn given as } U_t = 2 + r_t - 0.3 \cdot \frac{P_{t-1}}{P_{t-2}} + T_t^C + T_t^S + 2.4 \cdot MRAT_t \]

Consider now a change in the user cost of capital \( U_t \) (for example, as a result of a change in the mortgage interest rate). The price equation implies that a decrease in \( U_t \) by 1 percentage point will increase the house prices by 2.03% in year 1. But one year’s house prices feed into next year’s prices by a coefficient of 0.718. Therefore, in year 2 the initial decrease in \( U_t \) will raise the house prices by 2.03 X 0.718 = 1.46%. This price increase will then feed into year 3 prices, raising them by 2.03 X 0.718 X 0.718 = 1.05%. Similarly, in year 4 the initial decrease in \( U_t \) (year 1) will raise house prices by 0.75% - and so on.

The size of the effect diminishes with time, because the coefficient of the lagged house price is less than 1. Therefore, if in year 2 \( U_t \) return to its initial level (year 0), its effect on house prices will eventually die out, albeit after several years. If on the other hand the increase in \( U_t \) is permanent, then every year a new effect will be added up. In that case the effect of 1% decrease of \( U_t \) will be 2.03% in year 1, 2.03 + 1.46 = 3.49% in year 2, 2.03 +1.46 + 1.05 = 4.54% in year 3, and so on. The \textit{long term} effect is

\[
\frac{2.03}{1 - 0.718} = 7.2\%.
\]

The following figures show how the effect of a permanent change builds up and how that of a temporary change eventually dies out:
As can be seen, the repercussion of a temporary shock lasts for some time after the shock is gone, while the effects of a permanent change take several years to fully materialise. Although the user cost of capital was used as an example, the conclusion holds for every factor that affects house prices; the important property is that one year’s prices have a strong effect on the next\(^3\).

4.3 Tenure Choice

The probability that any household, with a given set of characteristics, will be in one of the three tenures (owner occupier, renting privately or renting socially) in each time period is modeled. The set of characteristics includes the gender of the household head, the age of the household head, marital status, presence of children, household income quartile and tenure in the previous year. The modelling is done separately for the three age groups: 20-39, 40-59, and 60+.

The model adopts a two stage, hierarchical approach. In the first stage, the probability that each household head is an owner or a tenant is calculated, depending on whether they owned their house in the previous period. In the second stage, for those likely to reside in one of the rented sectors in the first stage, i.e. not owners in the current period, the probabilities of being a private tenant or a social tenant are estimated. These probabilities depend, amongst other variables, on whether current tenants were social tenants in the previous period.

The estimated tenure probabilities are then multiplied by the number of households in each group to obtain the distributions of households by tenure. The next chapter describes the way household formation is modelled;

---

\(^3\) Note the presence of the term \(\frac{P_{t-1}}{P_{t-2}}\) in the user cost of capital \(U_t\) has an additional effect. In particular, the initial increase in the interest rate raises \(U_t\), which as discussed reduces the price \(P_t\).

This means that it also reduces the term \(\frac{P_t}{P_{t-1}}\), which is included in next year’s user cost with a negative sign. Therefore, next year’s user cost is increased even further than implied by the increase of the mortgage interest rate alone. Yet this additional effect is small in the short term and it disappears completely in the long term, as the price level converges to its long term equilibrium and \(P_t \approx P_{t-1}\).
therefore the remainder of this chapter focuses on influences on tenure choice.

As noted above, tenure probabilities vary with demographic characteristics. Having a partner increases the probability of ownership, while having children lowers it. The high costs of having children are well known. Those with children and on low incomes are more likely to be in the social sector. This also reflects the fact that single parents with children receive higher priority in social housing. For the under 40s, male heads have a higher ownership probability.

Previous tenure is particularly important. Across all household types, the probability of home ownership in the current year for those who were owners last year is well over 90 per cent. This is because tenure transitions, typically, do not take place rapidly.

But there are four classes of economic variables, which have a fundamental influence:

- **Income**
- Relative housing costs in the tenure
- Credit restrictions
- Housing supply constraints

1. **Income**

Household incomes among other things influence their tenure choice. Households in the highest income quartile are likely to own their house while households in the lowest income quartile are likely to be social tenants. Indeed, as Andrew and Meen (2003) argue, the decline in ownership amongst young households in the first part of the nineties was linked to a change in the income distribution. In particular, the incomes of older households were growing at a faster rate than young households.

2. **Relative housing costs in the tenure**

The Tenure module calculates the price of each tenure type and ensures that over the long run the relative prices of tenure do not change. In other words, rents change in line with ownership costs. Since tenure choice is sensitive to differences in relative tenure costs, relative prices have to be tied together in the long run. Otherwise, eventually, all households will choose the cheapest sector, for a property of a given quality, in the absence of other constraints (e.g. supply shortages).

In the case of the price paid by tenants, the model uses CLG’s measures of regional average rents in the private and public sectors. A fixed differential between real public and private rents is added in order to keep gross social sector rents in line with the private sector.

In order to calculate the tenure price for owners, the model calculates the real per period unit cost of owner-occupier housing services as a measure of owner-occupier housing costs.
The effect of relative tenure costs on tenure choice is such that when the housing user costs increase relative to other housing costs the probability of ownership declines. Also, the influence of relative tenure costs on households’ tenure choice is expected to be higher where supply restrictions are less binding. Since access to social housing is more constrained in the South, equations for rental demand allow differential effects for the four southern regions compared with the rest of the country.

3. Credit restrictions
Household formation is not the only route through which income affects housing demand and hence house prices. A more direct influence of income on affordability is through credit repayment constraints. For example, the reduction in owners in the 20-24 age group that has been observed in the last 20 years occurred at a similar time to the increased deposit requirement for first-time buyers. This is why the financial constraints, particularly in terms of deposits, were also included in the Affordability model.

There are two potential constraints – an income multiple constraint, which reflects repayments for a given level of interest rates and an LTV constraint. As part of the latter, the model attempts to calculate household wealth since this affects the ability to raise the initial deposit. None, one or both constraints may be binding. For example, at a time of low nominal interest rates, the importance of an income constraint may be limited, but as house prices rise, the ability to meet the deposit becomes more difficult, without relying on family and friends.

Unsurprisingly, for higher income households credit constraints are less likely to be binding since they will find it easier to accumulate the required deposit or meet mortgage repayments. Those on low incomes have a higher probability, not only of being renters, but also of being in the social sector. Empirical results from the model find that the constraints are only statistically significant for the under 40 age group (credit constraints were found to be insignificant in the 40-59 age group tenure equation), although this may change in the future. At least historically, the older age groups appear to have accumulated sufficient assets by that stage of their lives.

One of the important features of such constraints is that they do not necessarily provide a permanent hurdle to home ownership; rather they delay entry until the household can accumulate sufficient resources, through saving, to meet the deposit requirement. Therefore, the assumption of the model is that the delayed entry is a function of economic influences, and is not related to age *per se*.

4. Housing supply constraints
Finally, demand for a particular tenure may exceed supply for a given set of relative prices. It is possible, for example, that demand for social housing will exceed supply, particularly in the southern regions. The model accounts for the possibility of supply shortages in the tenures. Supply shortages are partly reflected in the coefficients on relative prices in the tenure equations, but, in addition, supply shortages in the social sector (for given levels of official
household projections) imply that any excess number of households has to be housed in the private rental sector.

4.4 Household formation

The model based household forecasts (further referred to as the ‘market’ number of households) rely on economic and demographic variables. They point to the number of households that would have formed had it been left to the market and had both economic and demographic factors been accounted for.

Household formation depends on three broad elements:
- the natural population change (deaths and births) in the region
- migration flows and
- the probability that any individual will form a household.

In order to arrive at the ‘market’ number of households, the first two elements (natural population growth and migration) produce the distribution of individuals across the categories defined by gender, age, marital status, presence of children and income. Multiplication of these numbers by the third element (the probability that individuals in each of the above categories will form a household) produces the number of households.

1. Population

Population statistics come from the ONS Annual population projections, except for inter-regional migration which is determined by the model. The numbers of births and deaths are determined in the current period, but are effectively exogenous. Annual statistics on conception rates, conception-to-birth rate and female population are used to calculate the number of live births. Death rates are assumed to be the same as in official projections. Statistics on couple rates and the presence of children come from the census. These allow the working out of the distributions of men and women according to their marital status and whether they have children. The income distribution of individuals is taken from BHPS and these proportions are used to calculate the income quartiles for individuals in each category (defined by gender, age, marital status, presence of children and income).

2. Migration

Migration flows are endogenous, i.e. inter-regional migration is endogenously determined by the model and depends on relative house prices, earnings, and employment. In other words housing and labour markets affect a region’s population by generating migration streams. Because of this endogeneity, population estimates do not exactly match official population estimates (but they do match them broadly). For details see sections 4.5 and 4.6.

3. Probability of household formation

Nevertheless, what matters for housing demand is not population but households, although the latter obviously depends on the former. The other important factor is the household formation rate, that is, people’s propensity to
form households. This is expressed in the model as the probability that an individual will form a separate household.

Similarly to the distribution of individuals across categories, the probability that individuals will form a household is modelled depending on gender, age, marital status, presence of children and income. But it also depends on whether an individual was the head of the household in the previous period (year). Under the “other things equal” assumption, the probability of forming a household is higher if an individual was the head of the household in the previous period; if their income is higher; if they have children, and if they are a man.

Since income is one of the factors listed above, the probability of forming a household depends on affordability. The other economic factor influencing the probability is housing costs proxied by interest payments. Since interest payments depend on house prices household formation depends on prices too. This is another channel through which affordability affects household formation. As affordability worsens, the probability of forming a household decreases.

The model based forecasts of the number of households differ from official household projections because the latter only rely on demographic trends and do not account for housing affordability. But the model assumes that the households expected by the official projections will indeed form and they will have a place to live (although this assumption can be varied). The household projections above the model’s own household forecasts are housed in the rented sectors.

4.5 Inter-regional migration

One of the factors affecting affordability is the number of households and changes in household formation potentially provide an important stabiliser or destabiliser to prices. However, changes in the numbers of households in each region arise from both changes in household formation rates amongst the population already living in the region and from migration into the region. At the same time, household formation and migration flows are expected to be responsive to house prices, implying that migration flows are endogenous factors.

Gross inflows and outflows are treated separately. Regional gross outflows are modelled and then used to define gross inflows. Modelling requires assumptions about migration distances. The data from the National Health Service Central Register (NHSCR) shows that most migration is to contiguous regions. For example, approximately 60% of total migration flows take place between the four southern regions (measured as the sum of inflows and outflows in the four regions as a proportion of total English inflows and outflows). This is why outflows are distributed to each region according to the fixed coefficients derived from the matrix of gross migration flows across the English regions in 2005 using the NHSCR data.
In the model, the dependent variable is gross migration outflow expressed as a percentage of the resident population. The independent variables are:

- unemployment. The unemployment rate is determined within the model. The gross inflow of migrants to the region increases when its unemployment declines and when unemployment is high mobility is reduced.
- the mortgage interest rate. The higher the mortgage rates, the less people are moving in and out of the region.
- variables representing prices and availability in the home region relative to the alternatives. To construct the latter, a form of distance decay is employed so that contiguous regions typically have higher weights.
- the relative rate of change of house prices attempts to capture price expectations. It is measured by the relative percentage change in prices over the previous year. In principle, this is part of the user cost of capital in addition to mortgage rates.

The results of modelling show that the relative availability variable is significant in all regions except the West Midlands and North West, i.e. the regions that have higher proportions of low demand areas and, consequently, housing shortages are less severe. Relative house prices are positive everywhere, except in the North East where prices have no significant effect. Since this is the cheapest region of England, again, this is perhaps unsurprising. High interest rates tend to reduce migration flows, but the effects of unemployment differentials are not uniform.

With regard to the relative rate of change of house prices, the findings are mixed; in most regions the variable is insignificant and although the variable takes the expected negative sign in East Midlands and Yorkshire and Humberside, it is positive in London. This may represent the fact that prices are higher in London than elsewhere and rapidly rising prices require households to leave London, particularly since a much smaller share of households in London are owners than elsewhere and, hence, do not gain from rising prices on existing properties. Lower prices in any southern region leads to migration to that region and since the regions are broadly part of the same travel to work area, individuals still have the option of commuting without changing jobs. Since price growth is very similar, expectations of capital gains should also be similar and agents would find it difficult to distinguish between the areas.

4.6 International Migration

International migration flows can either be entered exogenously or run with a series of equations. The latter attempts to explain in-flows and out-flows from the following groups of countries of birth:

- Ireland, Australia, New Zealand, USA, Malta
- Africa, West Indies, South and Central America
- Asia
- Europe
The migrants are defined as those staying in the country for more than one year. The model of the housing demand of migrants is decomposed into two sets of flows – in-flows and out-flows.

Inflows

For the modelling of housing demand by in-migrants, there are four key sets of equations, given the total number of in-migrants to the country.

1. The regional distribution of migrants
2. Expected earnings
3. The household formation rates of migrants
4. The tenure choices of migrants.

1. Modelling the Regional Distribution of Migrants
The distribution is modelled as the share of migrants going to each region (between zero and one). The model examines the sensitivity of new migrants to economic, housing and labour market variables. Five sets of variables are tested as possible determinants of migrant location choices: relative average earnings, relative unemployment rates, relative house prices, housing availability and the existing stocks of migrants. In each case, the regional variable is expressed relative to the national average.

Separate equations are estimated for each country of birth group mentioned above. The regional shares of gross migrant inflows by country of birth were multiplied by the national numbers of in-migrants in each country of birth in order to determine the regional inflows by country of birth.

2. Modelling Migrant Earnings
The expected level of hourly earnings is imputed because full information on the earnings of all migrant households in the LFS is not available. Migrant earnings are modelled primarily as a factor determining headship rates and tenure shares. The earnings equation includes demographic variables, measures of skills, schooling, and the industrial sector in which the individual is employed and regional dummy variables. The more novel feature is the inclusion of ethnicity, country of birth and number of years since arrival in this country. In the future, the average level of migrant earnings is assumed to grow at the same rate as domestic earnings so there is no change in the income distribution.

3. Modelling Migrant Household Formation
This is modelled as the probability that in-migrants with a given set of demographic and economic characteristics will form a household. A probit equation is used, so that the dependent variable takes a value of one if the individual is a head of household. The modelling mirrors the treatment of the UK-born, using LFS data. The equations include a wide variety of regressors, including country of birth, age, gender, length of residence in the country, marital status, recent/non-recent migrant status and presence of children. In
addition, the equations take account of earnings (see below) and rental costs of housing.

4. The tenure choices of migrants
In line with the headship equations, the probability is modelled that a household head will be either an owner or a renter. The Affordability model already contains a detailed tenure model for UK residents, but it is not possible to incorporate the same degree of detail into a migrant tenure model, which again relies on LFS data. There are two main differences. First, only the allocation between owner-occupation and renting is modelled because in the early years of arrival most migrants are housed in private renting. Second, it is not feasible to incorporate similar credit market constraints for migrant tenures given the nature of the data. In the estimated equation, only migrant households are included in the sample. The model calculates ownership probabilities disaggregated by country of birth, number of years since arrival, gender, marital status and presence of children.

Since the probabilities of household formation are disaggregated by gender, marital status, presence of children and length of time in the country, the numbers of in-migrants have to be broken down into similar categories. Then the total number of households is determined by multiplying the probabilities by the number of individuals in each category.

Fixed coefficient matrices derived from the LFS give a more detailed break down of the length of time since migrants arrived in the country. Given these coefficients, the number of households in each category and the estimated ownership probabilities, the number of owners is determined.

Outflows
The number of out-migrants distinguishes the UK-born from those born abroad. The latter will, in some cases, be in-migrants from earlier years returning to their country of birth. For this group, the estimated headship and ownership rates from the inflows equations is employed in order to obtain estimates of out-migrating households and owners. For UK-born emigrants, appropriate estimates of headship and tenure rates are obtained from the domestic equations in the model.

These data are used in equations for net inflows of individuals, households and owners. This difference between the number of immigrant and emigrant households (and owners) generates the net housing market effects of migration.

4.7 Demolitions and Vacancies

Because of historical supply shortages vacancies and demolitions have been permanently below their long-run equilibrium values. If higher levels of new

4 Indeed, in some cases, e.g. A8 migrants, do not qualify for social housing until they have been in the country for at least a year.
construction occur in the future, then vacancies and demolitions become part of the long-run adjustment process in addition to prices. The model equilibrium is based on the equilibrium to all these variables - second homes, vacancies, conversions and demolitions, as well as prices.

Demolitions and vacancies are modelled separately but they are linked: the number of dwellings to be demolished depends on vacancies. In turn, the number of vacancies is linked to the difference between household numbers and the dwelling stock. The model can be solved to base this on either the ‘market’ number of households or the number of households implied in official projections. Consequently, the number of demolitions and the number of vacancies are part of the adjustment mechanism.

The model distinguishes between long- and short-term vacancies. Long-term vacant are properties that have been vacant for more than 6 months and short-term vacant are properties that have been vacant for less than 6 months. Short- and long-term vacancies are modelled separately. The long-term vacancy rate depends on demand in each area, where the level of multiple deprivation is the key indicator, and supply is represented by the housing stock. The rate is higher in areas of low demand. Short-term vacancies are not dependent on IMD to the same extent and the primary driver of short-term vacancies is the deviation between the housing stock and the number of households in the region.

Once vacancies and household numbers are calculated, the number of demolitions can be worked out. But the model also identifies the types of properties to be demolished. This is based on their market values relative to the value of a comparable new property (see the following section). Those that have the lowest values face demolition.

4.8 Effective housing stock

The original version of the model took no account of variation in the type of housing dwellings – it was just a number count (Meen et al, 2005). The change in housing supply generated by the new build was the same, regardless of whether the new build was a 4-bedroom house or a 2-bedroom flat. But, in fact, a 4-bedroom detached house delivers more housing services than a 2-bedroom flat. And as the supply of services increases one would expect their price to fall. This is achieved in the new version of the model. Housing supply is now measured through the volume of housing services that each dwelling contains.

In order to distinguish housing supply that takes account of housing quality from housing supply that solely operates in terms of the number of units, the concept of effective housing stock is developed. The effective stock is then used in house price equations. The number of dwellings representing housing supply is weighted, so that properties with a lower value receive a lower weight and properties with a higher value receive a higher weight.
The implication is that as one lower value dwelling is demolished and one higher value dwelling is built, changes in housing supply do not cancel each other out. A decline in housing supply following the demolition is smaller than an increase in housing supply following the new build. The net change in housing supply is positive because the newly built dwelling delivers more services than the demolished dwelling. In this way the model allows different dwellings to have different impacts on housing supply and therefore, on house price and affordability.

How does one know that one dwelling delivers more housing services than another and therefore has to receive a higher weight in the equations? The indicator is the house price - if one dwelling commands a higher price than another dwelling, this is because it delivers more housing services. For example, with other things held constant, a 3-bedroom flat will trade at a higher price than a 2-bedroom flat because it delivers more housing services. In the effective stock module of the model, the factors that impact on house prices are identified and used to determine the weights. Using the previous example, the model will attach a higher weight to the 3-bedroom flat. Consequently, building a new 3-bedroom flat will lead to a greater increase in housing supply than building a new 2-bedroom flat and house prices will decline to a greater extent in the former case.

One may question if building smaller dwellings should be encouraged, given that affordability is measured at low quartiles of house prices and incomes. The model shows that in this case, the improvement in affordability will be smaller than if larger properties are built. In the latter case, the decline in house prices will be felt throughout the house price distribution due to the filtering process. At first, the decline in house price will benefit households at the top end of income distribution because the newly built larger properties are likely to be afforded by existing households wishing to improve their housing conditions. However, the properties they free will appear on the market and become affordable to the households with a lower income. This filtering will continue and eventually households at the bottom end of the income distribution will move into properties they could not afford before the decline in price.

If all new build consists of 1-bedroom properties these properties will not improve the housing position of households at a higher end of income distribution. Their demand for housing will not be satisfied and it will put upward pressure on house prices. In the long-run, although some demand at the bottom end of the housing market will be satisfied, affordability will not improve to the same extent as when larger properties became available. This is because the greater the values of new built properties, the greater is the improvement in housing supply overall, other things being held constant. This is why building larger properties leads to a greater improvement in affordability than building smaller units.

The examples above compare the quality of two properties expressed in terms of their size. In fact, any attribute of the property that affects its price (location, age, design, etc.) should be accounted for in the concept of effective
housing stock. In the model, the data constraints limit the attributes to location, size, type and age of properties.

The ranking of properties according to the level of housing services they deliver enables the model to identify the properties with the lowest value. These become the first candidates for demolition, if demolition is required. As was explained above, demolished dwellings drop out of the stock and, even if the number of demolished dwellings matches the number of new built properties, the effective stock rises.

4.9 Right to buy and Second homes

4.9.1 Right to buy

The model takes into account Right to Buy (RTB) sales, even though RTB sales net out across the public and private sectors together. This is because RTB sales affect ownership rates and the model needs to distinguish the public and private sectors.

However, the contribution of RTB sales to raising ownership rates depends on a number of factors. For example, if real house prices are rising strongly the cost of purchase is also high, unless the average discount is raised to offset the increase in costs.

In the model, the determinants of RTB sales are assumed to be the local authority housing stock, the average RTB discount percentage, the mortgage interest rate, and house prices. Increases in the discount percentage and higher (expected) capital gains raise RTB sales, but increases in interest rates, which raise borrowing costs, reduce demand. RTB sales are not expected to have much effect on house prices because it both increases the number of owner-occupied households and the owner-occupied supply.

4.9.2 Second homes

Second homes are taken into account as a component of housing demand. However, not all second homes “use up” dwellings. For example, second homes that are let out in the private rental market, e.g. Buy to Let properties, do not have a net effect on demand. Therefore they are not entering the model as second homes. Second homes are held for a number of other purposes as well. Some of these are temporary – dwellings that are going through probate, homes required for individuals working away, homes bought for student offspring. Since these are typically fairly small or temporary categories they are ignored in the model. But holiday homes or weekend cottages (as defined in the Survey of English Housing) are explicitly modelled because they add to demand and influence house prices.

Modelling second homes involves estimation of the probability that a household with a given set of characteristics will own a holiday home. The set of characteristics includes household age, gender, presence of children, marital status and income. The sample used in estimation is restricted to those households who already own a first home as owner-occupiers.
In general, the probabilities of holiday home-ownership are low. As an extreme case, a married male in London with children, aged 45, with an income in the forth quartile has a probability of 5.5 per cent. The probabilities show that gender and marital status do not have strong effects on the probability of owning a holiday home but income and age are important influences. Age has a non-linear effect so that more than 90% of holiday home owners are over the age of 40.

Multiplying the probabilities by the number of households in each group yields the expected number of households with holiday homes. This number influences demand for housing, which in turn affects house prices.

5 Conclusion

This paper presented three blocks of the Affordability model (demographic, housing and labour market) and showed how these are inter-linked. For example, household formation depends on economic factors, such as income, housing cost and unemployment, as well as on demographic factors, such as gender, age and presence of children. These factors affect not only the own population of the region but also generate inter-regional migration flows. Therefore, in addition to demographic factors, housing and labour markets affect the number of households in a region. This number determines demand for housing and hence house prices and the circle of interdependence between the housing market, the labour market and the population completes.

Housing supply is also part of this inter-linked system. Since the number of households forecasted by the model takes account of both economic and demographic variables it contrasts with the official household projections which do not consider economic factors and rely on demographic trends alone. The Affordability model can assume that the official number of households is indeed formed and, if so, allocates houses to those households that are projected above the model’s own household forecasts. This is achieved by suppressing vacancies and demolitions to levels lower than their market equilibrium level – also estimated within the model. This prevents the demolition and renewal of old or less desirable housing stock. The model points to such stock by introducing a concept of effective housing stock. Housing supply is now measured through the volume of housing services that each dwelling contains, allowing the quality of dwellings to be taken into account.

This description shows how affordability is not only the outcome of changes in house prices and incomes but also a factor influencing them. Two more examples highlight the effect of affordability on the tenure split. The distribution of households across tenures takes account of the relative tenure costs, so that when the user costs of housing increase the probability of ownership declines. However, households that are projected above the model’s own forecasts are allocated to the rented sectors. It is assumed that

---

5 The total number of holiday homes is scaled in order to approximate CLG live tables data on second homes.
they would not have formed had housing affordability been taken into account and therefore could not have chosen owner-occupation.

Credit constraints to owner-occupation are another example of the effect of affordability on tenure. However, one of the important features of such constraints is that they do not necessarily provide a permanent hurdle to home ownership; rather they delay entry until the household can accumulate sufficient resources, through saving, to meet the deposit requirement.

Finally, it is important to remember that the Affordability model is concerned with long-term equilibrium and incorporates a number of assumptions based on historical data. The effect of short-term cycles, such as those caused by the credit crunch, may still be observed but this would require a further number of assumptions on the part of the model user.
References


