LONDON'S GLOBAL UNIVERSITY

London's Housing Crisis

A System Dynamics Analysis of Long-term Developments: 40 Years into the Past and 40 Years into the Future

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Declaration

I, Kaveh Dianati, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

Dedication

To Azar,

the love of my life and the light of my world

And to my parents,

for their boundless and unconditional love

تقدیم به **بابا** و **مامان،**

که بهترین‌های زمین‌اند؛

و به **آذر،**

یار و همراه روزهای ابری و روزهای آفتابی.

Abstract

In London, housing affordability has been rapidly declining over the past few decades. Furthermore, London, and the UK in general, has experienced persistent volatility in house prices, new housing supply, and housing finance. These features characterise the main aspects of London's housing crisis which is the topic of this PhD. Our existing understanding of this crisis remains largely fragmented and mostly qualitative.

In this thesis, I build a novel quantitative system dynamics model based on existing literature and statistical data to explain developments in London's housing system since 1980, with a particular focus on the feedback loops between house prices and housing credit. The model is shown to be capable of endogenously reproducing the salient features of the system's past behaviour, such as the excessive growth in prices and housing credit as well as the characteristic boom-bust cycles. Extending the simulation into the future under business-as-usual continues to generate exponential growth and increasingly larger amplitude oscillations.

Furthermore, I simulate a number of policies aimed at mitigating the unchecked growth and volatility. Supply side policies considered include a steep increase in affordable housing construction, a relaxation of planning restrictions, and a combination of the two. These policies show promise in slowing the growth in house prices (and housing debt) but do little to curb market volatility. Demand side policies considered include introducing a capital gains tax on all residential property, lowering average loan-to-value ratios, enforcing historically anchored property valuations for mortgage lending, and a combination of all three. These policies, particularly when combined, appear to be highly effective in eliminating periodic oscillations. They also serve to slow down the worsening of affordability to some extent, but demand-side policies alone do not appear capable of stopping the trend in deteriorating affordability. In order to eliminate large-scale market volatility and simultaneously stop the continual worsening of affordability, it is shown to be necessary to intervene on both sides of the problem with a portfolio of targeted policies.

In conclusion, I argue that the unit of analysis in housing policy and discourse must become feedback loops rather than individual factors. Integrated, feedback-centred, dynamic simulation tools are needed in long-term planning for the affordability and stability of the housing market in London and in the UK. The system dynamics model introduced in this thesis serves as a proof of concept for a promising approach to policymaking in the area of the UK's housing policy.

Impact Statement

Throughout the following chapters, this thesis distils and organises the daunting complexity of the existing knowledge on the UK's/London's long-term housing developments in a set of causal loop diagrams highlighting key feedback loops, which is useful both for understanding past developments and for communicating this understanding. In an environment of predominantly linear narratives seeking to explain the housing crisis, the thesis offers a feedback-oriented explanation which has the potential to enhance the scientific and political discourse around housing.

Furthermore, the thesis describes a quantitative system dynamics model developed during this PhD which offers a useful tool for the analysis of the likely impacts of various policies on the future of housing in the long run. It also serves to integrate existing theories on London's housing crisis into a more holistic picture that contains within it the most important narratives found in the literature. Based on model simulation, the thesis sheds light on possible trends in house prices and housing finance and warns of the dangers of continued large-scale boom-bust cycles in the housing-finance system, if current conditions continue to prevail. Furthermore, upon comparing the relative effectiveness of some key policies on both supply and demand sides, it demonstrates that curbing the continued decline in affordability as well as the unhealthy volatility in the system is possible but requires an ambitious portfolio of policies on both the demand and supply sides of the market.

From an academic perspective, the model presented in this thesis presents an example of applying the SD method adhering to highest standards of rigour and well-grounded in literature. This modelling work can help set a systematic research agenda on well-formulated research questions on particular uncertain links, parameters, and time lags involved in different effects in the system.

From a practical perspective, the transparent model-based analysis presented in this thesis has the potential to make an impact on policymaking in the area of housing in London, as results have been disseminated to policymakers in the Greater London Authority. Given the scale and ambition of the thesis, should these results make their way to make even the smallest adjustment in housing policy, it has the potential to make an impact of millions of households, hopefully improving (even marginally) their access to more affordable housing or their quality of life via mitigating their housing costs.

Acknowledgements

Throughout this PhD, I have been fortunate to have received guidance, help and support from more than a few people (and organisations). The order in which I acknowledge their help does not necessarily correlate with their impact on my work.

I am indebted to EPSRC for having funded this PhD. Before anyone else, I would like to thank my supervisors Dr. Nici Zimmermann, Prof. Mike Davies, Prof. Nick Gallent, and Dr. Josh Ryan-Collins. I am grateful to Nici and Mike for believing in me, for supporting me throughout the PhD and for involving me in high calibre research work besides the PhD, and to Nick for helping me navigate the complex housing literature. I am especially thankful to Josh, whose incisive books and articles and invaluable advice have had a profound impact on my work. I would also like to acknowledge the pivotal influence the late Neil May had in determining the path of this research in its early months.

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On a personal level, I would like to raise a glass to the friendship of my friend Miguel, whose company helped me survive this PhD. Until we meet again, amigo!

When it comes to my family, I cannot begin to express my gratitude towards my parents, who have given me everything. I can only hope and aspire to be worthy of their countless sacrifices. I am as proud as anyone can be of my father, who is my hero, and my mother, who is a saint. My infinite love and gratitude also go to my siblings, Shahram, Zohreh, Yaser, Somayeh, and Ensieh, for always being there for me. I am forever indebted to my sister Zohreh who, many years ago, paid her university allowance to enrol me in English language classes, without which I would not be able to write these words, and to my brother Yaser, who generously paid his wedding gifts so I could travel and study abroad.

Last but certainly not least, I owe more than I can say in a few words to my wife and companion in good and bad days, Azar. Thank you for putting up with my not infrequent existential crises during the course of these PhD years and with the psychological, financial, and sometimes even spiritual hardships of having a PhD student as a partner. Credit for this work goes as much to you as it does to me.

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Abbreviations

AHP	Affordable Homes Programme (scenario)
AST	Assured Shorthold Tenancy
BAU	Business-as-usual (scenario)
BIS	Bank for International Settlements
BSA	Building Societies Association
BTL	Buy-to-let
CDC	Caisse des Dépôts
CGT	Capital Gains Tax (scenario)
CLD	Causal Loop Diagram
CLT	Community land trust
CML	Council of Mortgage Lenders
DCLG	Department for Communities and Local Government
DETR	Department of the Environment, Transport and the Regions
DSR	Debt service ratio
DTI	Debt-to-income
EU	European Union
FCA	Financial Conduct Authority
FML	Financial market liberalisation
FPC	Financial Policy Committee
FSA	Financial Services Authority
GDP	Gross domestic product
GFC	Global Financial Crisis
GDHI	Gross disposable household income
GLA	Greater London Authority
HA	Housing Association
HAV	Historically Anchored Valuation (scenario)
HEW	Home Equity Withdrawal
HTB	Help to Buy
IDS	Integrated Demand-Side (scenario)
IMF	International Monetary Fund

IRR	Interest Rate Rise (scenario)
IRRC	Interest Rate Rise Comprehensive (scenario)
ISS	Integrated Supply-Side (scenario)
LA	Local authority
LSHMA	London Strategic Housing Market Assessment
LSVT	Large Scale Voluntary Transfer
LTI	Loan-to-income
LTV	Loan-to-value
LVT	Land value tax
MHCLG	Ministry of Housing, Communities and Local Government
MIRAS	Mortgage interest relief at source
MIT	Massachusetts Institute of Technology
MMR	Mortgage Market Review
MSE	Mean squared error
NHBC	National House Building Council
NIMBY	Not in my backyard
OECD	Organisation for Economic Co-operation and Development
ONS	Office for National Statistics
PRS	Private Rented Sector
QE	Quantitative Easing
RMBS	Residential mortgage-backed securities
RMPSE	Root mean square percentage error
ROI	Return on investment
RPR	Relaxed Planning Restrictions (scenario)
RSL	Registered Social Landlord
SD	System dynamics
SME	Small and Medium Enterprise
UK	United Kingdom
US	United States

Chapter 1. Introduction

Chapter 1. Introduction

Housing plays a crucial role in the macroeconomy, accounting for the largest part of both wealth and debt for most households (Stockhammer & Wolf, 2019). Based on a recent report by Savills real estate agents, despite the economic uncertainty due to Brexit and the Covid-19 pandemic, the total value of the UK's housing stock has hit a record high of over £7.5 trillion in 2020, with London accounting for 23% of this total (Savills, 2021). In spite of its importance, 'housing is an oddly under-researched topic in macroeconomics' (Stockhammer & Wolf, 2019, p. 43).

Throughout the past decades, a worsening 'housing crisis' has been unfolding in the UK—with London at its epicentre—characterised by 'a widening gulf between those who can afford to house themselves in the market sectors and those who can't' (Edwards, 2016b, p. 222). London's experience of the crisis is particularly extreme, as we will see in the next section. Some scholars view this housing crisis as the 'defining issue' (Dorling, 2014a) or the 'existential crisis' (Gallent, 2019) of our times. This PhD thesis focuses on London's housing crisis from a long-term, systemic perspective and sets out to explain it with reference to developments in various parts of the housing system, on both supply and demand sides. A system dynamics (see Chapter 4) model is developed for this purpose, which is subsequently used to simulate several different policy scenarios.

In this first chapter, we will start by defining and characterising the problem of London's housing crisis in more detail, as seen and dealt with within the scope of this thesis in the next section. The subsequent section briefly discusses the extent to which the specified problem is a unique London issue or a common feature of today's global megacities. The third section outlines some of the socio-economic implications of the housing crisis. Having laid out this background, Section 1.4 will outline the study's overall objectives and approach. Finally, the last section will give an overview of the structure of the remaining chapters of this thesis.

1.1. Characterising London's Housing Crisis

London's housing crisis (and more generally the UK's housing crisis) has many faces, and thus, the term is used to refer to a variety of dysfunctional features of the housing system. This is one of the reasons it has been referred to as a *wicked problem* (Rittel & Webber, 1973) by Gallent (2019) in his recent book *Whose Housing Crisis? Assets and Homes in a Changing Economy*. The various forms of dysfunction that the term has been used to describe include, but are not limited to, the crisis of shortage in housing supply, the housing affordability crisis, the crisis of unequal distribution of housing, the crisis of poor spatial distribution of housing supply and demand, and the crises of homelessness, overcrowding and poor housing conditions. Often, the term 'housing crisis' is used without being explicitly defined or characterised first, with the *a priori* assumption that all readers would have the same understanding of it. To avoid confusion, in this sub-chapter we will attempt to formally define the problem of London's housing crisis with regards to the scope of this study.

This thesis primarily concerns itself with three distinct features of long-term developments in London's housing system, sometimes collectively referred to as the 'housing crisis' in this document. These features include (a) continuous worsening of housing affordability and excessive house price inflation, (b) the inherent volatility in the housing system, and (c) the rise in privately rented housing, the most expensive form of tenure. The following three sections describe each of these dysfunctional trends in more detail.

1.1.1. Developments in Affordability

When referring to the 'housing crisis', the 'affordability crisis' is perhaps the most common meaning that comes to mind. The most common indicator used for measuring developments in housing affordability over time and across regions is the median house price to earnings ratio. This median ratio is determined by ranking all house prices to incomes in ascending order. The point at which one half of the values are above and one half are below is the median (GLA, 2020b). This indicator has been criticised as a measure of affordability, e.g. for not taking into account changes in interest rates (Affordable Housing Commission, 2019a). For a detailed discussion of the relative merits of various measures of affordability, which is not the object of this thesis, the interested reader is referred to Affordable Housing Commission (2019), Meen (2018), or Stone (2006). House price to earnings ratio is still the most widely used measure due to practical advantages such as its intuitiveness and regularly and widely available data (Meen, 2018), and is going to be a key indicator used in this thesis.

In London, as shown in Figure 1.1, the median ratio of house prices to residence-based earnings is now 12.77, down from a peak of 13.25 in 2017 which signified the worst affordability level since data became available. In other words, the ratio has tripled in London since 1997, while in England as a whole it has grown by a factor of 2.2. Since 1997, average gross disposable household income per head of London population has grown by about 3.9% annually (ONS, 2020h), while average house prices have grown twice as fast, at 7.9% per year (ONS, 2020c). This rapid growth of house prices with respect to household earnings signifies an affordability crisis which is not unique to London in the UK but is particularly severe in the capital (Hilber & Vermeulen, 2016).

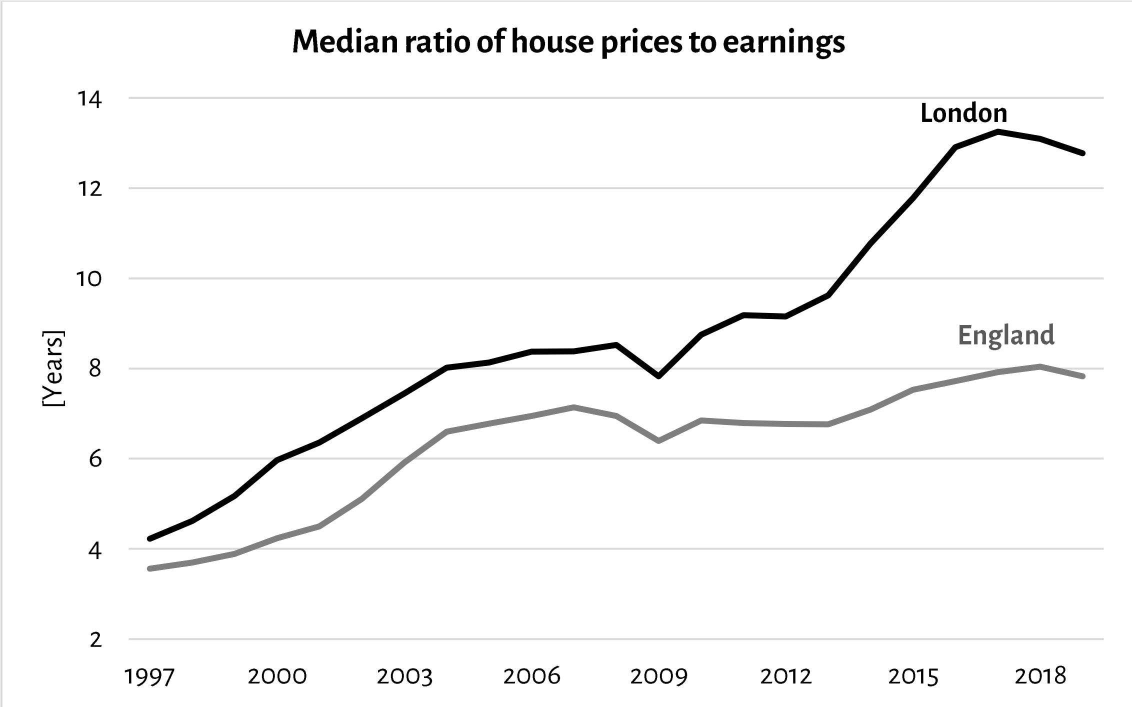


Figure 1.1 – Housing affordability in London and in England 1997–2018

Sources: Table 577 (MHCLG, 2016b) *and the London Datastore* (GLA, 2020b)[1]

1.1.2. Volatility and Cyclicality

Another key dimension of London's housing crisis that is of interest in this research is the cyclicality of house prices, housing finance and housing supply. Figure 1.2 shows a graph of oscillations in house prices, new mortgages, and private residential construction in London since 1980. These are obtained by subtracting an Excel-fitted trendline (exponential in the case of prices and mortgages and linear in the case of construction starts) from the original data on yearly values. Average house price data

[1] Primary data source is the GLA's London Datastore which has been calculating regional data since 2012, when DCLG stopped publishing regional data. The first four years (1997–2001) are extrapolated based on the rates of change in the DCLG data.

GLA stands for Greater London Authority. DCLG stands for Department for Communities and Local Government, which has been replaced by the Ministry of Housing, Communities and Local Government (MHCLG) since 2006. DCLG and MHCLG are sometimes used interchangeably.

from the Office for National Statistics (ONS) and mortgage data from UK finance are adjusted for inflation before being used to derive fluctuations with respect to trendline.

As seen in the figure below, all three variables show short-term fluctuations as well as clear long-term cycles. The latter feature is a central focus of this thesis. With respect to cycles, a high degree of co-movement is visible among the variables. This is particularly stark between *new mortgages* and *private residential construction starts*, both showing two major peaks around twenty years apart – one in the late 1980s and the most recent in the late 2000s – and a smaller one around 2014. In comparison, *average house prices* behaves more smoothly: while it rises and falls broadly in synchrony with the other two variables up until the 2008 financial crisis, it does not show the precipitous fall (and later recovery) thereafter seen in mortgages or construction. Among the three variables, the highest volatility is seen in the derived series for *new mortgage advances*, with a standard deviation of 33%, while the less volatile *average house prices* still shows a substantial standard deviation of 16%.

Housing market volatility is by no means a unique feature of London or the UK. Housing markets worldwide are known to be volatile (Sommervoll, Borgersen, & Wennemo, 2010; Tsatsaronis & Zhu, 2004). Mashayekhi *et al.* (2009) attribute this susceptibility to oscillations to various inherent 'cycle-producing mechanisms' in the housing market that interact in a complex non-linear fashion. These include the long lag in supply, speculation, myopic expectations of actors in the system (Eskinasi, 2014; Wheaton, 1999), as well as the interlinkages between vacant housing and price (Mashayekhi et al., 2009). In a similar vein, within the behavioural economics literature, real estate 'bubbles' are explained with reference to psychological factors, irrational expectations and social epidemics (Shiller, 2007).

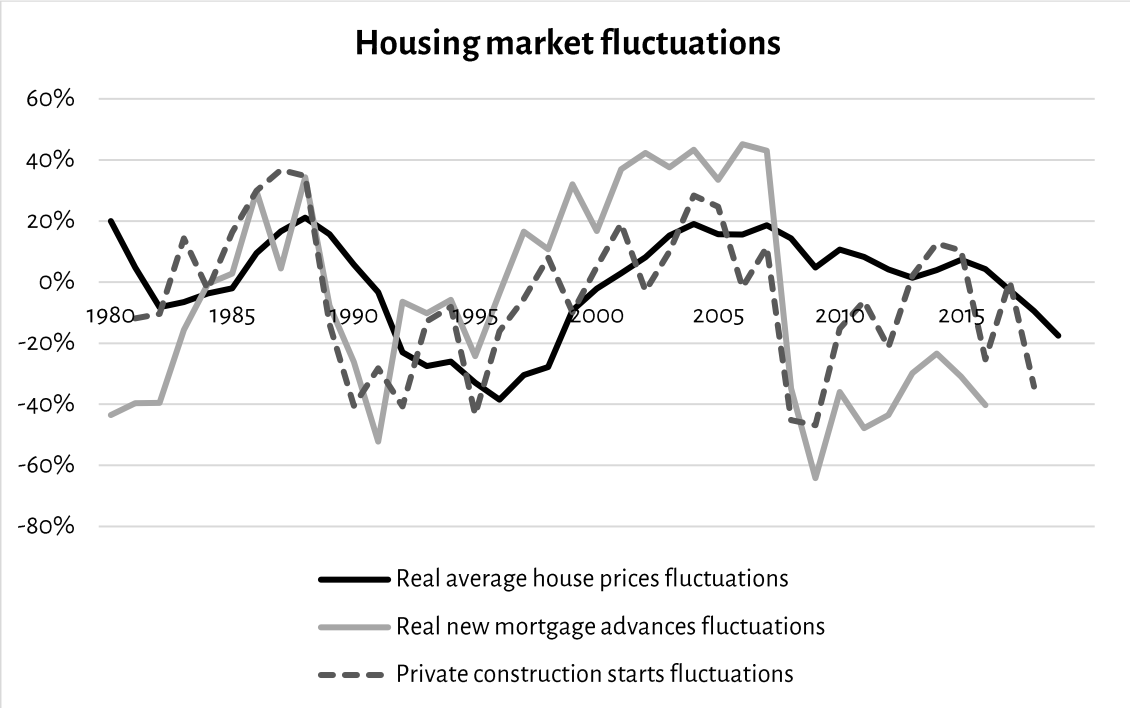


Figure 1.2 – London housing market fluctuations since 1980.

Source: author calculations. Original data sources: average house prices (ONS, 2020c), *new mortgage advances (UK Finance, 2017), permanent dwellings started by private enterprises, Table 253* (MHCLG, 2020b)

Nevertheless, the UK's housing market is known to be one of the most notoriously volatile housing markets in Europe or among OECD countries (Engsted & Pedersen, 2014; Oxley & Haffner, 2010; Whitehead & Scanlon, 2015). Such large-scale cycles contribute to macroeconomic volatility (Barker, 2004, p. 3), distort housing choices, increase instances of negative equity and defaults on housing debts, and contribute to the unfavourable cyclical nature and instability of the overall economy (Stephens, 2011). House price volatility also acts as a major constraint on housing supply as it poses a significant risk in the development process for builders of all sizes (Jefferys et al., 2014).

1.1.3. Developments in Tenure

Figure 1.3 shows developments in the shares of the four main tenure types in London since 1991 based on data from MHCLG's Table 109. It can be seen that, as a consequence of dwindling affordability, the share of homeownership in London peaked around 2000-01 at 58.6% and started to decline thereafter, reaching a trough of 48.2% in 2016 when, as we saw earlier in Figure 1.1, the worsening of affordability seems to have reversed, at least for the time being. Owner-occupiers have now lost their long-held majority in London, holding a current share of 49.1%. This pattern of behaviour is mirrored in *privately rented dwellings*, which starts growing at an accelerated pace around the peak in homeownership in the beginning of the century, until 2016 where the curve flattens around 29%, in line with the halting of the decline in affordability. Within the affordable housing sector, local authority dwellings have been in rapid decline, reflecting the large-scale Right to Buy scheme (see Section 3.4.1.1) and the move towards privatisation which started during the Thatcher administration. In the meantime, some of the loss in council housing has been recompensated by the growth in the number of housing association dwellings. Overall, however, the sum of the latter two types of tenure which together represent the affordable housing sector declined from around 850,000 to around 750,000 units from 1991 to 2007, after which it bounced back slightly up to around 780,000 where it has more or less stagnated since 2010. According to available data, the Private Rented Sector (PRS) surpassed the affordable housing sector in numbers for the first time in London in 2009.

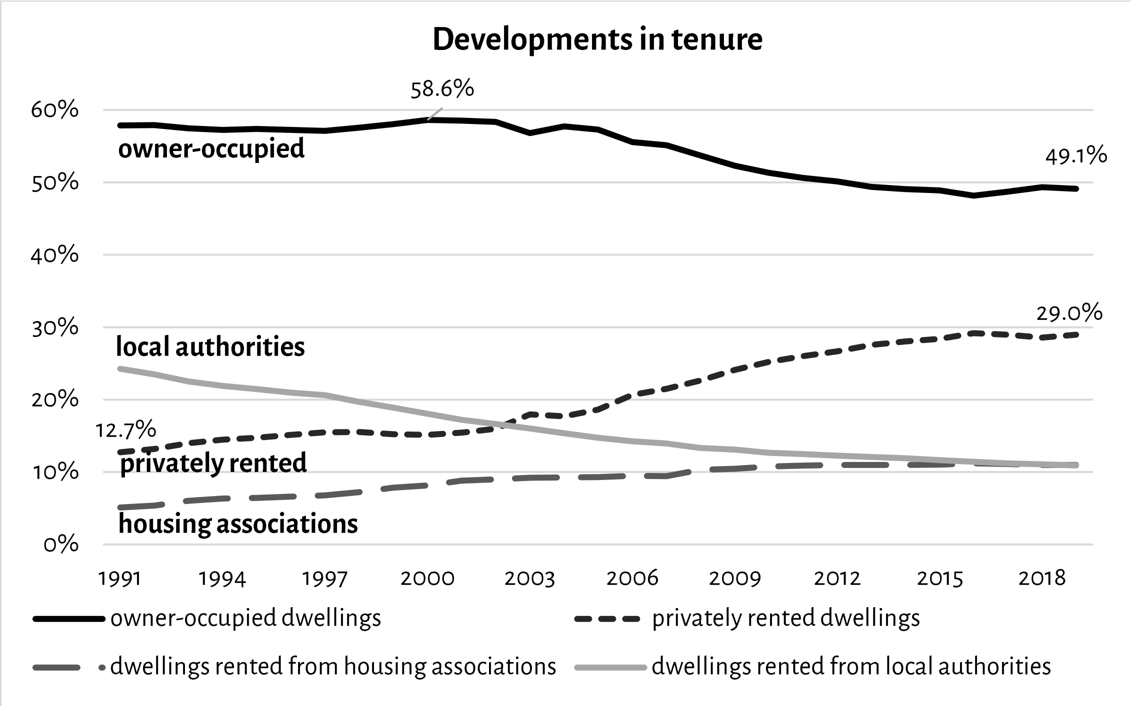


Figure 1.3 – Developments in tenure, London 1991–2019

Source: Table 109 (MHCLG, 2020a), *author calculations for owner-occupied dwellings years 1991–2011 based on existing data for other tenure types and total dwellings.*

Thus, for the most part since the beginning of the century, the PRS has been rapidly growing to fill the gap left behind by declining homeownership and affordable housing. This is despite the fact that, at least on the surface, the government has been actively promoting homeownership throughout the past decades, through tax subsidies for homeowners and the Help to Buy scheme, among other policies (see Section 3.4.1.3). This can be considered a textbook example of what is called *policy resistance* in the system dynamics literature (Sterman, 2000, p. 3), as those very policies designed to promote homeownership are believed to have achieved the opposite of what they were intended to achieve due to unforeseen reactions of the system. As will be discussed later in Section 3.4, the government's housing policy framework targeted towards increasing homeownership is believed by critics to have ultimately led to further inflating house prices, pricing out more households into the PRS than those helped into owner-occupation, gradually slowing down the growth in owner-occupation and eventually reversing the trend by the 2000s.

Growing homeownership is not a prerequisite for a healthy society or economy. While higher rates of homeownership can have positive social outcomes such as increased societal cohesiveness and improved health, from an economic perspective it may restrict labour mobility and, therefore, productivity (Dietz & Haurin, 2003). However, the increasing proportion of households priced out of the buying market and into private rental in London (and more generally in the UK) has been accompanied by a concurrent trend of increasingly expensive, often low quality private rental housing as well as declining security of tenure for renters (see Section 3.2.2). This is partly a result of the passing of Housing Act in 1988 and the introduction of Assured Shorthold Tenancies, which aimed at making renting more attractive via giving more rights to landlords vis-à-vis tenants (Ginsburg, 1989). On the other hand, private renting is the most expensive form of tenure in terms of proportion of income spent on housing. In their recent report, the Resolution Foundation show that, in the UK, 'private renters consistently spend a higher proportion of their incomes on housing than any other tenure group, with significant implications for both their immediate living standards and longer term prospects' (Clarke, Corlett, & Judge, 2016, p. 6). The increasing share of the population living in relatively more costly, insecure and lower quality private rental housing and the plight of a growing swathe of younger households labelled as 'Generation Rent' who face private rental as their only option have been causes for mounting concern (Coulter, 2017).

1.2. London within a Wider Context

The described developments that characterise London's housing crisis, and in particular the declining housing affordability, are not exclusive features of London or the UK. On the contrary, such trends are rather widespread in advanced capitalist economies, so much so that Wetzstein (2017) has coined the term 'Global Urban Housing Affordability Crisis' defined as 'the accelerating trend of housing-related household expenses rising faster than salary and wage increases in many urban centres around the world'

(Wetzstein, 2017, p. 14). Currently, many countries face housing affordability problems and stagnating or falling homeownership rates (Kohl, 2018). Ryan-Collins documents this trend in his recent book *Why Can't You Afford a Home?* (Ryan-Collins, 2018), where he stresses how Anglo-Saxon economies in particular, 'where home ownership is deeply embedded in the culture (Ryan-Collins, 2018, p. 1),' are being especially severely hit.

However, it must be stressed that although declining affordability of housing is now a common feature in modern economies, it is not an inescapable fate. Over the past twenty years, housing affordability as measured by price to income ratio[2], has, on average, remained relatively stable in the OECD area as a whole and has in fact improved in some OECD countries, including Germany, Japan, and Korea (Figure 1.4). During the same period, house price to income ratio has risen by about 50% in the UK. In Europe, Germany and Switzerland have been successful in maintaining healthy and productive economies without relying on the accumulation of excessive amounts of non-productive wealth in the form of housing. These countries have strived to provide their citizens with a variety of attractive tenure options, instead of focusing policy on promoting homeownership as the only desirable form of tenure. Lower levels of homeownership in these countries have not slowed down economic growth (Ryan-Collins, Lloyd, & Macfarlane, 2017, p. 158). In some Far East countries such as Korea and Singapore, economic rent from rising land values is socialized to a far greater extent compared with the UK (Ryan-Collins, 2019). This has helped keep housing affordable in these countries (Ryan-Collins, 2018, p. 127).

Moreover, not all advanced economies have experienced high house price volatility in recent decades. Germany, for example, has been particularly successful in retaining

[2] Nominal house price divided by nominal disposable income per head.

stable house prices and shielding housing from financial or macroeconomic shocks (Voigtländer, 2014). All this is evidence of the fact that there are viable alternatives for social and economic prosperity that do not involve ever-declining housing affordability, as in the house price-centred model implemented in the UK (see Section 3.4.3), or a highly volatile housing market.

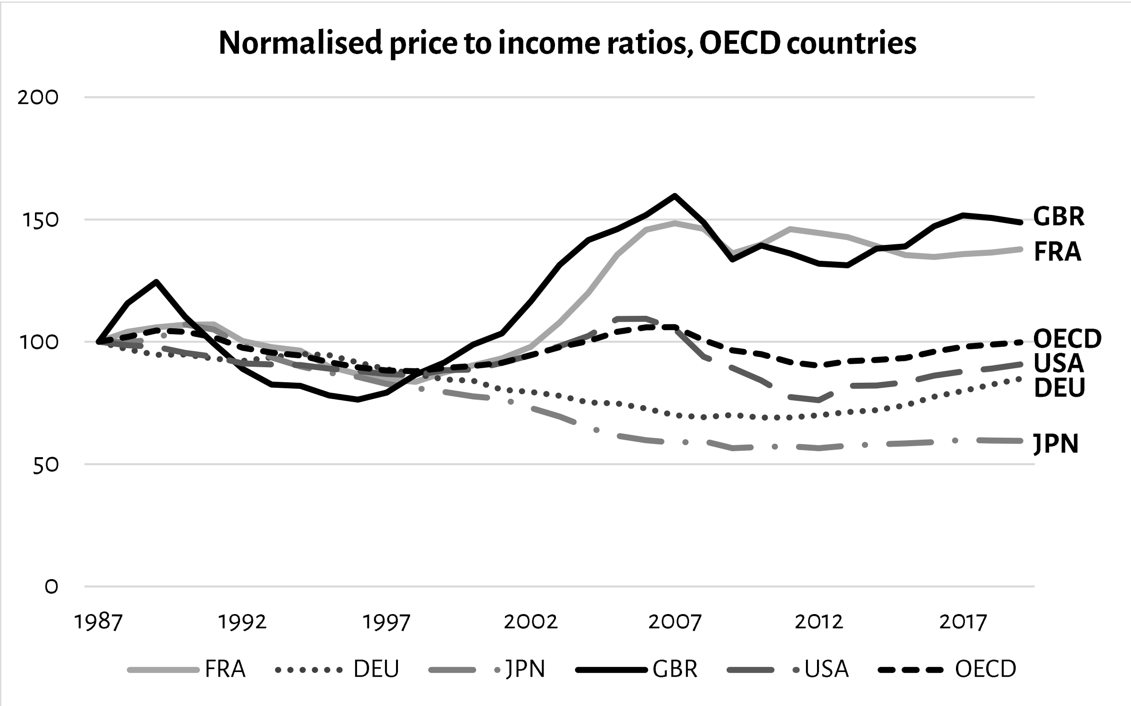


Figure 1.4 – Housing affordability in Great Britain versus other OECD countries

Source: (OECD, 2020)

Within the UK, there is a wide gap between the South of England and the rest of the country in terms of developments in affordability. In Greater London in particular, average house price-to-income ratios are significantly higher than the rest of the country. The region has shown by far the largest decline in affordability since the early 1980s (Halifax, 2016). Having in mind London's position as a global city and a major financial hub, the nature of the housing problem is very different in the North of England, for example, than in the Greater London region. McKee *et al.* (2016) emphasise the importance of spatial nuance and maintain that there is no such thing as a 'UK experience' in housing and housing policy. On the other hand, house price movements in London have tended to anticipate those across the rest of the UK and ripple out across the South East and beyond (Meen, 1999; Muellbauer & Murphy, 1997). London's unique position in the region and in the country justifies considering the study of developments in its housing market as a separate field of study in its own right.

1.3. Socio-Economic Implications of the Housing Crisis

The socio-economic consequences of London's housing crisis are severe. These include overcrowding, homelessness, and adverse health impacts (Edwards, 2016a). London has become increasingly unaffordable for key workers such as nurses, teachers, as well as for the younger generation. Rising prices rippling out from Central London to the outskirts has led to suburban gentrification, which is a threat to communities and social cohesion (Ryan-Collins, 2018, p. 4).

In addition, the widespread wealth inequalities of capitalist societies are often most visible and most material in housing. From a political economy perspective, the relationship between housing and inequality is not one-way but reciprocal and bi-directional: on the one hand there is the Marxian view that social class determines and is crystallised in one's position in the housing market, and on the other hand, we have the Weberian view which maintains that housing actively shapes social relations and is a determinant of social class (Aalbers & Christophers, 2014). In London, the housing market has become an engine of growing inequality, concentrating wealth in the hands of landowners, landlords and established owner-occupiers at the expense of tenants, new buyers and the growing numbers rendered homeless (Edwards, 2016a). With continually rising house prices, socio-economic disparities between the 'housing haves and the housing have-nots' are increasing (Appleyard & Rowlingson, 2010; Barker, 2004, p. 3). Based on data from the UK Wealth and Asset Survey, Arundel (2017) has empirically established housing as the major driver of wealth inequality in the United Kingdom. This inequality is apparent in a myriad of guises for disadvantaged households, from poor location of housing causing negative neighbourhood effects such as long commute times, lack of access to good schools and clean air, as well as a variety of recreational and commercial spaces (Aalbers & Christophers, 2014), and it extends to access to credit, which very much depends on ownership of landed property (Stiglitz, 2015b, p. 134), a preferred type of high-quality collateral (Aalbers, 2016, p. 134) for banks. Furthermore, due to the increasingly larger deposits required to 'get on the housing ladder', it now seems impossible for many young people to afford the initial deposit towards purchasing their first homes without a loan or a grant from the 'Bank of Mum and Dad' (Ryan-Collins, 2018, p. 5). Through linking wealth and opportunity to unearned inheritance, this can hinder social mobility and entrench inequalities across generations (Marsden, 2015, p. 4).

From an economic perspective, the high housing costs in London constitute a major burden on the productive economy and its competitiveness (Edwards, 2015). Furthermore, consumer spending is closely linked to house prices (Berger, Guerrieri, Lorenzoni, & Vavra, 2018; Mian, Rao, & Sufi, 2013) and therefore volatility in house prices, as seen earlier in historical London data (Figure 1.2), can lead to instability in the overall economy. This impact also functions via the financial sector channel since the financial sector and the housing market are tightly inter-dependent under the current deregulated financial regime. This is because real estate is the most important asset on UK banks' balance sheets as well as their key source of collateral for both mortgage and business lending (Jordà, Schularick, & Taylor, 2016; Turner, 2017). Therefore, falling collateral values could lead banks to contract their lending to businesses (Kiyotaki & Moore, 1997). The interactions between the financial and the real economy have been increasingly studied and uncovered since the global financial crisis in 2008 (Duca & Muellbauer, 2013). As made devastatingly clear during that still recent episode, volatility in the housing market can lead to instability in financial markets, and therefore threaten the overall economy.

Given the importance of housing in the economy, the much too real economic hardships associated with housing finance-induced economic slumps, and the severe socio-economic consequences of the rapid decline in housing affordability throughout recent decades, it becomes clear why London's housing crisis, as characterised in this chapter, 'is so threatening to the health, stability and cohesion of the society' (Edwards, 2015). Maclennan and Miao (2017) argue that unless a major shift in housing policy occurs, housing market processes and outcomes will continue to drive higher inequality and lower productivity into the future. Aalbers (2016, p. 32) asserts that 'there can be no meaningful and sustainable progressive socio-economic change *without* the housing question being directly addressed'. Echoing the subtitle of the 2014 book *All That Is Solid* by Danny Dorling (2014a), the housing crisis is a defining issue of our times.

1.4. Research Motivation, Objectives and Approach

Our current understanding of London's housing crisis remains fragmented and mostly qualitative. Studies often tend to look at the issue through a narrow lens, e.g., new housing supply, planning constraints, or credit availability, while those that do attempt to take a more holistic approach draw conclusions based on 'mental simulation'—i.e., mentally inferring and anticipating the dynamic behaviour of the system under study based on cognitive maps of causal interlinkages and feedbacks—whilst it has been established that the human mind cannot be trusted with correctly inferring the behaviours of complex systems with multiple feedback loops (Sterman, 1994). Furthermore, despite the importance of spatial nuance in housing studies (McKee et al., 2016) and the significance of London's housing developments for the country as a whole, there are strikingly few modelling studies of long-term housing developments that focus on London in particular. Based on a review of the state of the art of mainstream economic housing market models in the UK, Bramley and Watkins (2016) observe that '[t]here is a lack of whole-system simulation models, as opposed to models focussed on particular variable' (Bramley & Watkins, 2016, p. 4). In an earlier article, MacLennan &

More (1999) similarly criticised a predominance of sector-specific, cross-sectional and qualitative methods within UK housing studies which, in their view, hindered the production of useful evidence for policymaking. In their own words, 'reliance only on qualitative outcomes may risk the glorification of the anecdote. Research in econometrics, on the other hand, can place too much reliance on prior abstractions about behaviour' (Maclennan & More, 1999, p. 22). The authors conclude that the complex evidence required to support housing policy requires improved analytical frameworks and multi-disciplinary approaches.

The lack of an integrated quantitative study of London's long-term house price developments motivates the choice of scope and methodology in this thesis (see Chapter 4 for more on the choice of methodology). Given the gap in literature briefly alluded to in the previous paragraph, Table 1.1 broadly outlines the overall approach taken in the present study, as compared to those predominantly seen in the UK housing literature.

Table 1.1 – The overall approach of this study versus the predominant approach in the UK housing literature

Most common approaches in the literature	The approach of this study
Fragmented, sector-specific	Holistic, integrated
Static, cross-sectional	Dynamic, long-term
Qualitative	Quantitative
Focus on the UK	Focus on London

Against this backdrop, in this PhD I will apply the system dynamics method towards achieving two principal aims: (a) to put forth a *dynamic hypothesis*—i.e., a theory explaining the dynamics characterising the problem in terms of its underlying feedback structure (Sterman, 2000, p. 95)—for the excessive house price inflation and periodic oscillations in London's housing market since 1980, and (b) to investigate the implications of the proposed dynamic hypothesis for the long-term future of London's housing, both under business-as-usual and under alternative policy assumptions.[3] Rephrased as questions, these principal aims also express the main research questions of this thesis.

Box 1.1. Main Research Questions

a) What are the key underlying mechanisms and central feedback loops responsible for the excessive growth and periodic oscillations in house prices, housing finance and residential construction in London since 1980?

b) What are the implications of this underlying structure for the future of London's housing market under business-as-usual and under alternative policies aimed at dampening excessive house price inflation and oscillation?

Towards reaching the overarching principal aims and answering the central research questions stated above, the following concrete objectives must be attained along the way:

- Develop a systemic understanding of the mechanisms governing London's housing market based on a review of the subject literature;

[3] Note that my main focus in this thesis is on developments in the private housing market, rather than the social/affordable housing sector (although, as will be seen in Chapter 5, affordable housing provision does appear in the model as an important external policy lever).

- Capture and visualise the high-level causal feedback structure of London's housing system with the aid of *causal loop diagrams* (CLDs, see Section 2.6.1);
- Formalise and quantify the dynamic hypothesis within a novel quantitative system dynamics model, parametrised and calibrated based on existing (secondary) time series data from publicly available sources;
- Validate the dynamic hypothesis by using simulation to reproduce past developments in the real system;
- Use the sufficiently validated model to simulate selected alternative policies on both supply and demand sides, derived from the literature;
- Discuss the results and make policy recommendations based on them.

The primary methodology used in this study is system dynamics modelling (Forrester, 1961). System dynamics is a computer-based simulation methodology based upon the idea of capturing elements of 'dynamic complexity' (Sterman, 2000, pp. 21–23), i.e. feedback loops, accumulations, delays, and nonlinearities, which are key in shaping the dynamic behaviour of complex systems. Such elements are ubiquitous in socio-economic systems such as London's housing system, which makes system dynamics modelling a highly suited approach for this research (see Chapter 4).

1.5. Thesis Structure

Following this introductory chapter, in the next two chapters I will present an overview of the literature related to developments in the UK's and London's housing market in recent decades. The upcoming Chapter 2 will focus on the supply side of housing and Chapter 3 on the demand side. At the end of each chapter, I will synthesise the information gleaned from the literature on cause-and-effect relationships in a set of causal loop diagrams, which become increasingly comprehensive as the chapters advance. Next, in Chapter 4 I will present my methodology, give a brief overview of housing-themed literature in the field of system dynamics, and introduce the key data series and sources used in this study. Subsequently, building on the qualitative dynamic hypothesis developed through Chapters 2 and 3, I will document the formal quantitative system dynamics model in detail in Chapter 5. Then, in Chapter 6, I will present the results of simulating the described model and attempt to validate its behaviour against available historical data. Next, with sufficient confidence built in the usefulness of the model for its purpose, I will use it to make projections into the future in Chapter 7, both under business-as-usual and under different policy scenarios. Finally, in Chapter 8, I will summarise and discuss the insights gained through simulation, the policy implications, and the study's limitations, and I will close with a few concluding remarks. Two glossaries are appended to this thesis; the first covers housing terms (p. 358) and the second covers system dynamics terms (p. 360).

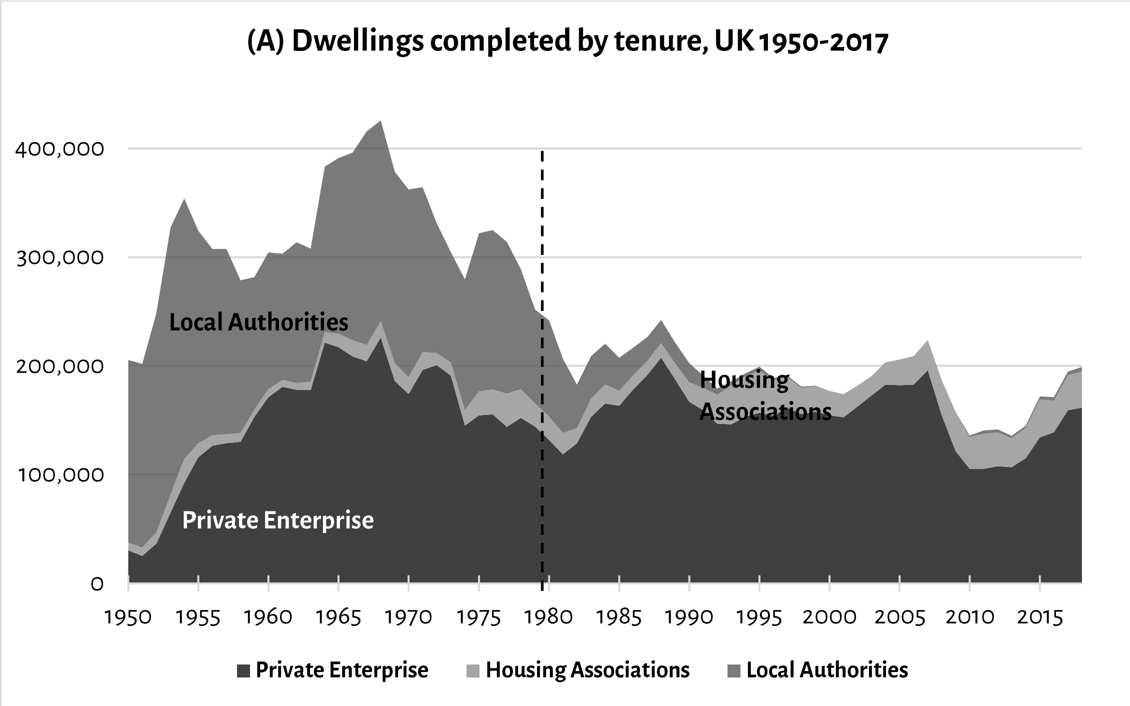
Chapter 2. The Supply Side of Housing

Chapter 2. The Supply Side of Housing

The prevailing account of the housing crisis in London (and more generally in England) is a narrative revolving around a shortage of new housing supply, to the extent that for many, the 'housing crisis' is synonymous with a crisis of shortage in supply. I will start this chapter by an account of the supply shortage discourse in the next section. Next, I will turn to a competing narrative which views the crisis from a lens of unequal distribution of housing space rather than an absolute shortage. Subsequently, Section 2.3 attempts to shed some light on the question of the extent to which planning restricts the supply of new build housing. The following section looks at the structure of the housebuilding industry and how the way it is structured influences the rate at which new housing units are supplied to the market. The single most important input to housebuilding is land. Section 2.5 covers key issues around residential land, such as residual land pricing, economic rent, and speculation in the land market. In Section 2.6, I synthesise the cause-and-effect notions alluded to in this chapter in a causal loop diagram of the supply side of housing in London. Lastly, the final sub-chapter gives a summary of the literature reviewed on housing supply.

2.1. The Supply Shortage Narrative

As shown in Figure 2.1, the total supply of new housing in the UK has been in decline since 1968 and has consistently failed to reach government targets, 'despite repeated reviews and policy initiatives to reform the planning system and boost private house building' (Ryan-Collins et al., 2017, p. 99). In London, where data from the MHCLG is only available since 1980, on average about 17,500 total dwellings have been completed every year since then, 25% lower than the starting point at about 23,000 and likely much lower than the peak in the late 1960s judging by the overall UK trend.



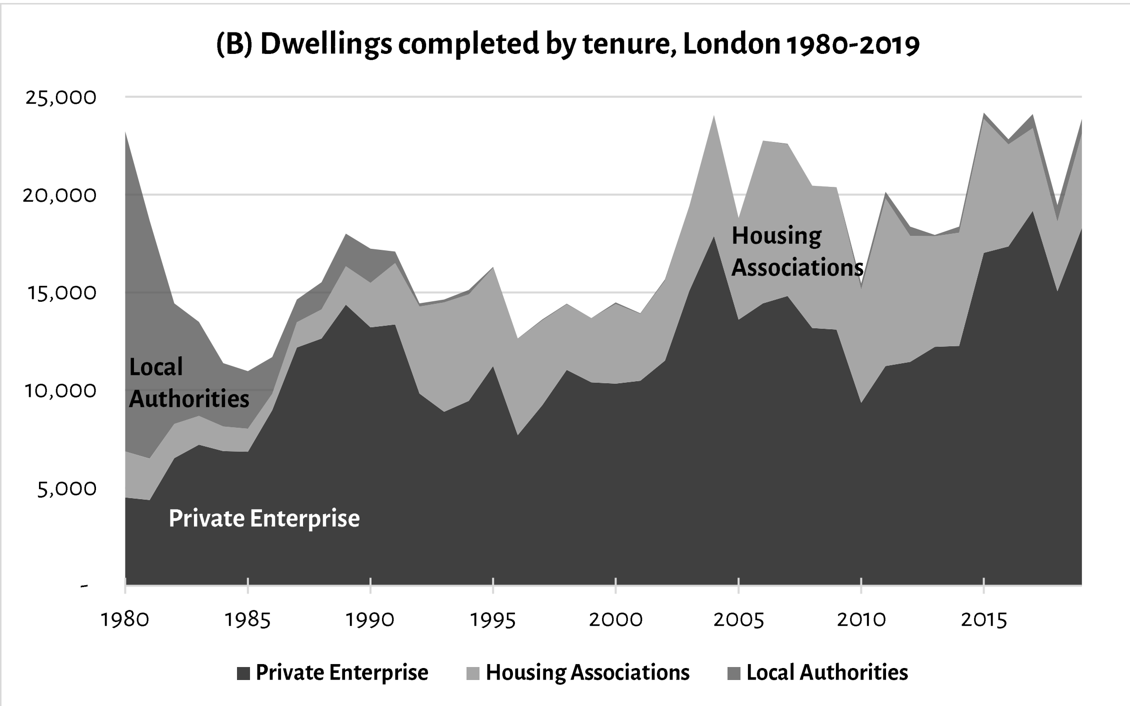


Figure 2.1 – Dwellings completed by tenure: (A) UK 1950–2018; (B) London 1980–2019

Source: (MHCLG, 2020b) *Tables 241 and 253. Note that the scales and timeframes of the two graphs, as determined by data availability, are different.*

London, and the UK, used to have a huge and growing public housing sector up until the 1980s. Housebuilding in the UK reached its peak in the 1960s, with over 425,000 homes being built in 1968, nearly half of which was contributed by the public sector (Figure 2.1, A). State building did not cause any crowding out of private sector building, as during the same years of maximum state intervention, the private sector was also building at its fastest. This boom in housebuilding led to a rapid rise in owner-occupancy, making it the dominant form of tenure in the UK by 1971 (MHCLG, 2020a). Since then, however, there has been an enormous contraction—or an almost complete cessation—in public sector housebuilding, which is the main contributor to the decline in overall housebuilding since the 1970s. A small proportion of this loss has been replaced by an increase in building by housing associations, but this increase has been marginal. The decline in supply has therefore been largely at the affordable end of the market (Harris, 2003).

Over the last 40 years, private housebuilding in London and in the UK has failed to keep up with the growth in house prices. Housing supply in the UK is known to have a low price elasticity. Malpezzi and Maclennan (2001) estimate a price elasticity of supply between 0 and 1 for the post-war UK, while their estimate for the US for the same period is between 6 and 13. Meen (2005) reviews existing evidence on the responsiveness of housing supply to changes in house prices in the UK and his conclusion includes the following assertion:

> *There is no doubt that price elasticities of supply in England are low (in comparison with the US) and have fallen further since the early 1990s.*
> (Meen, 2005, p. 968)

In the words of Maclennan and More (1997, p. 539), in this case 'Adam Smith's "Invisible Hand" may not be so sure and steady'. In a recent Australian study, Murray (2020) has theorized that rising house prices might even disincentivise supply by encouraging developers to wait for higher prices that make higher densities of building economically viable.

The most significant document on the topic of housing supply during the 2000s was Kate Barker's *Review of Housing Supply*, commissioned by HM Treasury and the UK Government (Barker, 2004). The Review predominantly highlighted the supply shortage, its impact on declining affordability, and the unresponsiveness of housing supply to house prices. It defined two ambitious alternative scenarios where an additional 70,000 (120,000) units of private sector housing per year could help reduce the then long-term annual house price growth rate of 2.4% down to 1.8% (1.1%—the European average). Towards achieving these ambitious targets, the Review set out several recommendations primarily targeted at making the planning system more aligned and responsive to market developments, e.g., via setting national and regional affordability targets and via reforms to local government finance to incentivise stronger local authority support of new housebuilding.

The supply shortage narrative is further bolstered if we compare growth rates in population, number of jobs and the dwelling stock for London against the same growth rates for England as a whole. Figure 2.2 shows average annual growth rates of these three variables between 1996 and 2019 for London and for England. As can be seen, while both population and the number of jobs have been growing at a considerably faster rate in London as compared to England as a whole, the stock of housing has grown at the same rate of 0.8% per year on average. It should perhaps come as no surprise, then, that, during the same period, average house prices in England grew by 6.3% per year while prices in London grew by 8.1% per year on average.

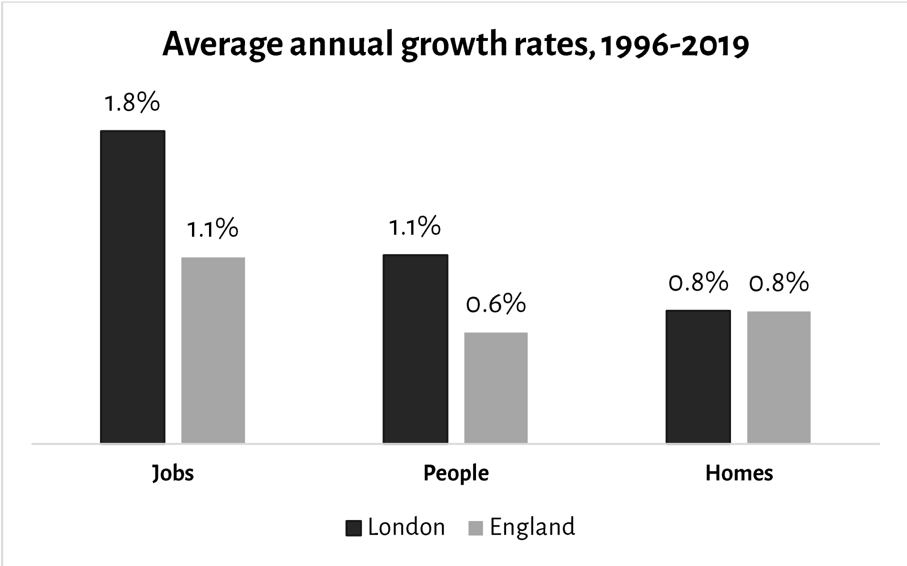


Figure 2.2 – Average annual growth rates of Jobs, People, and Homes, London vs. England 1996–2019
Source: author's calculations based on workforce jobs by region (ONS, 2020f), *mid-year population estimates* (ONS, 2020a), *and Table 109* (MHCLG, 2020a) *for Job, People, and Homes, respectively*

The latest London Strategic Housing Market Assessment (LSHMA) 2017 (GLA, 2017, p. 94) estimates a need for about 66,000 new homes every year between 2016 and 2041. In the same year, the latest London Strategic Housing Land Availability Assessment 2017 (LSHLAA) (Mayor of London, 2017, p. 1) shows that London has the capacity for about 650,000 new homes over the 2019–2029 10-year period, i.e. 65,000 per year. This figure is reflected in the GLA's recent analysis of London's affordable housing funding requirements, which envisages 50% of this target (i.e., 32,500 units per year) being delivered as affordable homes over the 2022–2032 period. It is easy to see how highly ambitious this target is if we note the fact that in 2019, total new housing supply was about 24,000 new units, out of which only about 5,500 were affordable. In other words, the above target is 2.7 times higher than the present rate of total new supply and about 6 times higher than the rate of new supply of affordable homes.

The new draft London Plan (Mayor of London, 2019) sets out a slightly lower, but still ambitious, target of 522,870 total new units over the 10-year period 2019 to 2029 (52,287 units per year on average) out of which 35% (18,300 units per year) must be affordable

(Mayor of London, 2019, p. 177,199). Already in 2019, actual figures fell far short of these targets, undershooting the target for total new housing by about 54% and the one for affordable units by 70%. Each year we fail to build enough homes, we add to the growing backlog of unmet need. According to estimates in the LSHMA (GLA, 2017, p. 6), in London there may be a backlog of over 452,000 units of housing who are currently in unsuitable accommodation. These include households not in self-contained accommodation of their own, households in self-contained private sector accommodation who need to move to affordable housing, and households in self-contained affordable housing who need to move to a more suitable home. LSHMA 2017 also reports that the scale of backlog need is far higher in London than in the rest of the country.

Thus, a supply shortage is seen by many (Barker, 2004; Breach, 2019; Cheshire, 2014; Hilber, 2015; Hilber & Vermeulen, 2016; Jefferys et al., 2014; Ratcliff, 2019) as the essence and the main driver of the UK's and London's worsening housing crisis. This prevailing characterisation of the housing crisis is in line with neoclassical economic thinking, the dominant school of economics in teaching, research and policymaking since the 1970s, which places an emphasis on supply-side solutions (Ryan-Collins et al., 2017, p. 5). This view transcends political divides (Gallent, Durrant, & May, 2017) and is so ubiquitous that is held as synonymous to the housing crisis in much of today's media discourse on housing.

2.2. Critiques of the Supply Shortage Narrative

Notwithstanding the dominant discourse outlined in the previous section, it is essential to note that not all commentators concur with it. Indeed, Mulheirn (2019) argues that both in England as a whole and in London in particular, new housing supply has exceeded new household formation for decades and, as a result, we have an absolute surplus, rather than a shortage, of housing. Official ONS and MHCLG statistics show that since 1991, London's total housing stock and total number of households have both grown by around 19% (MHCLG, 2016a, 2020a; ONS, 2020b). In absolute numbers, total housing stock has grown by 547,000 units while number of households has grown by 542,000. Estimates by the GLA based on census data show that in 1991 there was a surplus of about 150,000 units of 'dwellings' over 'households' and in 2018 we still had a surplus of about 70,000 units (GLA, 2020a). Furthermore, a recent study by Tunstall finds that between 1981 and 2011, median housing space per person remained at roughly 1.5 rooms per person in London, which does make the capital the worst off region in England in terms of space per person but still implies that space per person has *not* shrunk during the three decades of the study (Tunstall, 2020).

Furthermore, the idea of shortage in supply as the sole cause of house price inflation has been criticised for not taking into account the fact that the housing market is a predominantly second-hand market, with new build accounting for only a small proportion of housing sales per year. As shown by data on residential property sales from the ONS visualised in Figure 2.3, since 1995 the share of newly built houses in total sales has fluctuated between 5.3% and 16.3% of total and has been just below 10% on average. Therefore, it is difficult to see how this relative minority of transactions should determine prices in a largely second-hand market (Barker, 2004, p. 4).

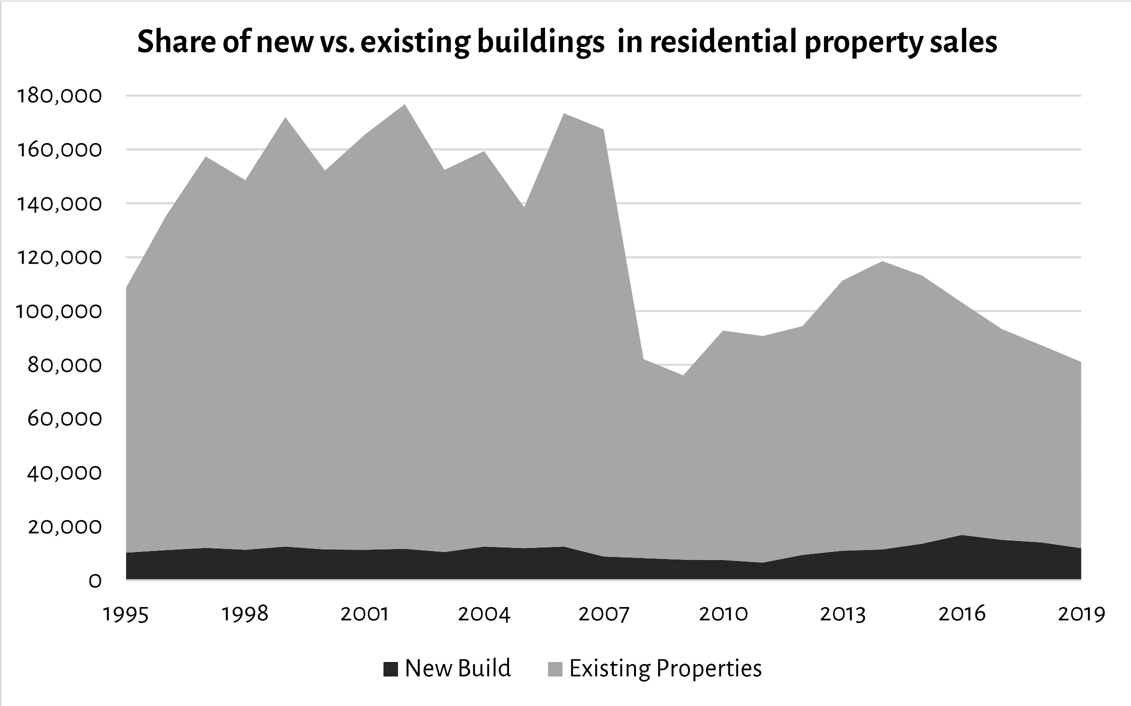


Figure 2.3 – Share of new build vs. existing properties in total residential property sales, London 1995–2019

Source: ONS House price statistics for small areas in England and Wales (ONS, 2020d), *HPSSA datasets 7 and 8*

Fingleton, Fuerst and Szumilo (2019) use a dynamic spatially disaggregated panel model while accounting for the knock-on effects of local supply shocks to other districts and find that increasing housing supply in the most critical areas in London and the Southeast has little impact on affordability.

Such arguments make it hard to believe that the key to London's housing crisis would lie solely in accelerating the supply of new build homes. The question that still remains, however, is why then there appears to be a growing backlog of housing need in London, having grown from an estimated 349,000 units in 2013 (GLA, 2014b, p. 2) to 452,000 units in 2017 (GLA, 2017, p. 6).

Dorling (2014) argues that, rather than an absolute shortage of housing, the housing crisis has to do with inequality in the distribution of housing which has been growing since the 1980s (Dorling, 2014a, p. 65). In his argument, Dorling cites the work of Tunstall (2015) who finds that, while housing space inequality continuously decreased from the 1920s up until the 1980s, between then and the 2010s the trend has reversed and housing space inequality has risen back to levels of 50 years prior or higher. She reasons that considering that income inequality appears to have gone through a similar trend of continued falls since the 1930s and a sharp rise since the late 1970s, it is plausible to expect that the corresponding trend in housing space inequality should be related to developments in income inequality, especially given the growing role of the free market—as opposed to the state—in housing allocation since late 1970s (Tunstall, 2015). The link between income inequality and housing space inequality is further corroborated by the fact that housing space—as a 'positional good' linked to social status (Ryan-Collins et al., 2017, p. 9; Veblen, 1899)—is known to have a high income-elasticity of demand: a 10% increase in income leads to over 20% more spending on housing space for upper income groups (Cheshire & Sheppard, 1998).

Dorling (2014) stresses the role of rising numbers of vacant properties, often left empty as speculative investment vehicles, in the growing inefficiency in the use of housing space. In the same vein, Mulheirn (2018) highlights the role of the growing number of second homes, Airbnb, and buy-to-hold properties in restricting 'effective supply' (see Section 3.2.2 for more on buy-to-let and private landlordism) and argues that an affordability measure is therefore a preferred metric in order to decide whether effective supply has been growing at an adequate rate. Mulheirn's argument is along the same lines as Dorling's and Tunstall's, all concurring that London's housing crisis has to do with growing income inequality worsening the inequality of access to housing, rather than a growing shortage in supply *per se*.

To reiterate, Dorling (2014) maintains that '[t]he British have enough land and housing; it is just that increasingly most of is owned by a smaller and smaller elite (Dorling, 2014a, p. 306),' and that 'the housing market will not be made more equitable through voluntary action on the part of the most interested parties' (Dorling, 2014a, p. 307). He therefore makes an argument for a reorientation of UK housing policy from an emphasis on expanding supply towards redistribution of the existing housing stock in a more efficient and equitable manner, not only among people but also among regions of the country.

2.3. The Role of Planning in Restricting Supply

The prevailing paradigm which frames the housing crisis as a crisis of shortage in supply also tends to blame the UK's restrictive and bureaucratic planning system as the prime culprit for this shortage. Taking an ideological 'free market' perspective, a vocal stream of neoclassical literature (Breach, 2020b; Cheshire, 2014, 2018; Hilber, 2015; Hilber & Vermeulen, 2016), blames the failure of planning in releasing sufficient parcels of land quickly enough as the root cause for the shortage in supply. Based on a review of the evidence on the relationship between house prices and housing supply, Barker (2008) suggests that 'planning constraints are a key factor behind the long-term upward trend in house prices. (Barker, 2008, p. 34). A leading theory contends that these constraints 'reflect political economy forces that convey the interests of current homeowners to planning decisions in disproportionate and excessively influential ways' (Coelho, Dellepiane-Avellaneda, & Ratnoo, 2017, p. 31). Coelho *et al.*'s (2017) empirical survey finds that in the decade to 2011, the housing stock grew significantly less in local authorities with higher proportions of owner-occupiers, suggesting that planning decisions may have been distorted in favour of current homeowners.

Typically, housebuilders join in on putting the blame on the planning system. In a recent report by the Home Builders Federation (HBF), for instance, the current planning system is said to have had a significant long-term impact on new build supply:

> *The introduction of the plan-led system in 1991, and its creation of a near-absolute limit on the availability of housing land, has had a significant long-*

> *term impact on housing completions. Under our plan-led system, in which many local authorities have operated without robust, up-to-date plans, house building has become a more complex, risky and costly business.* (HBF, 2015, p. 2)

Thanks to the far-reaching influence of the incumbent mainstream neoliberal school of thought, in the words of Gallent *et al.* (2017), '[a] point has been reached in policy discourse where the elimination of barriers to increased housing supply appear to be the only show in town, supported by a partial political economy that frames housing as an investment choice shackled by bureaucracy in the form of land-use planning' (Gallent et al., 2017, p. 2209). Parts of London's Green Belt are particularly singled out as unnecessary barriers to housebuilding with little or no environmental or amenity value (Cheshire, 2013).

A competing perspective, however, maintains that planning restrictions simply reflect the reality of the inherent scarcity of land, and that rather than planning restrictions, the most important bottleneck in housebuilding has historically been excessive land banking, which in some instances can be best described as 'land hoarding' (D. Adams, Leishman, & Moore, 2009; White, 1986). The issue of land banking will be discussed further in Section 2.5.3.

Further undermining the idea of planning restrictiveness as the culprit behind slower-than-desired private construction, Ryan-Collins *et al.* (2017, p. 158) also argue that, unlike the UK, Australia and the US have relatively decentralised and faster-moving planning systems with greater local autonomy, but they have both experienced periods of very rapid house price inflation. Murray (2020) tells a similar, but more drastic, story of land hoarding in Australia, where he finds that the eight largest housing developers hold an equivalent of 13 years of new supply in their land banks, and that the rate of new housebuilding is in fact unrelated to the amount of land zoned and approved for residential building in a region. Furthermore, Ryan-Collins (2018) points out that, although the UK's planning system might be less flexible than elsewhere in Europe, the planning system did not suddenly become more restrictive during recent decades, and therefore this alone cannot explain the exponential rise in prices in this period (Ryan-Collins, 2018, pp. 34–35).

In sum, there continues to be heated debate around the extent to which planning restrictions inhibit new housebuilding, as well as the extent to which any subsequent shortage in supply might be driving declining housing affordability. As briefly introduced here, the evidence appears to be mixed and inconclusive.

2.4. The Housebuilding Industry

The vast majority of new homes completed in the UK since the early 1980s have been built by the private house-building industry (MHCLG, 2020b), which is dominated by a small number of very large firms (D. Adams et al., 2009). Most houses are built speculatively rather than by contract (Callcutt, 2007, p. 15). This dominant business model has important implications for the quality and quantity of new supply of housing and gives rise to several important features of the housing system.

Speculative housebuilding is risky business. Land development and housebuilding involve lengthy time lags and therefore land purchasing and buildout rate decisions need to be made on the basis of highly uncertain forecasts of house prices and housing finance, especially given the volatility of the housing market (Ball, 2003). In order to mitigate the high risk, developers employ various strategies. For instance, speculative housebuilders are geared to mass production and the industry is believed to suffer from a lack of innovation, poor customer focus and scant interest in environmental sustainability (D. Adams et al., 2009).

Moreover, the risky and capital-intensive nature of the business means that developers tend to shy away from expanding buildout volumes, even in times of high demand, and instead focus on maximising profit margins and return on capital employed (Payne, 2020). The next section looks at this prevalent attitude towards volume within the UK housebuilding industry. Subsequently, the following section looks at the trend of increasing consolidation in the housebuilding industry and its implications.

2.4.1. Developers' Attitude towards Volume

The UK has a relatively low housing development intensity, completing fewer dwellings (2.65) per thousand population compared with other European countries such as Germany (3.53), The Netherlands (4.06) or France (6.70) (Linhart, Hána, Zsebik, & Marek, 2020). In the past decades, numerous reviews and analyses have studied this comparatively low level of housebuilding (Greenhalgh, McGuinness, Robson, & Bowers, 2021).

Jefferys *et al.* (2014) argue that competition in the housebuilding industry occurs at the wrong stage. Typically, there is fierce competition in the land acquisition stage where developers are bullish and tend to bid the highest possible price in order to secure land—a key determinant of their share of the market. Such bullish bids to acquire land are only viable because developers often face limited competition in any particular site. With reduced threat of competition, it becomes easier to programme the housing development process to achieve optimistic revenue predictions when bidding for land, which is done by drip-feeding the market, i.e., limiting the number of units for sale at any one time so as to maximise profits (D. Adams et al., 2009; Gallent et al., 2017; Jefferys et al., 2014).

Payne (2016) argues that research examining housing supply constraints has conventionally focused on investigating structural barriers e.g., planning, and land allocation systems, while more recent research on developer behaviour indicates that their institutional behaviours play a much more significant role in constraining housing supply than traditionally thought (Payne, 2016).

In principle, private companies do not exist to build the socially optimum or economically essential number of homes (Archer & Cole, 2014). As noted by John Callcutt in the Callcutt Review, '[h]ousebuilders are not in business to serve the public interest, except incidentally. Their primary concern is to deliver profits for their investors' (Callcutt, 2007, p. 4). Private housebuilder build only when it is profitable to do so (Archer & Cole, 2014). Thus, in her article based on interviews with executives of large housebuilding companies, Payne (2016) points out the cautious attitude of developers towards expanding volume and concludes that Britain's private speculative housebuilders alone will not be able to build out in sufficient volume to meet the country's housing supply needs.

A recent review by Conservative MP, Sir Oliver Letwin, commissioned by the Chancellor of the Exchequer, concludes that the principal cause of the slow buildout rates is a lack of diversity of new build units in terms of size, type, tenure and design, which restricts the absorption rate (Letwin, 2018). However, Greenhalgh *et al.* (2021), using data from the Leeds City Region over an 11-year period, find the exact opposite of this, reporting that residential developments with higher diversity have lower absorption rates and vice versa. They find, nevertheless, that smaller sites are built out faster and recommend measures to increase the number of small residential sites and 'break the oligopoly of the volume housebuilders and provide more opportunity for small housebuilders to enter the market' (Greenhalgh et al., 2021, p. 17). This links to the topic of the next sub-section on increasing consolidation in the housebuilding industry.

2.4.2. Industry Consolidation and Its Effect on Supply

The private residential development market has become increasingly concentrated and oligopolistic over the last decades. By 2012, the share of homes in Britain built by large house building firms, each building over 500 units per year, had grown from about 40% in 1990 to nearly 70% (see Figure 2.4). Various factors, some unique to the UK, have contributed to the fact that larger housebuilders have steadily increased their market share. For example, larger developers often take over smaller firms as a strategy to access their land banks, given the constrained availability of development land in the UK (Archer & Cole, 2014).

With each housing boom-and-bust cycle, a number of smaller more vulnerable housebuilders do not survive the bust and end up either going out of business or being bought up by the larger players. Larger developers have a greater chance of riding out difficult times, thanks to their larger portfolios, land banks and asset bases and better access to credit, luxuries that SME developers do not have (Ball, 2003; Jefferys et al., 2014). Therefore, volatility in the housing market and the high levels of risk of doing business that goes with it have led to increasing consolidation over time. This has been especially important since the decline of social housebuilding, which traditionally acted as a countercyclical force (Stockhammer & Wolf, 2019). Furthermore, fierce competition over securing access to increasingly expensive plots of development land poses an insurmountable barrier to entry in the industry for many potential new entrants to enter the market and grow (Ryan-Collins et al., 2017, p. 95).

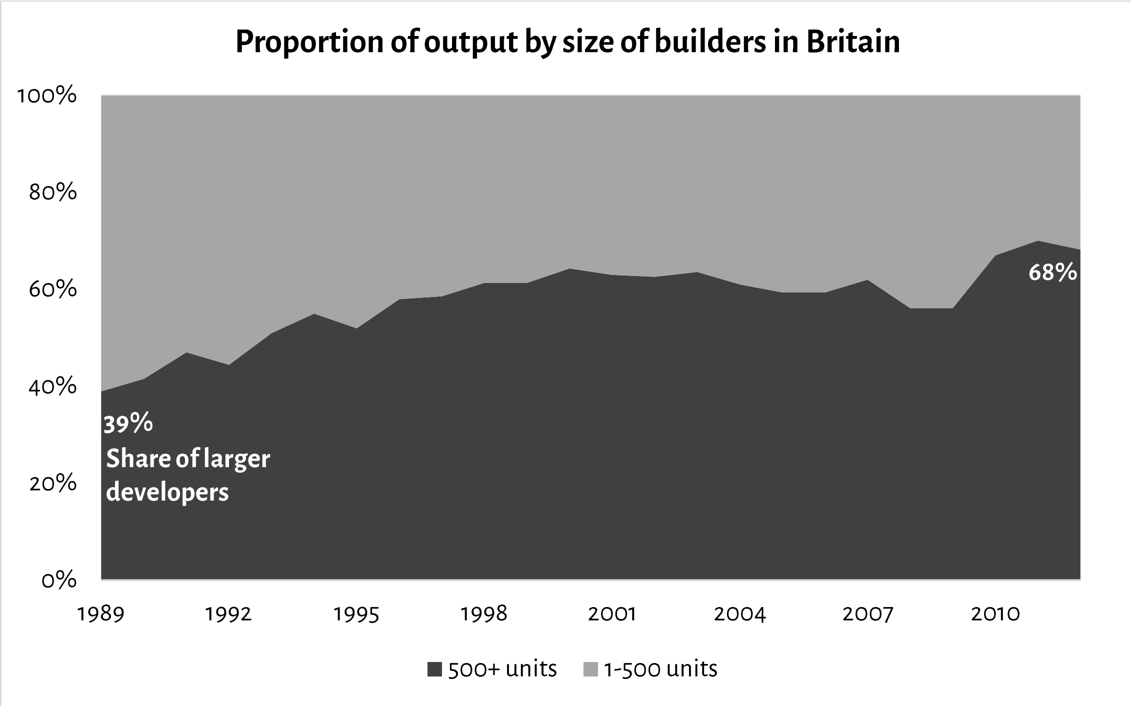


Figure 2.4 – Market share by size of housebuilding firm, builders building 500+ units per year (dark grey) vs. smaller builders (light grey)

Source: (NHBC, 2007, p. 17) and (Jefferys et al., 2014, p. 67). *Data reflects builders registered with the National House-Building Council (NHBC) only.*[4]

This trend towards increasing concentration in the housebuilding industry has implications for both the quantity and the quality of new housing supply. As mentioned in the previous sub-section, competition among developers happens upstream during land acquisition. Once land is secured, competitive pressures are reduced downstream in the housing market. In terms of buildout rate, as discussed earlier, it is argued that reduced competition as a result of the increasingly oligopolistic structure leaves the quantity of new supply in any area at the discretion of the few big market players, who tend to seek to maximise profit margins as opposed to output volume (Jefferys et al., 2014; Ryan-Collins et al., 2017, p. 108). In terms of innovation and quality, it is argued

[4] NHBC no longer produces updates for this data series.

that increased concentration means that 'to a large extent, housebuilders can "sell anything"' (D. Adams et al., 2009, p. 297).

Therefore, in relation to the idea or the likelihood of a shortage in new supply playing a key role in the housing crisis, the trend towards increasing concentration and the emergence of an oligopolistic structure in the industry finds relevance. Besides the high degree of market volatility, we saw that access to land also appears to play a role in this trend. The next section will focus on land, the single costliest input to the housebuilding process and the housebuilder's key asset.

2.5. Land for Housing

Land is the principal input to housebuilding. The dynamics of house prices are very tightly related to the dynamics of land prices (IPF, 2018). Conceptually, some economists view the price of housing as the sum of the price of the land underneath the housing unit plus the 'replacement cost' of the house, i.e., the value of the physical structure of the building, which is a function of construction costs (Knoll, Schularick, & Steger, 2017). In a large-scale study of 14 advanced economies (including the UK), Knoll *et al.* (2017) conclude that it is land prices, not construction costs, that hold the key to understanding long-run developments of house prices, and that by far the greater part of the increases in house prices in recent decades in the 14 economies in question has originated from land prices rather than construction costs which have been relatively flat in comparison. Similarly, in a UK study, Devaney *et al.* (2018) use a residual valuation model (see the next sub-section) to generate land value series for different types of land and different regions in England. They find that a common feature in their various results is that land values are primarily driven by development values, with construction costs being 'remarkably stable over time' (IPF, 2018).

In recent decades, much of the increase in economic wealth in some advanced economies, including the UK, has been in the form of accumulation of non-productive wealth in land, as extensively documented by Thomas Piketty in his seminal book, *Capital in the Twenty-First Century* (Piketty, 2014). Piketty suggests that this trend is related to the growing inequality in many advanced economies since the 1970s. In a review of the role of housing in recent developments in wealth inequalities as identified by Piketty (2014), Maclennan and Miao (2017) highlight the significance of shifting housing wealth in increasing inequalities in advanced economies.

In the 2017 book, *Rethinking the Economics of Land and Housing*, Ryan-Collins *et al.* give an incisive account of how the under-representation of land in neoclassical economic thinking has led to the failure of policy to address structural problems related with land, most important of which is the extraction of economic rent (Section 2.5.2) that is related to the rising inequality observed by Piketty (2014). Ryan-Collins *et al.* (2017) give an account of how in classical political economy, the predecessor to modern neoclassical economics, land was seen alongside capital and labour as one of the three main factors of production (Ryan-Collins et al., 2017, p. 3). In the 1930s, however, based on Clark's seminal *marginal productivity theory*, economists Harrod and Solow developed their ground-breaking 'two-factor growth model', which became an important foundation of neoclassical economic theory. The two factors of economic production according to this foundational model are capital and labour. In this still prevalent model, land has been conflated with capital and is therefore absent as a distinct factor of production from neoclassical economic theory (Ryan-Collins et al., 2017, pp. 4–5).

However, several features of land make it distinct from capital and difficult to fit into existing neoclassical economics theory. Above all, land is inherently scarce and irreproducible. The supply of land cannot readily expand to meet an increase in demand and is often fixed—more so in dense urban environments like London. Also, land is permanent and does not depreciate in value over time, as does capital. In fact, the value of land tends to appreciate over the years. The scarcity and permanence of land along with its tendency to increase in value over time make it a highly desirable asset for storing wealth as well as an ideal collateral for raising finance (Ryan-Collins et al., 2017). As pithily put in the quote attributed to Mark Twain, *'buy land, they're not making it anymore'*.

Albeit that land plays a central role in the economy, its role is often overlooked and under-represented within mainstream economics. Ryan-Collins *et al.* (2017) suggest that this poor understanding of the role of land in economies is at the root of 'many of the policy failures and problems that bedevil modern societies (Ryan-Collins et al., 2017, p. 1)' and contributes majorly to the housing affordability crisis and the related crises of financial instability and excessive household debt (more on this in Chapter 3).

In this section, we are going to look briefly into some of the key issues around land which are particularly relevant to developments in the housing market. The first sub-section on residual pricing of land explains the way in which housing and land prices are intertwined. The second sub-section discusses how key characteristics of land enable the possibility of the extraction of economic rent from land. The third sub-section takes a closer look at land banking, which was briefly alluded to earlier. Lastly, the final sub-section highlights how speculation in the land market can lead to volatility of land prices.

2.5.1. Residual Land Valuation and Its Consequences

In order to determine the highest viable bid to make for any piece of land, developers start with evaluating what might most profitably be built on a site within a particular market, given any constraints including those arising from planning obligations. As mentioned earlier, the supply of homes for sale in any area is vastly dominated by the second-hand market, making housebuilders price-takers in this sense (D. Adams et al., 2009). Subsequently, from the estimated selling price of the envisaged development, the costs of production and the desired level of profit are deducted, leaving the ceiling price that the builder is prepared to pay for land (Jefferys et al., 2014, p. 34). This is referred to as 'residual land value', as illustrated below in Figure 2.5, taken from IPF (2018), and has widespread global applicability for calculating land values in the development industry (Murphy, 2020).

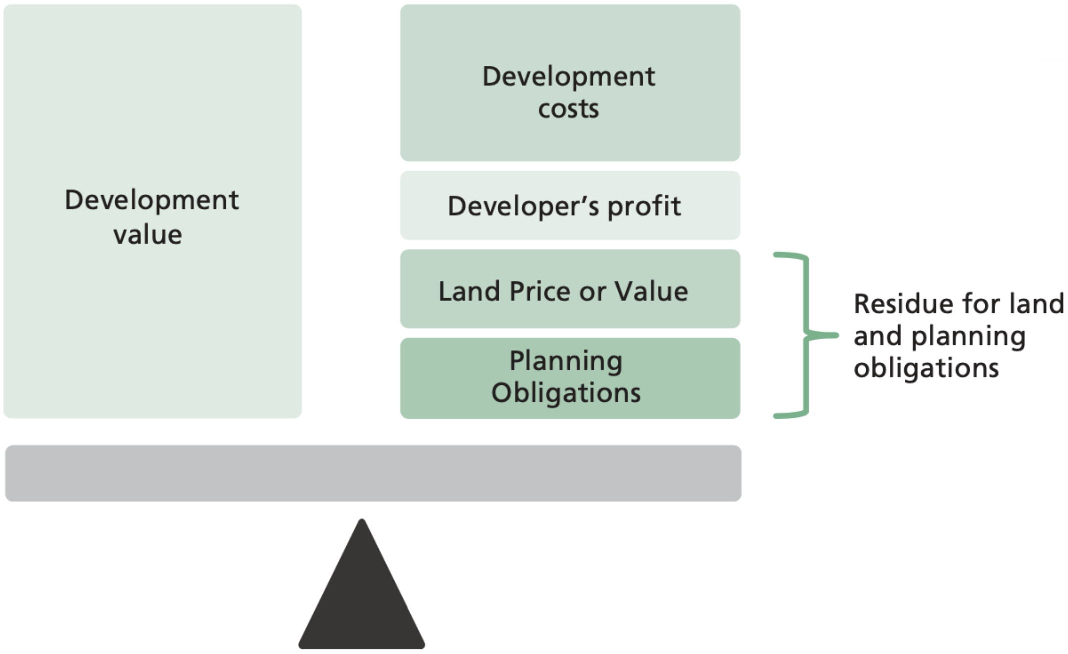


Figure 2.5 – Residual land valuation.

Source: (IPF, 2018)

Residual land valuation entails that developers who bid most optimistically will win the site, while those who are not bullish enough risk losing their market share. Over-optimistic bids ratchet up the target price at which developers must later sell the houses to make their target profit margins (D. Adams et al., 2009; Jefferys et al., 2014, p. 38), activating a self-reinforcing cycle whereby higher house prices spur higher bids for land that in turn push up target housing sales prices.

An important consequence of this system is that highest-density, lowest-cost development with the lowest possible affordable housing and infrastructure provision is systematically prioritised by profit-maximising private developers (Jefferys et al., 2014). Furthermore, as this process involves highly uncertain forecasting of future prices and market conditions, it poses the caveat of transferring a significant amount of risk, including risks associated with planning delays, interest rate changes, and house price variations to housebuilders. This means that development tends to be close to the margin of viability and vulnerable to external shocks. In a review of the wide-ranging consequences of the residual valuation method for the housing market, Murphy (2020) concludes that it is 'more than a mere technical device.[...] Through its recursive employment, it enrols actors in practices that cumulatively co-produce prices and enact physical outcomes (housing developments)' (Murphy, 2020, p. 1514).

Residual valuation also means that landowners tend to capture much of the rise in house prices in the form of windfall gains (Jefferys et al., 2014, p. 38; Ryan-Collins et al., 2017, p. 98; White, 1986). This is linked to the issue of land and economic rent which is explored in more detail in the following sub-section.

2.5.2. Land and Economic Rent

Economic rent has been defined as 'income derived from the ownership, possession or control of scarce assets and under conditions of limited or no competition' (Christophers, 2019, p. 2). Since each location can be considered more or less unique, ownership of every piece of land is to a large extent monopolistic (Ryan-Collins, 2018, p. 13). As a result, landowners can, by virtue of ownership of a particular piece of land rather than any effort on their side, extract rent from users of the land (Ryan-Collins et al., 2017, p. 11).

The topic of economic rent extraction from land features prominently in the Marxian political economy literature. The highly influential British political economist David Harvey (1999, p. 330) stresses how 'ground rent' was a major area of concern for Marx. In the Marxian view, densely populated and/or scarce and prestigious locations create opportunities for extracting 'monopoly rent'. This should be a cause for concern and scrutiny since such rent is 'a deduction out of the surplus value produced in society as a whole [and] a redistribution [...] of aggregate surplus value [towards the landlord]' (*Capital*, vol. 3, p. 833 cited in Harvey, 1999, p. 350). In this view, such distributional relations are considered an outcome of class struggle and 'an expression of deeper forces which circumscribe the relative powers of the classes involved' (Harvey, 1999, p. 362). It is also worth noting that, for the influential political economist and author of *Rentier Capitalism*, Brett Christophers, since the rise of neoliberalism during the 1970s and 80s, the UK economy has been not only financialised (see next chapter, Section 3.3) but also, equally importantly, *rentierized*, in the sense that it has increasingly shifted towards economic activities 'structured around the control of, and generation of income ("rents") from, scarce assets' (Christophers, 2019, p. 2), as demonstrated by his quantitative and qualitative analysis of trends in eight key 'rentier' sectors.

The value of a particular piece of land is a function of the uses it can be put to. Therefore, public investments in infrastructure can boost the value of nearby land (Henneberry, 1998). A review commissioned by Transport for London (TfL) and carried out by KPMG and Savills estate agents, which used transactions data from Land Registry and controlled for background price inflation and local place effects, revealed that past London transport projects such as the Jubilee Line Extension and the Docklands Light Railway extension to Woolwich produced significant value uplifts in nearby land of 52% and 23% respectively, relative to controls. Looking ahead, it was estimated that a portfolio of eight prospective TfL projects that are projected to cost around £36bn (including Crossrail 2, the Bakerloo line extension and the DLR extension to

Thamesmead) could produce land value uplifts of about £87bn (TfL, 2017, p. 7). Such capitalization of public investment in private wealth implies large-scale transfers of wealth from the taxpayer to a minority of landowners (Ryan-Collins et al., 2017, p. 195).

Fairness considerations aside, excessive rents from the ownership of land are also considered economically inefficient because as land prices rise, this does not lead to an increase in economic productivity. According to economic theory, this can in fact lead to a stagnation or decline in wages because a rising share of revenues going towards rents implies a lower share of revenues going towards wages (Stiglitz, 2015a, p. 143). Rent seeking involves efforts towards getting 'a larger share of the pie rather than increasing the size of the pie' (Stiglitz & Bilmes, 2012).

As a result of the dominance of the two-factor production model in mainstream economic theory which neglects land as a distinct source of income, windfall gains extracted in the form of rent from exclusive ownership of land are often overlooked (Ryan-Collins et al., 2017, p. 217). Ryan-Collins *et al.* (2017) suggest this is the key reason why policymakers have failed to address the problem of excessive economic rent from land ownership.

2.5.3. Speculation in the Land Market and Land Banking

The primary consequence of the inherent scarcity and permanence of land is that land values have risen over time since after the Second World War (Knoll et al., 2017), making it a desirable investment asset. The security and prestige traditionally associated with land ownership has always made it an attractive sink for surplus capital (Harvey, 1999, p. 348). These, together with long time lags in housing development, information asymmetries, and rapidly growing and volatile prices, incentivise speculation (Jefferys et al., 2014). Trading land speculatively is a way of extracting rent from exclusive ownership of land and turning it into profit. A business model based on speculation in the land market, rather than building and selling homes, is often the source of greatest profit for developers (Ryan-Collins et al., 2017, p. 96).

In the previous sections of this chapter, we briefly alluded to the issue of land banking. Put simply, land banks are portfolios of land held either as a buffer for housebuilding by a housebuilder or for speculative land trading purposes by a housebuilder or a non-developer organisation. Given the time involved in obtaining planning permissions, retaining a stock of land with permission as buffer can be an appropriate business strategy for smoothing out the peaks and troughs. This is called a 'current land bank' (Jefferys, 2016). However, developers also sometimes hold 'strategic land banks' without planning permission, often held with 'option agreements' to buy the land within a certain time or after it has gained planning permission. In this way, they can capture more of the uplift in its value once the land obtains planning permission. Strategic land banks also prevent any potential competitors from entering the regional market through making suitable development sites unavailable for purchase, and in effect giving developers monopoly power in a particular area (Griffith, 2011, p. 33).

A 2015 investigation by The Guardian revealed that Britain's top 9 housebuilders hold enough land to build over 600,000 new houses, four times the rate of annual housebuilding at the time (Graham Ruddick, 2015). While developers do need to hold a certain number of sites in their pipeline, in the piece in The Guardian, Toby Lloyd, former head of policy at Shelter, is quoted to have commented that 'when housebuilding is still stubbornly low and landbanks are this large it is a signal of how dysfunctional our housebuilding system is'. According to another estimate by the Shelter organisation, in England, the top 10 developers who are responsible for around half of all housebuilding hold an equivalent of more than 400,000 units of housing, or six years' worth of supply at the time, in their current land banks (Jefferys, 2016). This does not include strategic land banks. Jefferys (2016) estimates that the amount of land held onto strategically is even larger, at least equivalent to over 480,000 units or seven years' worth of supply. A 2007 report based on a survey of the top ten UK housebuilders' annual reports, the Royal Town Planning Institute found that these top housebuilders held outstanding planning permissions for about 225,000 homes, equivalent to 2.7 years of supply (MacDonald & Kliman, 2007). Comparing this figure with the more recent estimates by The Guardian (2015) and Shelter (2016) mentioned above could indicate a steep increase in developers' land banks since 2007.

Given the evidence on large land banks held by developers and the increasingly oligopolistic structure of the housebuilding industry which allows developers to plan the release of new units to achieve desired profit margins, Ryan-Collins *et al.* (2017, p. 216) stipulate that when developers criticise planning restrictiveness, what they are in fact seeking is a transfer of control over the speed at which land is released into the market (in the form of new development) from the state onto their own hands, not necessarily resulting in a large-scale land release at all.

More worryingly, a substantial proportion—an estimated 22%—of 'stalled sites' in London seems to be held speculatively out of production in the hands of non-development firms (GLA, 2014a, p. 17). Besides limiting the supply of much-needed homes, such hoarding behaviour has been shown to have destabilising effects in systems (Sterman, 2015), and may contribute to exacerbating volatility in property markets. This issue is further explored in the following sub-section.

2.5.4. Volatility in Land Prices

Speculation and excessive stocks of land being 'sat on' in land banks is not the only source of volatility in land markets. There is also strong evidence that the linking of land as the most important form of collateral to financial markets has exposed land prices to the inherent volatility of financial markets (more on this in Chapter 3). Figure 2.6 shows the trends in house and land prices in the UK over the last seventy years. Since the 1960s there have been three major boom–bust cycles, in line with expansions in bank credit in the 1970s, late 1980s and 2000s (Ryan-Collins et al., 2017, p. 8). It can also be seen that over this period, land prices have grown far more than house prices. Oscillations in land prices are closely related with those in house prices, as the cost of construction (labour and materials) tend to be less volatile and mostly follow the general economy-wide rate of inflation (IPF, 2018; Ryan-Collins et al., 2017). Ryan-Collins *et al.* (2017, p. 192) argue that this inherent volatility that occurs as a result of various complex drivers, including delays and information asymmetries in the property market, invalidates the general equilibrium and perfect market assumptions central to neoclassical economics, calling into question the usefulness of models and analyses built upon such assumptions.

Land and house price volatility, together with time lags involved in housebuilding, make developers largely risk-averse (Jefferys et al., 2014; Payne, 2015), with important consequences on their approach to output volume (as seen earlier in Section 2.4.1). This can bring new housing supply lower than it otherwise could have been under a stable regime, contributing to excessive growth in house prices.

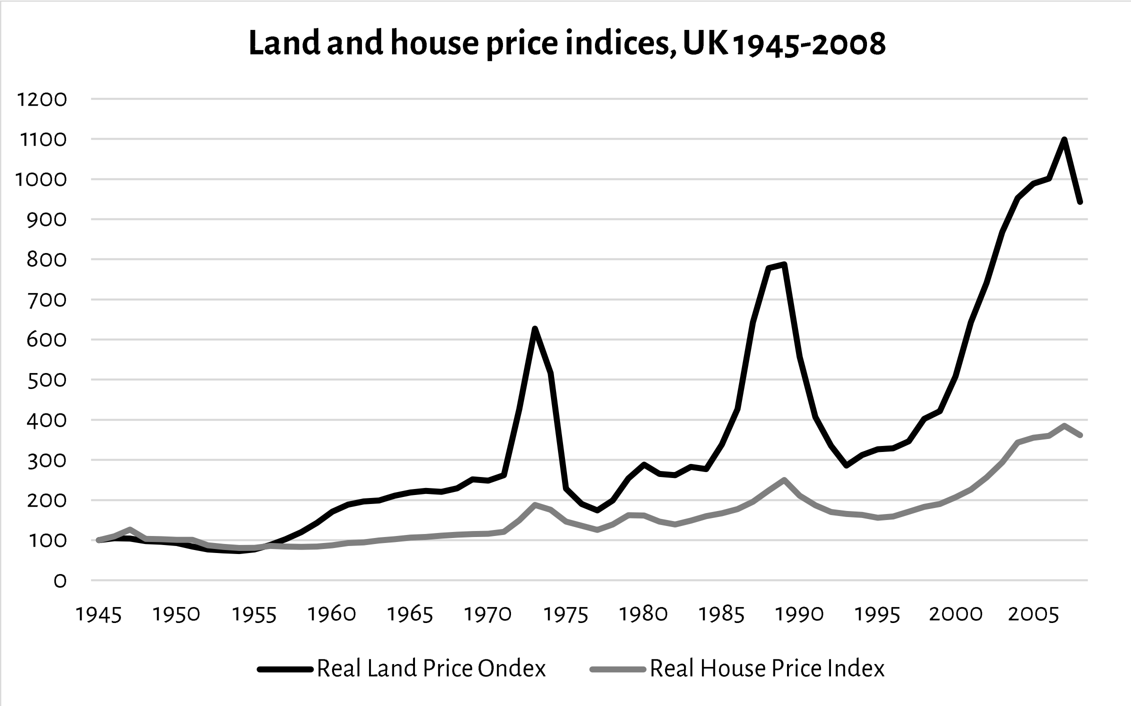


Figure 2.6 – Real land and house prices indices, UK (1945=100).

Source: (Cheshire, 2009)

2.6. Causal Loop Diagram

In the preceding sections of this chapter, I identified several causal relationships among variables on the supply side of the housing system. In this section, as in the final sections of the next chapter, I will build a causal loop diagram capturing key cause-and-effect interlinkages revealed in my review of existing evidence. In doing this, I am going to identify and highlight major feedback loops that are likely to be influential in determining the dynamic behaviour of the housing system, in relation to my central focus on housing affordability and housing market volatility. But first, I will give a short introduction to causal loop diagrams for the benefit of readers outside the field of systems thinking.

2.6.1. Introduction to Causal Loop Diagrams

Causal loop diagrams (CLDs) are tools (within the system dynamics approach which is fully described in Chapter 4) for representing feedback structure of systems, often used as powerful visual aids to capture existing theories about causal relationships observed in systems (Sterman, 2000, p. 137). A CLD consists of variables connected by arrows representing causal relationships. Each arrow captures a causal link from a *cause* to an *effect*. The polarity shown at the end of each arrow determines the direction of the relationship: A plus sign (+) indicates a same-direction relationship, where if *A* increases, all other things equal, it will cause *B* to increase, and if *A* decreases it will cause *B* to decrease as well (see Figure 2.7, left). A minus sign (-) indicates an opposite-direction relationship, where if *C* decreases, *ceteris paribus*, it will cause *D* to increase and if *C* increases it will cause *D* to decrease (see Figure 2.7, right).

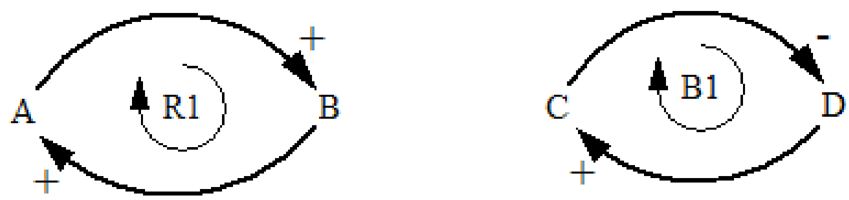


Figure 2.7 – Introducing causal loop diagrams (CLDs)

In real-world systems, causal relationships are often two-way relationships where *A* is not only a driver of *B*, but it is also affected by it. Such two-way relationships which often implicate more than just two variables, are called *feedback loops*. Feedback loops can be either *reinforcing* or *balancing*. A reinforcing feedback loop, such as *R1* in Figure 2.7, describes a dynamic where an initial increase in *A* will lead to an increase in *B*, which will feed back to result in a further increase in *A*.[5] Reinforcing loops are destabilising and have the potential to generate exponential growth in systems if left unchecked (Sterman, 2000, p. 108). In the real world, however, nothing can grow forever and, sooner or later,

[5] A reinforcing loop can equally result from the coupling of two or any even number of links with negative polarities. Conversely, if the number of links with a negative polarity in a feedback loop is an odd number, it becomes a balancing loop.

balancing forces will kick in to curb any exponential growth. Balancing loops, such as *B1* in Figure 2.7, on the other hand, occur when an initial increase in a variable—*D* in this example—would lead to an increase in another variable, *C*, but an increase in *C* would feed back to result in *D* going back down. Naturally, such mechanisms are stabilising and tend to generate goal-seeking behaviours where the system converges towards a certain equilibrium (Sterman, 2000, p. 111). The coupling and interlinking of several reinforcing and balancing loops, as in real-world socioeconomic systems, can generate all sorts of complex, unexpected, and often counter-intuitive behaviour.

With this introduction, I am now going to present a simplified CLD of major forces on the supply side of the UK/London housing market in the next section.

2.6.2. Causal Loop Diagram: Supply-side Dynamics

The supply-side CLD is shown in Figure 2.8. All links in this diagram are based on evidence already presented in this chapter. The CLD is therefore meant to synthesise the reviewed evidence in a visual and systemic way.

Let us start with our central variable of interest, *house prices*, and the first feedback loop labelled *R1: Housing-Land Prices Loop*. As *house prices* go up, the amount that developers are prepared to bid for land increases, raising *land prices*. Land is the primary input to housebuilding and higher *land prices* will inevitably feed into higher *house prices*. This constitutes a tight reinforcing feedback relationship between *house prices* and *land prices* with the potential to bring about a rapid concurrent rise or a precipitous fall in both, depending on whether we are in a boom or a bust period. Furthermore, as briefly mentioned in the Land and Economic Rent section, a rise in *land prices* can also put pressure on *household disposable income* via increased prices and rent that businesses pay for industrial and commercial properties and therefore a reduced proportion of revenues available to pay as wages. This leads to a further increase in *house price to income ratio* (a decrease in housing affordability) by way of the earnings channel.

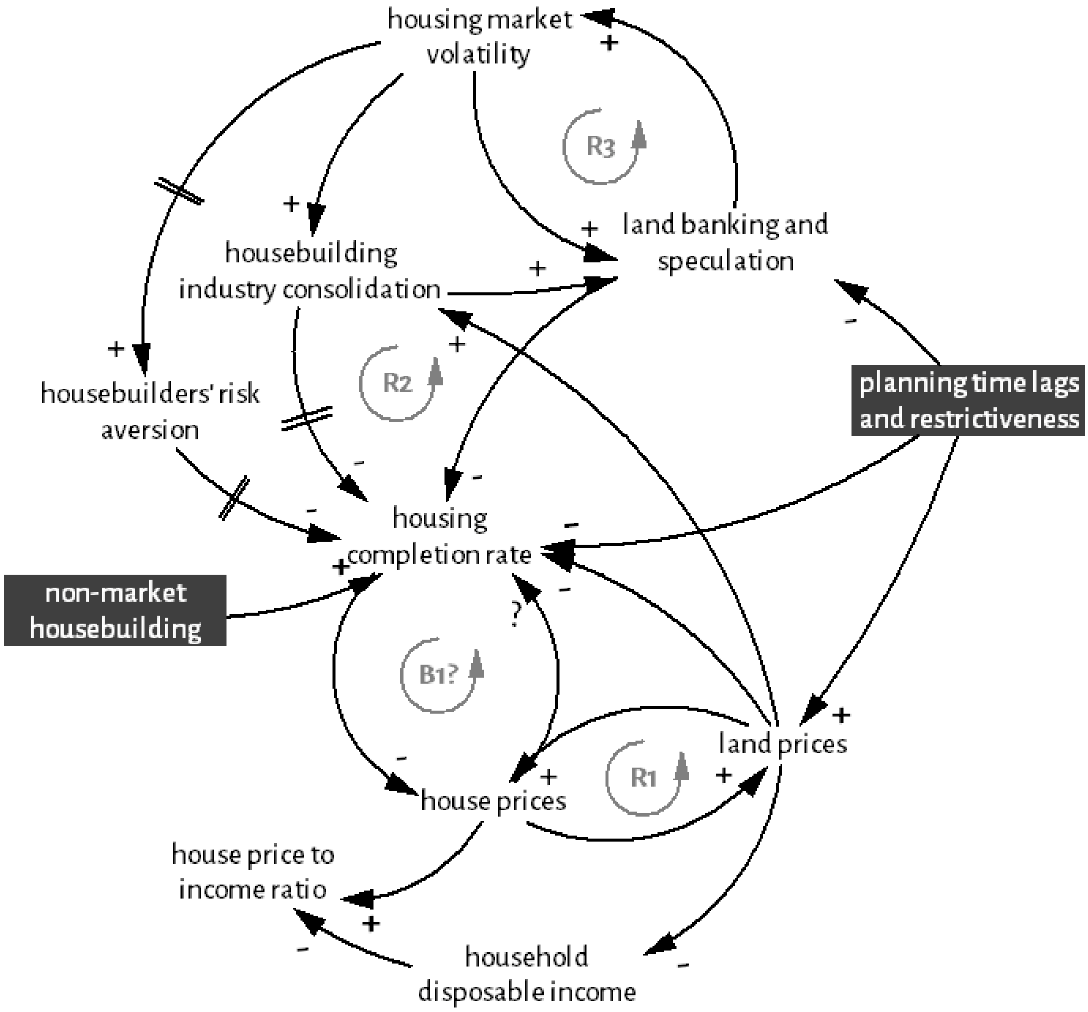


Figure 2.8 – Causal loop diagram of the housing supply side

A potentially balancing feedback loop may exist between *house prices* and *housing completion rate*. Higher rate of new housing supply is considered to keep *house prices* in check. The link in the opposite direction, however, is less straightforward. In conventional economic thinking, higher prices are believed to automatically boost supply. However, in the case of housing, as alluded to in Section 2.1, steep rises in prices have in no way led to comparable rises in private housebuilding in the UK. A consequence of residual land valuation is that any increase in *house prices* is soon capitalised in *land prices*, cancelling out any rise in developers' profit margins that could otherwise have incentivised an increase in buildout rate. Indeed, it has been argued that rising prices may even incentivise delaying the release of new units in the hope of maximising profits. Therefore, the literature appears to be inconclusive on the polarity of the effect from *house prices* to *housing completion rate*. This issue is further discussed later in Chapter 5 (see Section 5.3). This ambiguous link is denoted by a question mark on the arrow from *house prices* to *housing completion rate*. Hence, the *B1? Supply Loop* which would have been a balancing loop based on conventional economic wisdom is also followed by a question mark in this case.

Housing completion rate depends on various other factors besides *house prices.* The rate of housebuilding can be restricted by *planning time lags and restrictiveness.* This latter variable is highlighted with a dark background to indicate that it is a policy variable. *Non-market housebuilding*, which has been drastically restricted during past decades, is another possible policy intervention which can directly boost *housing completion rate.*

Moreover, we saw that *land banking and speculation* is seen by many as an important bottleneck in new housing supply. Furthermore, increasing *housebuilding industry consolidation* entails a less competitive housing market in each locality, which is considered to enable quasi-monopolistic drip-feeding behaviour by developers which further restricts new supply. The diagram also includes an indirect link from *housebuilding industry consolidation* to *housing completion rate* which goes via *land banking and speculation.* This is because larger developers are considered more likely to engage in *land banking* and 'intentional delay' as they have the necessary financial resources to do so (Letwin, 2018, p. 8).

The two perpendicular dashes crossing the arrows going to *housing completion rate* is a symbol of the time delay (lag) associated with these effects.[6] This is because the cause variables actually affect the rate of construction starts, and the impact on *housing completion rate* only shows after a significant lag (delay).

As pointed out earlier, key drivers of increasing *housebuilding industry consolidation* are *housing market volatility* and increasingly expensive *land prices*—an important barrier for new entrants. The link between *land prices* and *housebuilding industry consolidation* closes the second reinforcing feedback loop *R2: Consolidation Restricts Supply*, where rising *consolidation* leaves the release of new housing units at the discretion of large nearly monopolistic developers, therefore raising *house prices* and with it *land prices*, thus completing the circle.

We also saw that, as a procyclical phenomenon, *land banking and speculation* is thought to be not just instigated by *housing market volatility*, but also a driver of it. This establishes another self-reinforcing vicious cycle, labelled *R3: Speculation Drives Volatility* in the diagram.[7]

Finally, *housing market volatility* is considered to have made developers more and more risk-averse over time. *Housebuilders' risk aversion* makes them less likely to expand volume as much as they otherwise could under predictable market conditions. This puts

[6] It must be noted that most real-life causal relationships involve delays of varying lengths, including many of the other links portrayed in this CLD without a delay sign. However, only some delays are made explicit due to their relevance to our time frame of several decades and in order to stress their relative potential importance in affecting the long-term dynamics of the system.

[7] An additional similar loop goes via *housebuilding industry consolidation* but is not labelled separately here to avoid a cluttered diagram.

further downward pressure on *housing completion rate* and upward pressure on *house prices*.

Table 2.1 – List of supply-side feedback loops

Reinforcing loops		
R1	*Housing-Land Prices Loop*	house prices $\rightarrow^{+}$ land prices $\rightarrow^{+}$ house prices
R2	*Consolidation Restricts Supply*	housebuilding industry consolidation $\rightarrow$- housing completion rate $\rightarrow$- house prices $\rightarrow^{+}$ land prices $\rightarrow^{+}$ housebuilding industry consolidation
R3	*Speculation Drives Volatility*	land banking and speculation $\rightarrow^{+}$ housing market volatility $\rightarrow^{+}$ land banking and speculation
Balancing loops		
B1?	*Supply Loop*	housing completion rate $\rightarrow$- house prices $\rightarrow^{?}$ housing completion rate

2.7. Chapter Summary

In this chapter, we saw how the housing crisis is held synonymous to a crisis of new housing supply shortage by many in policy, media, and academia. Within this discourse, a vocal branch of literature blames the claimed shortage of new supply on the restrictiveness and inefficiencies of the planning system.

Nevertheless, the reign of this incumbent narrative has not remained unchallenged. Critiques have pointed out official statistics which do not seem to support the existence or worsening of a housing shortage. In absolute numbers, both in London and in England, total housing stocks appear to have comfortably caught up with the number of households in terms of growth rate for at least the past three decades.

A competing narrative, therefore, maintains that, rather than an absolute shortage in housing, the housing crisis has more to do with worsening inequality in the distribution of the existing stock throughout the past few decades. Proponents of this perspective highlight growing numbers of second homes and vacant properties in support of their argument.

As for the role of planning in restricting the supply of land, opponents argue that a faster rate of land release by the planning system will not necessarily lead to an increase in the rate of private housebuilding. In this regard, they point out the excessive stocks of strategic land banks held by developers (as well as non-development firms) for speculative reasons. Besides the well-known lack of transparency in land holdings and transactions, an important enabler of this adverse and potentially destabilising phenomenon is believed to be the increasing consolidation and concentration in the housebuilding industry. An increasingly oligopolistic industry structure may enable developers to plan their buildout rates towards achieving their desired profit margins, but it does not benefit the end consumer in terms of affordability or quality of housing.

Lastly, we also saw that transaction figures show that the housing market is vastly dominated by second-hand, rather than newly built, home purchases. Therefore, one could argue that developments in the housing market have at least as much to do with factors on the demand side of housing as those of the supply side, if not more. In the next chapter, I will review existing evidence on forces and dynamics on the demand side of the UK/London housing system.

Chapter 3. The Demand Side of Housing

Chapter 3. The Demand Side of Housing

As mentioned in the previous chapters, within the literature on the UK's/London's housing crisis, relatively less attention has been paid to the demand side of the equation. In particular, the role of speculative investment demand and the role of finance in boosting that demand, and thus pushing prices farther and farther beyond the means of would-be first-time buyers, are relatively under-researched, although that seems to be changing (Gallent et al., 2017; Muellbauer & Murphy, 1997), in particular among those studies which take a cross-country view to house price booms (Cerutti, Dagher, & Dell'Ariccia, 2017; Ryan-Collins, 2018, 2019). As Ryan-Collins (2018) emphasises, in order to understand today's housing crisis, 'we must go beyond just looking at the *supply* of housing and examine *demand*, in particular demand for housing as a financial asset' (Ryan-Collins, 2018, p. 7).

In this chapter, I am going to focus on the demand side of housing, first by briefly covering the more straightforward component of demand, which is demand for housing as a home or 'utility-based demand'. Afterwards, I will turn my attention to the more complex issue of speculative investment demand, covering both foreign investment demand and the more domestic phenomenon of private landlordism. Subsequently, the third sub-chapter attempts a summary of developments at the housing-finance nexus, covering the liberalisation of financial markets, the housing-finance feedback loop between house prices and new mortgages, the growing burden of private housing debt, and the related financially induced housing cycles. Subsequently, in the fourth sub-chapter, I will describe how the UK government's housing policy framework has actively encouraged and promoted homeownership via several major policies, and I will discuss how this policy context is related to the UK's welfare and economic growth models. In the penultimate sub-chapter, I am going to attempt to distil some of the key concepts in this chapter in a causal loop diagram and highlight important feedback loops. Lastly, I will conclude the chapter with a summary.

3.1. Utility-based Demand

With a population of over 8.8 million, London currently harbours more people than ever in its history, having surpassed its previous peak of 8.6 million reached at the dawn of the Second World War. London's population is expected to continue to grow and is projected to exceed 9.7 million by 2040 (ONS, 2020g). Since 1991, the number of households in London, as well as the total housing stock, have grown by an average of 0.6% annually (MHCLG, 2016a, 2020a; ONS, 2020b). The number of households is projected to grow from currently 3.5 to over 4.8 million by 2040 (ONS, 2020b). In Sections 2.1 and 2.2 of the previous chapter, I reviewed in more detail existing evidence and arguments regarding the growing need for housing (and whether or not the growth in the housing stock has managed to adequately keep pace with it). We also saw how estimates by the GLA show a large and growing backlog of housing need in London.

New household formation, which is often used as a proxy for new housing demand, has nevertheless been criticised as an adequate metric. Gallent *et al.* (2017) argue that household formation projections as expressions of absolute housing need or demand need to be taken with caution because, on the one hand, they reveal no information on the number of suppressed would-be households which represent real housing 'need' but were never formed due to the unavailability or unaffordability of housing and, on the other hand, such figures do not reflect the extent of demand for investment buying (the subject of the next section), which cannot be derived by merely looking at demographic trends.

Moreover, Cheshire (2018) argues that, historically, changes in house prices have been totally unrelated to changes in population, and therefore population increase has very little impact on changes in the demand for new housing. Instead, he argues that changes in real incomes is a more important driver of demand for housing and housing space, and therefore, planning should allocate land for housing based on trends in total household income, rather than based solely on household projections, as is currently the case (Cheshire, 2018, p. R5).

3.2. Investment Demand

In London, since 1991, while the number of households has grown by 19.4% (ONS, 2020b), real house prices has grown by 260% (ONS, 2020c). It is difficult to argue that the former could have been the sole driver of the latter. In the previous chapter (Section 2.2), the role of the demand for housing as an investment asset (henceforth referred to as 'investment demand' in short) was mentioned as a contributor to declining affordability, and in relation to rising inequality in homeownership.

Ryan-Collins (2018) rejects demographic developments as the primary driver of house price inflation in advanced economies, pointing out that house prices have been rising even in cities with stable populations (Ryan-Collins, 2018, p. 7). Housing has long been known as a 'complex commodity' (Maclennan, 1979, p. 326), with much of its complexity arising from the fact that it simultaneously satisfies different sources of household utility. In other words, housing not only provides shelter but it is also the most widely held asset within the economy (except money) (Maclennan, 1979). To varying degrees worldwide, housing is considered a store of wealth and an investment vehicle. In a large-scale study of long-term developments in the rate of return of various risky and safe asset classes in 16 advanced economies between 1870 and 2015, Jordà *et al.* (2019) find that, among different investment vehicles, residential real estate, along with equities, has shown the highest long-term average return of about 7% annually. Their results show that while equity has outperformed housing since WWII, return on housing has been far less volatile. Indeed, although they classify housing and equity as 'risky' assets, they show that the return on these assets 'has often been smoother and more stable than the safe return' (Jordà et al., 2019, p. 1230). Furthermore, falling interest rates throughout past decades has served to increase the net present value of rental yields and capital gains and the attractiveness of real estate as a financial asset (Ryan-Collins, 2019).

French economist Thomas Piketty, in his seminal work *Capital in the Twenty-First Century* (Piketty, 2014) where he has investigated the long-run historical developments of capital and their implications for inequality in a few developed countries, shows that the greatest increase in capital in advanced economies since after the Second World War comes from an increase in housing wealth, which has now become the largest store of wealth in these economies. Based on data collated by Piketty and Zucman (2014), the share of housing in total national wealth in Britain, which was always been somewhere between 15% and 25% before the Second World War, soared up to nearly 60% of total national wealth by 2010 (Piketty & Zucman, 2014). Importantly, this phenomenal increase is mostly a result of rising house prices rather than additions to the housing stock, which have been much more modest. In relation to the link between Piketty's thesis and housing, Maclennan and Miao (2017) argue that ill-informed housing policies (see Section 3.4) have exacerbated income and wealth inequalities, hampered productivity growth and replaced entrepreneurial returns with a reliance on growing property rentier incomes.

Housing is a highly desired investment asset not only thanks to its high, reliable, and largely untaxed (see the later Section on Capital Gains and Imputed Rent Taxes) return, but also because it provides owners with collateral against which to borrow, spend and accumulate further fixed assets. Moreover, it is an excellent vehicle for inter-generational wealth transfer. It has also been suggested that in countries with rising house prices there is a strong 'hedging' incentive which tilts the tenure attractiveness balance further towards homeownership, whereas in countries with more stable house prices and more secure and affordable rental options, such as Germany, this is not the case (Voigtländer, 2009). In recent decades, it has been argued that the financial asset function of housing has risen to dominate its function as a consumption good in the UK and other advanced Anglo-Saxon economies (Ryan-Collins, 2018). 'Even the very phrase "housing ladder" entrenches the idea of property as speculation' (Dorling, 2014a, p. 103).

While investment in residential real estate—and the related rise in the share of housing in the wealth of nations—are global phenomena, London's position as a world city means that pressures from investment demand have become especially intense (Gallent et al., 2017). In London, since 2002, the total private housing stock has increased by about 495,000 units, while the stock of owner-occupied housing has *fallen* by 47,700 units. The stock of privately rented dwellings, on the other hand, has risen by 542,700 units which is the sum of the above two figures (MHCLG, 2020a). In other words, on aggregate, the PRS has not only absorbed virtually all the growth in the private housing stock, but it has also eaten up a substantial chunk of the existing stock of owner-occupied housing. In addition, according to the English Private Landlord Survey 2018 (MHCLG, 2019), close to 80% of tenancies in England belong to landlords who are renting out two or more units, having grown from 55% in 2010. Furthermore, half of PRS tenancies are let by the 17% of landlords with five or more properties (MHCLG, 2019, p. 5).

The evidence above highlights the fact that most newly built dwellings over the past few decades have been bought not as homes to live in but as assets to rent out. London's housing stock is now concentrated in fewer hands, with housing having become not only the face of wealth inequality but also its perpetrator. Investment demand fuels the market, pushes up prices, and in so doing further heightens the investment lure of housing (Eskinasi, 2014, pp. 53–54). This is a self-sustaining cycle that consumes the available supply of housing with an insatiable appetite and pushes prices up (Gallent, 2016). The concern is that, relying on existing housing wealth, streams of rental income and therefore easier access to credit, existing homeowners will continue to 'crowd out' would-be first-time buyers and those experiencing 'utility-based' need (Kennett, Forrest, & Marsh, 2013), much like in a rather one-sided game of Monopoly.

3.2.1. Overseas Investment Demand

Due to the desirability of prime Central London property located in boroughs such as Westminster or Kensington and Chelsea, London's real estate market has become a hub for a large volume of footloose global capital in search of low-risk and high-return investments (Armstrong, 2016). Heywood (2012) draws attention to the extensive prevalence of this phenomenon, and reports that, at the time of writing, over 60% of new dwellings in Central London were being bought by overseas investors, with overwhelming anecdotal evidence of a high proportion of these being left empty (Glucksberg, 2016; Heywood, 2012; Wallace, Rhodes, & Webber, 2017). More recently, it has been reported that in the two years up to March 2016, 13% of London's total new market housing was bought by overseas residents (Wallace et al., 2017), rising up to 50% in Central London (Scanlon, Whitehead, Blanc, & Moreno-Tabarez, 2017). There is a vast and growing body of literature on the extent and impact of overseas investment in London property, including a ripple effect of house price inflation from traditional to new prime markets and to nearby commuter regions (Gallent et al., 2017; Sá, 2016).

Glucksberg (2016) studies foreign investment in Central London property and offers a typology of foreign investors, grouping them into four conceptual categories of 'buy to invest', 'buy for business', 'buy for children', and 'buy to leave'. She concludes that foreign investment in prime London property does impact the rest of London but does not address the need for an increase in the supply of affordable housing, because there is a clear mismatch between what is needed in London and what is most profitably built by foreign investors (Glucksberg, 2016).

In another study, Sá (2016) uses regression modelling on a Land Registry dataset on property transactions registered to overseas companies to find that foreign investment in the housing market in England and Wales not only drives up prices of prime property but has a 'trickle down' effect to less expensive properties and has reduced homeownership. The same study finds no evidence that foreign investment has had a positive impact on the housing stock.

Hamnett and Reades (2019) use price data from 1969 to 2016 to track price differentials between London, especially Central London, and the rest of the UK through several cycles of boom-and-bust and highlight the importance of foreign investment in the growing regional house price gap in Britain. The financial crisis in 2008 did not turn investors away from the London property market, but rather increased demand and supported house prices 'as anxious foreign capital sought the relative safety of UK property' (Ryan-Collins et al., 2017, p. 100). Likewise, while Brexit may have reversed the latest boom in London property, according to Hamnett & Reades (2019) there are no indications that the regional gap between Central London and the rest of the country will close.

On a more alarming note, a 2015 report by Transparency International, a leading anti-corruption NGO, reveals, based on data from the Metropolitan Police and the Land Registry, the remarkable extent to which prime London property might be being used as a safe haven for corrupt capital from around the world (Transparency International UK, 2015). The report explains how this is a result of the UK legal system which allows property to be purchased anonymously through companies registered in secrecy jurisdictions and recommends that 'any foreign company intending to hold a property title in the UK should be held to the same standards of transparency required of UK registered companies' (Transparency International UK, 2015, p. 4).

While the supply of housing is necessarily finite, the globalisation of investment markets implies that the demand for housing is not spatially bounded (Gallent et al., 2017). London's housing problems are therefore deeply rooted in the city's unique position within the global economy (Watt & Minton, 2016), and linked to the favourable legal and tax environment in the UK (Ryan-Collins et al., 2017, p. 122). The evidence presented above on how London's prime property market is viewed as a safe haven for risk-free foreign investment, on the ripple effect of rising prices from these areas to all of Greater London, and on the failure of these overseas investments to result in an increase in the supply of mainstream market housing appropriate for the average Londoner must be a cause for urgent concern in relation to London's affordability crisis.

3.2.2. Buy to Let and Private Landlordism

An important aspect of the rising attractiveness of housing as an investment asset has to do with increasing private rents. In the two decades of 1995–2015, real (inflation-adjusted) median private rents in London grew by over 50%, from £173 to £265 per week.[8] This increase in housing costs makes it increasingly difficult for—typically lower-income—renters to save for a homebuying deposit and has significant implications for inequality both between generations as well as between the housing 'haves and have-nots'.

A driver of part of the revival of the private rented sector and the subsequent rise in renting costs is thought to have been the deregulation of private rents in early 1989 following the Housing Act 1988 (Kemp, 2015). Before the 1988 Act, most private rentals were 'regulated tenancies' with strong security of tenure and the right for both tenants and landlords to refer the rents to 'rent officers' of local authorities. Rents were usually agreed privately between landlord and tenant, rather than determined by rent officers, but the possibility of referral to local governments meant that rental yields on regulated tenancies were typically uncompetitive (Kemp, 2015). Following the mass privatisation of social housing with Right to Buy (Section 3.4.1.1), the 1988 Act was introduced to increase incentives for landlords to offer their properties on the market for rent

[8] Data from calculations made by the Institute for Fiscal Studies based on the Family Resources Survey, acquired by the author from the housing policy department at the GLA.

(Ginsburg, 1989). The 1988 Act deregulated rents and introduced the Assured Shorthold Tenancy contracts which have since been the default form of tenancy agreements. These contracts entitle private landlords to regain possession of the dwelling without giving any specific reason and allow tenancies as short as six months, making private renting far less secure for tenants (Shelter, n.d.). The deregulation of private rents, better rights for landlords, and increased liquidity of rental housing as an investment have played a partial role in making investing in residential real estate more appealing for landlords (Kemp, 2015).

However, the PRS really took off not right after the 1988 Act but following the more recent introduction of *buy-to-let* (BTL) mortgages, which led to the rapid expansion of 'amateur landlordism' in Britain (Gallent et al., 2017; Kemp, 2015). Until the mid-1990s, residential mortgages were mainly aimed at owner-occupiers. In 1996, following an initiative by the Association of Residential Letting Agents (ARLA) in collaboration with a panel of mortgage lenders (Kemp, 2015), a new BTL mortgage product was introduced for the first time, whereby the lenders agreed to reduce the 2% risk premium placed on mortgages attached to rental properties on the basis of the security offered by the stream of rental income from those properties (Ryan-Collins et al., 2017, p. 134). This financial innovation started taking off after the turn of the century, along with the broader liberalisation and internationalisation of financial markets, as discussed in the next section of this chapter. As shown in Figure 3.1, which depicts data from the Financial Conduct Authority (FCA) of the Bank of England on BTL mortgages in the UK (2007–2019), as share of total gross mortgage lending, BTL grew from a trough of 5.7% in 2009 following the Global Financial Crisis to a peak of 16.8% in 2015. Later, this share went down slightly to 12.9% of total, at a level of around £35 billion in 2019 (FCA, 2020). In a study published in the midst of the 2008 period of financial collapse, Sprigings (2008) show that BTL has demonstrably impacted housing markets in terms of both price and new supply. In terms of prices, it has contributed to disconnecting house prices from household incomes and has added to the speculative bubble, and in terms of new supply, developers have responded to immediate demand and inflated prices by increasing the supply of stock to investors. Despite the increase in new supply, the rise in BTL mortgages has caused would-be purchasers to be priced out into rental (Sprigings, 2008).

The introduction of BTL mortgages helped drive a large increase in the proportion of homes owned by landlords and is said to have created 'an entire new industry' out of private rented property (Scanlon & Adamczuk, 2016). Data from the UK Wealth and Asset Survey shows that, private landlords, constituting about 6% of households during 2014–2016, on average derive as much as 20% of their total annual income from rental payments (Stockhammer & Wolf, 2019). Since 2015, however, there have been a number of changes in the tax regime which appear to be suppressing the numbers of the of BTL mortgages (Affordable Housing Commission, 2019b). The changes signal a broad shift away from incentivising amateur landlordism via reducing tax advantages available to landlords. Policy changes include a 3% increase in Stamp Duty Land Tax for purchases of second homes (since April 2016) and gradually removing the ability to offset interest payments from BTL mortgages (since April 2017), among other changes (Rugg & Rhodes, 2018, p. 84).

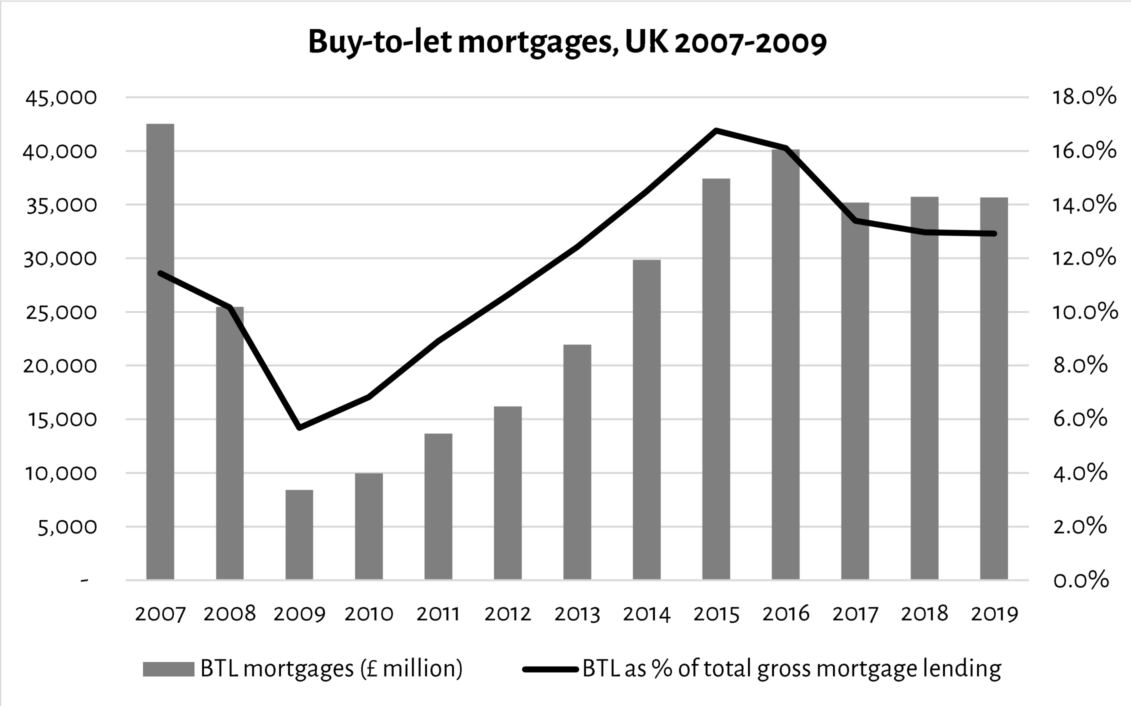


Figure 3.1 – Buy-to-let mortgage lending in the UK 2007–2019[9]

Source: Bank of England's Financial Conduct Authority (FCA, 2020)

In Chapter 1 (Section 1.1.3), we saw how homeownership levels have fallen in the UK during recent decades while the PRS has been rising concurrently. In this context, the literature has raised concern over the emergence of a young priced-out 'generation rent' against a counterpart cohort of amateur landlords, labelled 'generation landlord' (Ronald & Kadi, 2018). In fact, it has been suggested that the emergence of the former is, at least in part, a result of the rise in the latter (Ronald, Kadi, & Lennartz, 2015) via a pricing out mechanism. Following the 2008 Global Financial Crisis (GFC), despite the trough in BTL loans (Figure 3.1), the PRS did not lose any of its momentum. Indeed, the

[9] I was unsuccessful in obtaining BTL mortgage data for the London region (and for years prior to 2007). This data does appear to be held by UK Finance, a trade association for the UK banking and financial services sector and the successor to the Council of Mortgage Lenders (CML), but they only share their data with their member organisations and, on approach, were unwilling to do so for research purposes.

GFC appears to have been a catalyst rather than a brake on the rise in the PRS (Ronald & Kadi, 2018).

In tandem with the rise in the PRS and in private rents, the Housing Benefit (HB)[10] bill has been generally rising too, from £2.6m in 2001/02 up to a peak of £6.3m in 2015/16 and subsequently falling to £4.9m in 2019/20 in London (Figure 3.2). HB is a means-tested allowance that is paid to low-income social and private tenants to help them pay their rent (Hickman, Kemp, Reeve, & Wilson, 2017). The scheme, which was introduced in 1982/1983 in the Social Security and Housing Benefit Act 1982, can be considered part of the general housing policy shift away from supply side interventions towards demand side subsidies and part of the Thatcherite neoliberal move towards privatisations and market provision of housing (Ryan-Collins et al., 2017, p. 89). This paradigm shift has entailed switching public spending from investment in new homes to support for housing costs by successive governments since the 1970s/80s. In a survey of English housing policy between the 1975 and 2000, Stephens, Whitehead and Munro (2005) show that while in the beginning of that period 82% of total housing subsidies were 'bricks and mortar' subsidies towards the supply of affordable housing, the balance was fully leaning to the other side by 2000 when over 86% of housing subsidies was being spent on the demand side towards helping tenants in paying their rent.

HB is now the second largest component of state benefit expenditure following state pension. The UK has by far the highest per capita spending on housing allowances across the EU; 520 Euros per person in 2015 followed by Ireland in second place at 452 Euros per person (NHF, 2017). In London, HB is a particularly significant burden on the public purse, currently constituting 22% of the total benefit bill, while its share in England and

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[10] The Housing Benefit is currently being merged with five other types of benefit for low-income working-age people into a 'Universal Credit' (UK Government, n.d.-b).

the UK as a whole is 10% (DWP, 2021). This significant public spending should be a cause for concern if you consider that, in practice, HB payments can be considered a transfer of money from the taxpayer to the landlord. This, too, appears to be an important symptom of the severe housing crisis and closely related to declining affordability, developments in tenure (decline of social housing and rise in PRS), as well as rising rents in both the private and the affordable sectors (Johnson, 2019). From this perspective, HB can be considered a classic example of the *shifting the burden* archetype (Wolstenholme, 2003) described in the systems thinking literature as a situation where a symptomatic solution to a fundamental problem helps relieve the symptoms but worsens the root problem, while using up resources that could have been put to better use in addressing the more fundamental issue—i.e., the worsening affordability crisis in this case.

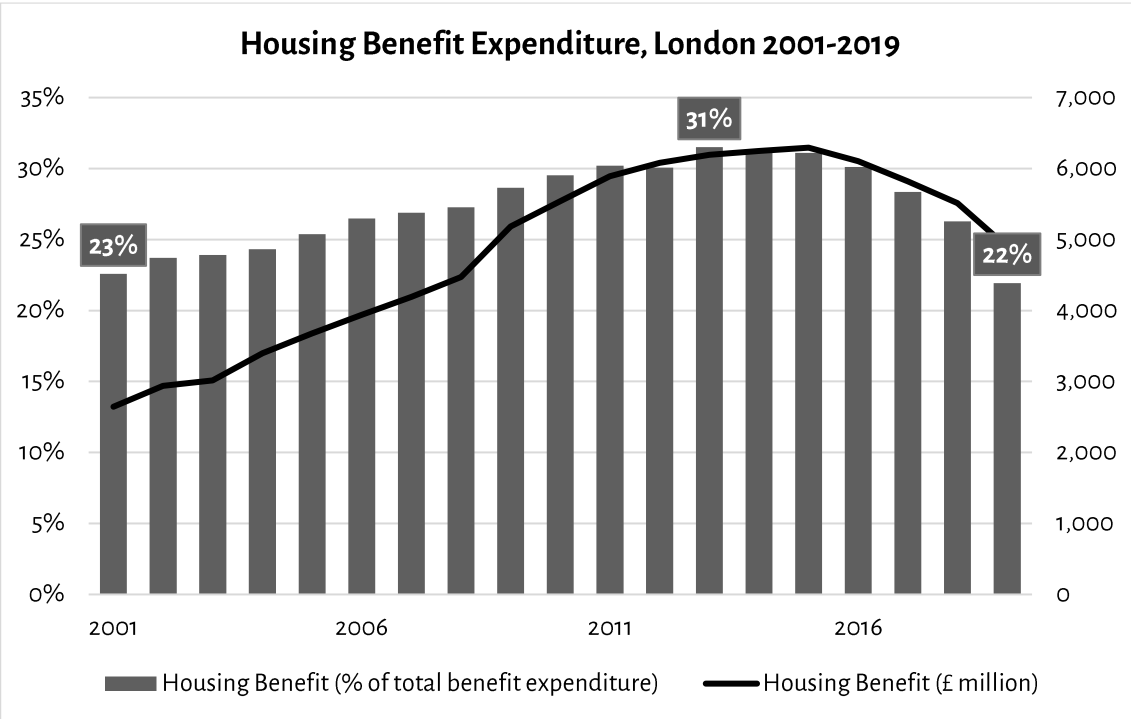

Figure 3.2 – Government Housing Benefit expenditure, London 2001/02–2019/20

Source: (DWP, 2021)

Let us now look at the role the housing finance market has played in bringing about the crisis, of which the rising HB bill is but one symptom.

3.3. Housing and Finance

Like the role of land (see Section 2.5), the role of credit in the economy has come to be largely ignored in mainstream economic theory. In conventional neoclassical economics, money has come to be considered a 'veil' over the 'real' economy (Borio, 2014, p. 182) (that which consists of the production, consumption and exchange of real goods and services) and banks are considered intermediaries, accepting deposits from savers and issuing loans to firms out of those deposits. This conventional theory does not attribute any causal weight to the workings of money, credit, banks or private debt which could substantially alter key economic variables in the long term (Ryan-Collins et al., 2017, pp. 110–111, 125–126). The conceptualisation of banks as intermediaries goes along with the expectation that their borrowers would be mainly productive firms, but this expectation is not supported by empirical data on bank loan portfolios (Erturk & Solari, 2007) (see Figure 3.3).

Shifts in credit conditions in economies with liberalised financial markets has been described as 'the elephant in the room[...]: large, and ignored at one's peril' (Muellbauer & Williams, 2011, p. 95). The 2008 Global Financial Crisis (henceforth GFC), however, 'prompted much soul searching (Borio, 2014, p. 182)' within the economics community, compelling many, e.g. New Keynesian economists (Bernanke, Gertler, & Gilchrist, 1999), to try to incorporate financial factors into standard macroeconomic models, albeit still not altering their core equilibrium assumptions (Borio, 2014).

With regards to housing, the mortgage market lies at the nexus between the financial industry, the housing market and the economy as a whole (Scanlon & Adamczuk, 2016). It is widely believed that the cost and availability of credit has had the greatest effect on housing market demand, and therefore house prices, over the last few decades (Savills, 2015). It is recognised that banks have played a central role in the financialisation of housing, defined as 'the increasing dominance of financial actors, markets, practices, measurements and narratives, at various scales, resulting in a structural transformation of economies, firms (including financial institutions), states and households' (Aalbers, 2016, p. 2). It has also been argued that the housing-finance feedback loop (Section 3.3.2) is at the heart of periodic financial cycles recurring in modern economies globally (Borio, 2014; Ryan-Collins, 2018, p. 31).

In this rather substantial section, reflecting a major focus of this thesis, I will explore some of the main topics at the intersection between housing and finance in more depth, starting by reviewing the literature on the deregulation of financial markets since the 1980s and its crucial impact on increasing financialisation of housing in the UK. Second, I will discuss how this liberalisation has given rise to the notion of the housing-finance feedback loop, leading to a concurrent exponential growth of house prices and housing credit. Third, the concerns around the rapidly growing stock of housing debt, a direct consequence of the above liberalisation, is discussed. Lastly, we will see how housing-related financial cycles have become more frequent and severe since the 1980s as a consequence of the financial deregulation.

3.3.1. Financial Deregulation in the UK

Following the experience of the financial collapse and the Great Depression of the 1930s, due to the resulting concern about real estate bubbles, the financial industry was tightly regulated until the 1970s (Peretz & Schroedel, 2009), in particular via mortgage rationing and the separation of financial functions. Mortgage rationing meant that a Joint Advisory Committee, composed of industry and government representatives, centrally decided the level of mortgage lending across the UK (Ryan-Collins et al., 2017, p. 130; Stephens, 1993). Separation of financial functions meant that building societies were the financial entities responsible for housing loans. Building societies were regulated separately from banks and given certain tax advantages which helped them dominate the market, accounting for up to 96% of mortgages loans in the 1970s (Scanlon & Adamczuk, 2016). These mutually owned, often local institutions were restricted to taking their members' deposits and issuing mortgages and residential construction loans to them on that basis (Scanlon & Adamczuk, 2016). Therefore, mortgage availability was to a large extent a function of the availability of deposits from savers which put a cap on available funds, with lending criteria that would be considered highly restrictive today (Ryan-Collins et al., 2017, p. 132). The interdependency between mortgages and savings maintained a link between property-related credit and the wider economy and prevented excessive growth and volatility in mortgage credit and property prices (Ryan-Collins, 2018, pp. 46–47).

During the 1980s, however, following the rise to power of Margaret Thatcher as Conservative Prime Minister in 1979, a series of major institutional and legislative changes, 'culminating in the Building Societies Act 1986 (Scanlon & Adamczuk, 2016, p. 129),' continuously liberalised retail financial markets—including the housing mortgage market—in the UK (Scanlon & Adamczuk, 2016). In 1979, the Tory government removed foreign exchange controls and gave UK banks access to overseas funding (Copley, 2019). Muellbauer and Murphy (1997) give a useful summary of the subsequent key stages of financial liberalisation in the UK during the 1980s (Muellbauer & Murphy, 1997). In 1981, the abolition of the 'corset' on bank lending[11]—i.e., credit controls—opened the property mortgage market to commercial banks, which they did before withdrawing again and re-entering permanently in 1983 (Stephens, 1993). From 1983, restrictions on building societies were gradually lifted, allowing them to borrow from wholesale money markets to finance home loans, as opposed to previously being restricted to lending solely based on their customers' deposits. This essentially shifted their status from mutuals to commercial banks (Aoki, Proudman, & Vlieghe, 2002; Muellbauer & Murphy, 1997). In

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[11] Under the 'corset' (adopted in 1973), banks had to keep zero-interest deposits with the Bank of England if their interest-bearing liabilities exceeded a prescribed growth rate. It had the effect of marginalising the banks' position in the mortgage market (Stephens, 2007).

1986, the Building Societies Act was passed, further liberalising the activities of building societies from any 'administrative guidance' by the Bank of England, and effectively allowing building societies to set interest rates so that mortgage rationing no longer occurred (Meen, 1990; Muellbauer & Murphy, 1997). The 'Big Bang' financial reform of 1986 eased quantitative restrictions on mortgage lending for banks and mutuals. As a result of looser lending criteria, the average loan-to-value ratio (LTV)—the ratio of the loan to the value of the purchased property—rose from 74% in 1980 to 85% in 1988, and average loan-to-income ratio (LTI) for first-time buyers rose from 167% to 219% in 1990 (Stephens, 1993). Due to the combined effect of looser lending criteria and progressively lower interest rates, gross mortgage lending in the UK grew by 380% between 1981 and its peak in 1988 (DETR, n.d.). In the same period, average UK house prices grew by 104% (ONS, n.d.).

Following the abolition of fixed exchange rates and capital controls in 1971–3, and under the auspices of the Bank for International Settlements, from the late 1980s the 'Basel Accords' introduced minimum capital requirements for all banks depending on the type of assets (e.g., loans) on their balance sheets (Ryan-Collins, 2018, p. 52). According to recommendations in this set of Accords, banks typically assign a much lower risk (often by a factor of two to three) to mortgage loans as compared to business loans because if a mortgage loan defaults the lender is usually entitled to claim the property (Ryan-Collins, Greenham, Werner, & Jackson, 2012). Always eager to lend against landed property as collateral, and in the absence of quantitative credit controls (Ryan-Collins, 2018, pp. 46–47), since the 1980s banks in the UK have switched from lending mainly to non-financial businesses to issuing mortgages to households as the single most important component of their business. As seen in Figure 3.3, which shows a measure of the composition of net lending by UK banks broken down by industrial sector, the share of *domestic mortgages* has grown continuously throughout recent decades, from 16% in 1986 to 34% in 2018, while the share of non-financial firms, which used to be the largest at 36% in

1986, has conceded that position to housing loans and is now merely 9% (Ryan-Collins et al., 2017).

It must be noted that this transformation of banks into mortgage lenders since the 1980s is not a uniquely British phenomenon. In most advanced economies, mortgage lending now comprises the lion's share of banks' business. Jordà *et al.* (2016) find, in their sample of 17 advanced economies, that the share of real estate lending in banks' total lending portfolios grew from about 40% in 1980 to 57% in 2010 (Jordà et al., 2016, p. 118).

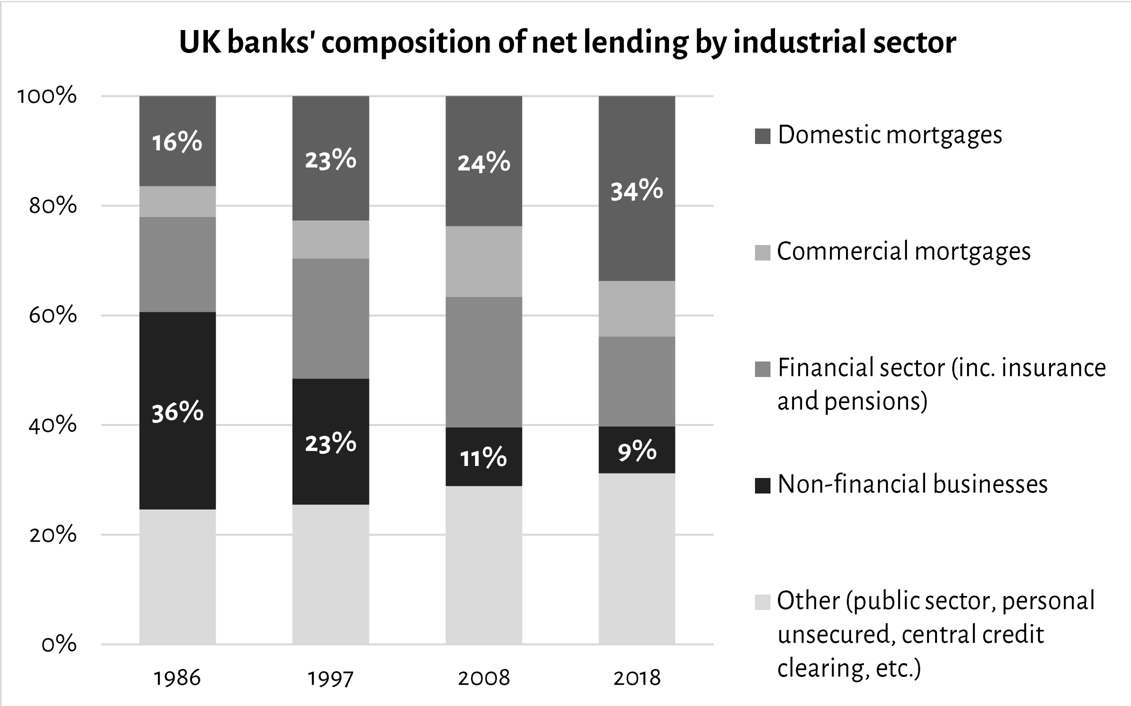

Figure 3.3 – Share of UK domestic banks' lending by industry sector 1986–2018

Source: Courtesy of Dr. Josh Ryan-Collins (Ryan-Collins et al., 2017, p. 118)*, gleaned from Bank of England's RPQT series.*

This is considered a perverse development from a macroeconomic perspective because lending towards productive businesses, rather than unproductive assets is key to economic growth and innovation (Ryan-Collins, 2018, p. 82). In a study of 46 economies over the period 1990–2011, Bezemer *et al.* (2016), find a negative relationship between bank lending to domestic real estate and economic growth, but positive growth effects of credit flows to non-financial businesses (Bezemer, Grydaki, & Zhang, 2016).

Similarly, in a study of 37 economies over the 1970–2012 period, Bezemer and Zhang (2014) find that 'credit booms in which the share of mortgage credit in total bank credit increases more, are credit booms which are more likely to "go bad", leading to subsequent credit growth contractions' (Bezemer & Zhang, 2014, p. 30). Furthermore, this 'debt shift' is also destabilising from the perspective of a 'maturity mismatch' which arises due to the mismatch between the short time horizons of banks' liabilities, which usually consist of deposits or short-term wholesale securities, and the long time horizons of their assets consisting mostly of mortgages with long maturities (Goddard, Molyneux, & Wilson, 2009). The disproportionate share of mortgages on banks' balance sheets also make their portfolios less diversified and thus creates systemic risk (Bullard, Neely, & Wheelock, 2009; Ryan-Collins, 2018, p. 108).

This development is not unrelated to the notion of 'capital switching' first put forward by French Marxist economist and philosopher Henri Lefebvre (1970) in *La révolution urbaine* (The Urban Revolution), and later expanded and made famous by British economist David Harvey (Harvey, 1985). In simplified terms, the concept of capital switching, which takes a Marxian 'process of circulation' view towards capital, describes the tendency towards overaccumulation of capital in production, which leads to declining profitability, and over time drives a switching of new capital investments from the 'primary circuit' of industrial production towards the 'secondary circuit' of the built environment and property assets, in search of higher profits (Beauregard, 1994; Christophers, 2011; Gallent, 2019, pp. 4–5; Harvey, 1985). This thesis links directly to financial liberalisation where Harvey asserts that this switch requires liquidity or 'money capital' that can be freely diverted into different forms of investment, and it therefore 'cannot be accomplished without a money supply and credit system which creates "fictional capital" *in advance* of actual production and consumption" (Harvey, 1978, p. 107). Harvey warns, however, that such switching of capital can only serve to postpone an economic crisis, rather than help avert it, and can therefore be considered a lead indicator of crisis. Christophers (2011) attempts to present empirical evidence for this highly influential theory based on developments in the UK economy in the run-up to the Great Financial Crisis (see Box 3.3), and shows that private sector spending as well as pension fund investment was increasingly diverted from the productive sphere into investments in property, indicating 'massive capital switching in the years following the turn of the millennium' (Christophers, 2011, p. 1360). He argues that this aligns well with Harvey's thesis which describes capital switching as a warning signal of impending crisis, only serving to transform an overaccumulation of capital into a crisis of overvalued property assets.

Liberalisation of financial markets opened the way to financial innovations that made mortgage lending even more attractive to banks. Based on new data collected on 74 economies over 1990–2013, Bezemer, SamarIna and Zhang (2017) find that financial deregulation strongly correlates with the debt shift. One important contributing innovation as a result of financial deregulation was the advent of securitisation and residential mortgage-backed securities. The impact and extent of prevalence of securitisation is reviewed briefly below in Box 3.1.

Numerous empirical studies have found that household credit and house price booms are tightly linked (Cerutti, Dagher, et al., 2017; Favilukis, Kohn, Ludvigson, & Van Nieuwerburgh, 2012; Gilchrist, Siemer, & Zakrajšek, 2018; IMF, 2011). Favilukis *et al.* (2012), for instance, present evidence demonstrating that a measure of credit supply—bank loan officers' accounts of their willingness to supply more mortgage credit, as distinct from their perceptions of the demand for credit—explains 53% of the quarterly variation in house price growth over the period 1992–2010 in the US. Empirical studies by Adelino *et al.* (2012) and Favara and Imbs (2015), again in the US context, find that exogenous expansions in mortgage credit supply (as a result of looser credit constraints) have significant effects on house prices, ruling out the view that credit market conditions purely respond to housing demand. Another study by the International Monetary Fund (IMF) looks at 36 advanced and emerging economies (including the UK) and finds that a 10% increase in household credit is associated with a 6% increase in house prices (IMF, 2011, p. 134). The authors stress, however, that the relationship works both ways, i.e., increasing house prices in turn lead to stronger credit growth by boosting demand for credit, households' net worth and expectations of future prices. This feedback relationship will be further elaborated in Section 3.3.2.

Although widened access to mortgage credit as a result of the liberalisation of financial markets initially led to a rise in homeownership (Stephens, 2007), through its long-term inflationary impact on house prices, this very objective appears to have been undermined. The owner-occupation rate in England has been falling since 2003 (MHCLG, 2020a). Kohl (2018), using long-run data from a panel of 17 countries, shows that:

> *'the effect of the "great mortgaging" on homeownership rates is not universally positive. Increasing mortgage debt appears to be neither necessary nor sufficient for higher homeownership levels. There were periods of rising homeownership levels without much increase in mortgages before 1980, thanks to government programs, purchasing power increases, and less inflated house prices. There have also been mortgage increases without homeownership growth, but with house price bubbles thereafter.' (Kohl, 2018, p. 177)*

Gallent *et al.* (2017) argue that the deregulated and abundant flow of credit into the housing market—now disconnected from savers' deposits—against the inherently inelastic supply of new homes is at the heart of the current housing crisis in London (Gallent et al., 2017).

Box 3.1. The Advent of Securitisation

Securitisation is defined as the 'practice of "bundling" together a stream of future obligations arising from mortgage repayments to provide the basis for the issue of, and the payment of principal and interest on securities' (Langley, 2006, p. 283). In other words, it is the process whereby banks pool together a portfolio of loans that they have previously issued to borrowers of diverse risk categories, making a new financial instrument called a security.

Securitisation offers several advantages from a financial perspective. First, there is high demand for such securities from large institutional investors, typically pension fund and insurance companies, seeking long-term reliable streams of income. Second, in the process, the banks originally issuing the mortgages transfer all the risks associated with the loan package to the buyers and remove the loans from their own balance sheets, enabling them to keep issuing further loans without violating capital requirements (Ryan-Collins, 2018, p. 51; Wainwright, 2009). Securitisation presented a new business model for banks, both offering a new source of funding other than traditional customer deposits—i.e., revenues generated through the sales of securities—as well as a new source of profits—via charging transaction fees on loans and securities (Ryan-Collins, 2018, p. 51; Ryan-Collins et al., 2017, p. 138). This new business model encouraged mortgage lenders to adopt an 'originate and distribute' approach towards issuing mortgages, issuing profitable, high-risk mortgages and passing on the risks to the buyers of the securities (Hay, 2009; Wainwright, 2009).

Before the advent of securitisation land, housing and housing loans were 'geographically fixed and illiquid assets' (Ryan-Collins, 2018, p. 53). Securitisation changed this by turning long-term mortgage loans into liquid and globally traded financial instruments. This financial innovation also made it possible for financial institutions to offer more attractive mortgages, at lower interest rates, as well as higher LTV and LTI ratios to a broader array of customers, including lower income demographics, widening access to homeownership. This of course entailed buyers taking on higher levels of risk in the form of private residential debt, which was at the core of the onset of the GFC (see Box 3.3).

Unsurprisingly, residential mortgage-backed securities (RMBS) became immensely popular. In the UK, between 2000 and 2007, the stock of outstanding RMBS and covered bonds grew from £13bn to £257bn, or in other words from 2.5% of the UK mortgage stock to 21.5% (CML, 2010 cited in Wainwright, 2010), leading to a sizeable growth in total mortgage lending. In 2006, the UK issued $241bn of securitised bonds, more than any other country in Europe and over five times as much as Germany in the second place ($47bn) (Wainwright, 2010). This is while mortgage lenders were also able to reduce their funding through customer deposits, practically decoupling growth in lending from savings in the economy. At the same time, the UK's median house price to income ratio doubled in the ten years between 1997 and the peak in 2007 (Ryan-Collins et al., 2017, p. 139).

Since the GFC, however, restrictions have been applied towards securitisation in an attempt to subdue the risks. Measures taken include higher capital requirements and mandatory risk retention by the originators of loans (Ryan-Collins et al., 2017, p. 141). This has led to a substantial shrinking of the stock of outstanding securitised residential loans to less than half of its pre-crisis size at currently around £106bn in the UK (FCA, 2020).

It must be pointed out that the deregulation of the last quarter of the 20th century has been to a limited extent reversed during the 21st century, especially following the GFC in 2008. In 2005, the Financial Services Authority instituted the Mortgage Market Review, 'a wide-ranging examination of the mortgage lending practices of UK banks (Scanlon &

Adamczuk, 2016, p. 128),' which was given a further boost following the financial crisis. The 2014 revision of the Review limited lenders' ability to offer some less conventional and risky products, such as pure interest-only, high LTV, and 'self-certification' mortgages (where the borrower does not need to provide proof of income, and which comprised almost half of new loans between 2007 and 2010). This means that access to mortgage has become more difficult in recent years, especially for first-time buyers (Scanlon & Adamczuk, 2016).

The result of the deregulation of financial markets during the past few decades has been the financialisation of housing (Aalbers, 2016). In practice, financialisation involves 'the transformation of work, services, land or other forms of exchange into financial instruments [...] that can be traded on financial markets. With regard to land and housing, for example, one might argue that these become "financialised" when households or firms hold and trade property primarily for the purpose of generating capital gains rather than as a place to live or work (Ryan-Collins et al., 2017, p. 120),' as has increasingly become the case in London during recent decades.

To summarise, deregulation of the mortgage market in the UK involved the ending of mortgage rationing via direct controls over building society lending, the abolition of exchange controls and the 'corset', and the creation of a level playing field between banks and building societies, which led to a much more competitive mortgage market with progressively lower interest rates and innovative mortgage products, such as RMBS (Stephens, 2007). This led to a huge increase in house prices because 'however fast you can build, banks can create new credit faster' (Ryan-Collins, 2018, pp. 67–68).

3.3.2. The Housing–Finance Feedback Loop

Ryan-Collins (2018, 2019) maintains that the most significant mechanism in explaining the significant growth in house prices during the 1990s and the 2000s has been a self-reinforcing feedback loop between housing credit and house prices. He elaborates on the core idea of a positive housing-finance feedback loop showing an illustrative diagram reproduced here in Figure 3.4.

The argument is that, starting with the circle in the lower right-hand side corner and going around clockwise, as house prices rise relative to incomes, this leads to an increased demand for mortgage debt, helping banks reap higher profits, while retaining a portion of those profits to expand their capital base (the required reserves to cover defaults on loans) in order to be able to further expand their business. This enables them to increase their supply of mortgage credit. With the supply of credit being highly elastic and 'essentially infinite' (Ryan-Collins, 2018, p. 32), it can grow far faster than the inelastic supply of homes, which will lead to a further increase in house prices, completing the loop. Ryan-Collins asserts that the steep incline in house prices would otherwise have been impossible without the abundant flow of credit, given the slow growth in household incomes in recent decades (Ryan-Collins et al., 2017, p. 117). In a sense, mortgage lenders create their own increased demand as they expand their lending and push up house prices (Ryan-Collins, 2019). The above self-reinforcing cycle is, according to Ryan-Collins (2018, 2019), at the centre of the precipitous growth in both house prices and mortgage credit, not only in London or the UK, but in many advanced economies and global cities. Equally importantly, this cycle keeps running in a context of financial deregulation and innovation, speculative trading of housing by both domestic and foreign agents, buy-to-let purchases, stagnating wages and pensions, as well as government policies that fuel the financially leveraged demand for housing (Ryan-Collins, 2018, pp. 59–60).

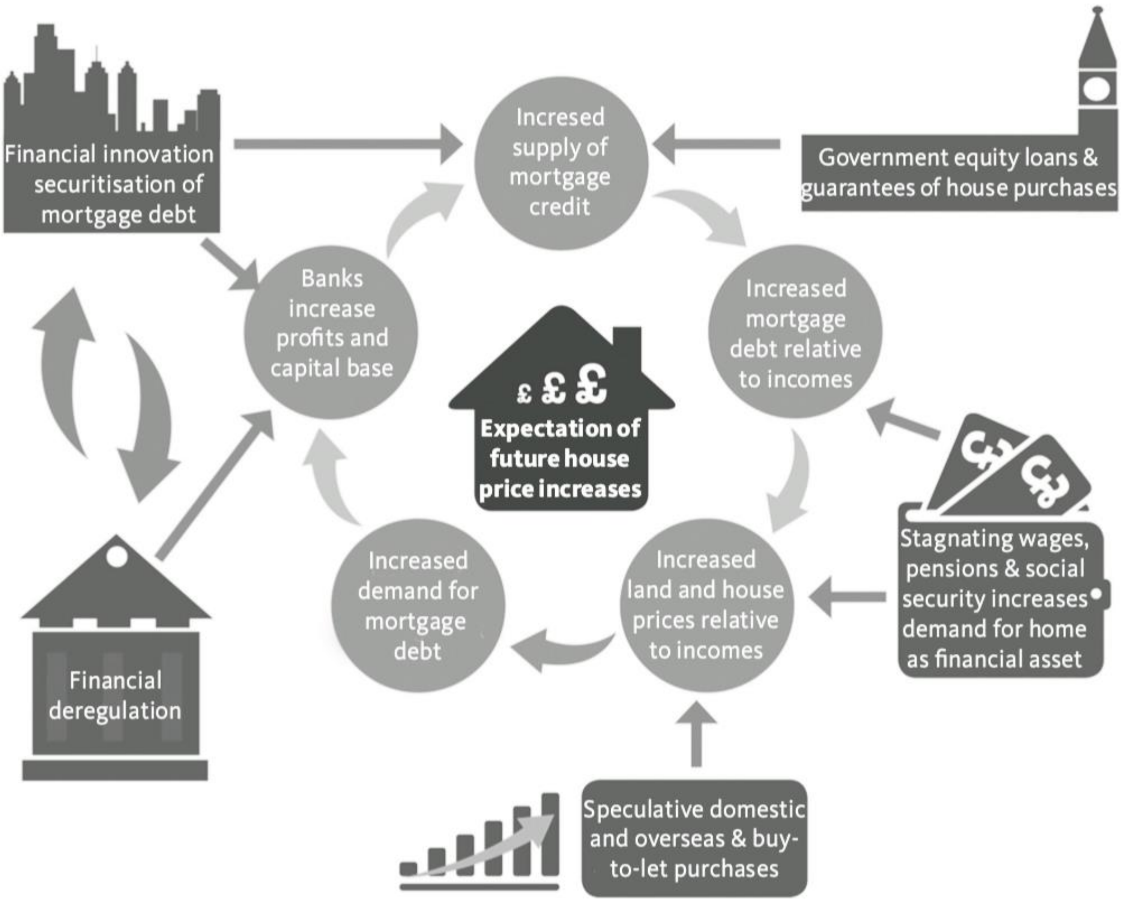

Figure 3.4 – The housing–finance feedback loop.

Source: (Martin & Ryan-Collins, 2016; Ryan-Collins, 2018, p. 59)

The positive feedback loop between house prices and housing credit is well established, in particular within the post-Keynesian economics literature (Arestis & González, 2014; Stockhammer & Wolf, 2019). This notion is also supported empirically, as on the one hand, studies have separately confirmed the positive relationship, as we saw earlier, from the supply of mortgage advances to house prices (Adelino et al., 2012; Cerutti, Dagher, et al., 2017; Favara & Imbs, 2015; Favilukis et al., 2012; Gilchrist et al., 2018; IMF, 2011) and on the other hand, from house prices to the supply of credit, with an increase in house prices boosting the net worth of households as well as leading to higher expected prices in the future (Goodhart & Hofmann, 2008; IMF, 2011, p. 134). Goodhart and Hofmann (2008) further find that, as a result of the financial markets liberalisation, the link between house prices and credit has become stronger since the mid 1980s. Furthermore, Tsatsaronis and Zhu (2004) find that in countries with more aggressive lending practices (i.e., variable mortgage rates, mortgage equity withdrawal, high LTVs, open market valuation method, and securitisation), such as the UK, the feedback from house prices to credit appears to be stronger. With regards to property valuation methods for mortgage lending, in particular, they argue that basing lending decisions on the current market value of the house can create a positive momentum in market demand, while anchoring property valuations to historical levels of prices can exert a countercyclical force on credit availability (Tsatsaronis & Zhu, 2004).

Furthermore, in the world of policy, Adair Turner, former Chair of the Financial Services Authority (FSA), has alluded to the housing-finance feedback loop in his 2017 book *Between Debt and the Devil*, arguing that ‘lending against real estate—and in particular against existing real estate whose supply cannot be easily increased—generates self-reinforcing cycles of credit supply, credit demand, and asset prices’ (Turner, 2017, p. 71).

Ryan-Collins (2019) addresses some potential critiques of this feedback hypothesis, including for instance the ‘correlation versus causation’ issue, also referred to as an ‘endogeneity bias’ in economics, where an opponent might say that bank lending and house prices might both have increased at the same time due to other factors in the wider economy, independently of each other. Ryan-Collins (2019) refutes this critique by referring to the fact that the Anglo-Saxon economies that liberalised their financial markets have seen faster growing and more volatile house prices than those economies that did not (Ryan-Collins, 2019). Favara and Imbs (2015) further corroborate a causal relationship using empirical data on the lifting of bank branching restrictions across US states, showing that credit increases for deregulated banks, but not for the placebo samples, ruling out any demand-based explanations. By incorporating a cyclicality-adjusted loan-to-value ratio for first-time buyers as a measure of credit constraints into conventional economic house price-to-rent ratio models, and using US data between 1979 and 2007, Duca *et al.* (2011) provide further empirical support for the view that credit standards significantly affect house prices.

3.3.3. Growing Stock of Housing Debt

Following the liberalisation of financial markets and the advent of securitisation and innovative financial instruments, and as a result of the exponential growth brought about by the reinforcing feedback loop between house prices and mortgages, the stock of outstanding mortgage debt in the UK grew by a factor of eight (in constant 2018 prices), from £180 billion in 1980 to a peak of £1.45 trillion in 2008, when it started declining slightly and stabilising following the GFC (BSA, 2020). As a percentage of net disposable income, the stock of household debt, which consists primarily of mortgage debt, grew from 98.6% in 1995 to a peak of 166.8% in 2007. Although it has since come down, it still stands over 40 percentage points higher than its 1980 value. As can be seen in Figure 3.5 below, household debt as share of disposable income in the UK is well above the G7 average and higher than all other countries in the group since 2002, save for Canada.

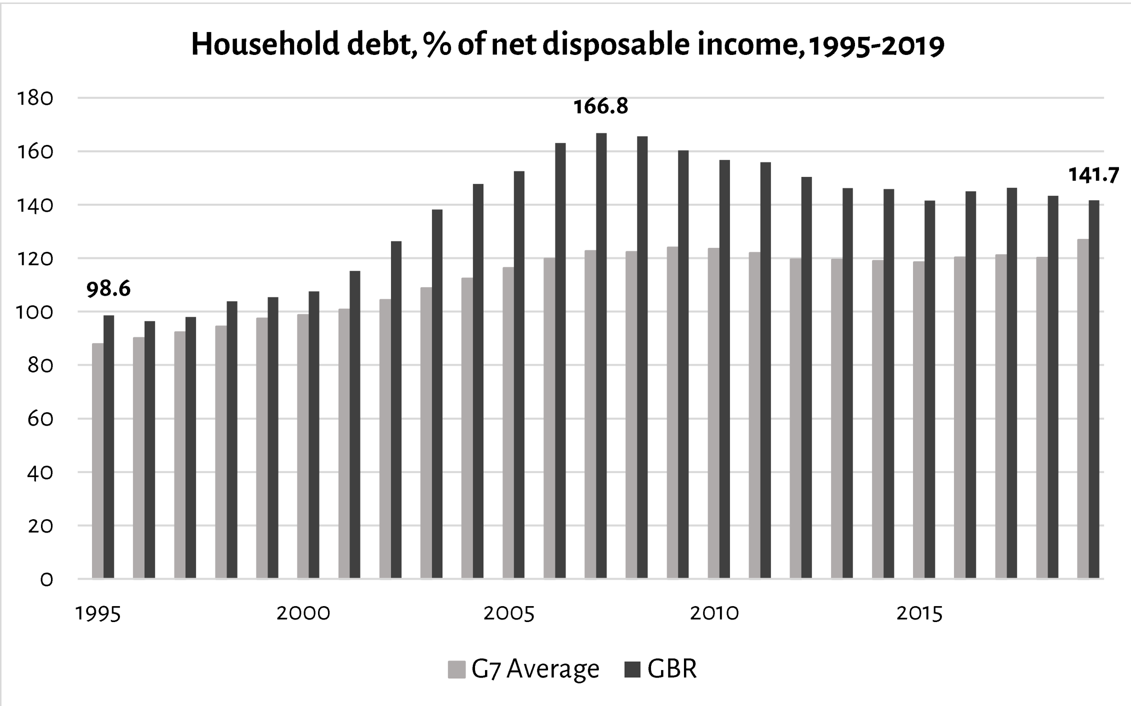

Figure 3.5 – Household debt as % of net disposable income, GBR against G7 average 1995–2019

Source: (OECD, 2021)

The inflation of housing wealth over the decades has been accompanied by a similarly drastic increase in the total amount of financial assets and liabilities, which was not higher than four to five years of national income in the early 1970s, but has since skyrocketed up to twenty years of national income in 2010, setting an absolute historical record (Piketty, 2014, p. 194). This is testimony to the severe financialisation of housing following the financial deregulation (Aalbers, 2016).

High levels of household mortgage debt have been linked with economic stagnation (Lo & Rogoff, 2015) and inequality in liberal economies (Wood, 2017). Using panel data from 30 countries from 1960 to 2012, Mian, Sufi and Verner (2017) found that an increase in household debt-to-GDP ratio predicts lower subsequent GDP growth and higher unemployment in the medium run. Jordà, Schularick and Taylor (2015) use data on bubbles in housing and equity markets in 17 countries over the past 140 years to demonstrate that, upon collapsing, credit-financed bubbles tend to be followed by deeper recessions and slower recoveries, with high levels of debt depressing demand and preventing growth. A major risk associated with the over-accumulation of housing debt has to do with housing-related financial cycles which is the topic of the next section.

3.3.4. Housing-related Financial Cycles

In many countries, including the UK, house prices are subject to boom-bust cycles which are linked to severe economic and financial instability (Muellbauer, 2012). These cycles have increased in both frequency and severity since the financial deregulation started in the 1980s (Ryan-Collins, 2018, p. 107). The generic pattern of such housing-related financial cycles is as follows: During the boom, house prices are rising, and mortgage lenders play a facilitating role by expanding their lending aggressively, confident with the rise in housing wealth—the banks' principal collateral. As a result of the over-allocation of credit to existing, non-productive landed assets, house prices and mortgage credit grow faster than the rest of the economy, and thus faster than household earnings. The housing economics literature also points out that homebuyers' irrational, extrapolative expectations of rentier returns (i.e., capital gains on housing) can lead to a 'frenzy' (Muellbauer, 2012) or 'euphoria' (Capozza & Seguin, 1996) phenomenon during boom periods, whereby the highly attractive expected gains can lead to a sharp rise in speculative demand and an overshoot in prices (Capozza & Seguin, 1996; Clayton, 1997). Eventually, perhaps triggered by a rise in interest rates or another external destabilising shock, there comes a point when borrowers start getting into arrears and defaults on their loans, suddenly making the banks much more cautious in their lending, dampening the demand for housing, and ultimately leading to a reversal of the boom trends. As the boom turns to bust, debt becomes a hanging burden and over-allocation of capital to property holds the economy back. During the downswing, liquidity dries up and credit becomes inaccessible and expensive, while at the same time house prices start falling, confronting an increasing number of households with financial insecurity and negative equity—a situation where the homeowner's mortgage debt is greater than the price of their house. Note that the abovementioned 'frenzy' can also operate on the downside, i.e., the fear of capital losses might lead to 'fire sales' (Shleifer & Vishny, 2011) of housing assets and raise transaction volumes, leading to sharp falls in price (Muellbauer, 2012). The same way as housing can be a wealth-generating asset during the boom, it can quickly turn into a highly leveraged financial vehicle capable of decimating the household's entire financial security (Borio, 2014; Montgomerie & Büdenbender, 2015).

The first notable theory of financial cycles was Minsky's (1992) Financial Instability Hypothesis (see Box 3.2 below), where—without bringing property or housing into the equation—he describes how excessively risky lending practices during 'good' economic times can result in overaccumulation of debt, making the economy vulnerable to shocks and causing endogenous boom-and-bust cycles. According to Minsky (1975), the inherent instability in capitalist economies lies in the systematic tendency of investors in asset markets towards overoptimistic and excessive leveraging enabled by the financial system (Bezemer, Ryan-Collins, van Lerven, & Zhang, 2018).

Box 3.2. The Financial Instability Hypothesis

Hyman Minsky is one of the most influential economists who has worked on the topic of financial instability. Minsky (1919–1996) was an American economist who focused on the origins of financial cycles and crises in capitalist economies in his research. During his lifetime, Minsky remained a marginal figure in the field of economics. However, in the aftermath of the 2007-08 GFC his ideas suddenly gained immense popularity. In his seminal contribution, the *Financial Instability Hypothesis* (Minsky, 1992), Minsky identified three possible income-debt relations for economic units, which he labelled as hedge, speculative, and Ponzi finance, ranging from conservative (zero/low leveraging) to excessively risky financial regimes. He theorized that during 'good' economic times, capitalist economies tend to become more and more lax in their financing regimes, shifting from the more stable hedge financing towards speculative and Ponzi financing. This will result in an over-accumulation of debt to an extent that borrowers will no longer be able to afford servicing their debt. As a result, economies become highly vulnerable to even small shocks, such as a rise in interest rates, which can bring about financial crises with rising defaults, falling business investment, and a drying up of bank lending (Minsky, 1992).

Essentially, the *Financial Instability Hypothesis* is 'a model of a capitalist economy which does not rely upon exogenous shocks to generate business cycles of varying severity. The hypothesis holds that business cycles of history are compounded out of (i) the internal dynamics of capitalist economies, and (ii) the system of interventions and regulations that are designed to keep the economy operating within reasonable bounds' (Minsky, 1992, p. 8). Based on Minsky's hypothesis, Keen (1995, 2013) builds a dynamic macroeconomic model, using simultaneous differential equations, which succeeds in capturing developments in key indicators before, during, and after the 2008 GFC. Unlike mainstream economists who tend to relate financial crises to exogenous shocks, Minsky and Keen take a clearly dynamic, systemic, and endogenous view towards the workings of capitalist economies, a perspective that is very much in line with the principles of the system dynamics methodology, the main methodology applied in this thesis (see Chapter 4).

Although Minsky's theory was conceptualised on private economic firms, the notion of endogenous financial instability has also been applied to the household sector and debt, e.g., by Ryoo (2016). The *Financial Instability Hypothesis* turned out to have extraordinary explanatory power for the GFC, to the extent that that episode has often been called a 'Minsky moment' (Cassidy, 2008).

More recently, building on Minsky's seminal contributions, Borio (2014, p. 183) defines the financial cycle as 'self-reinforcing interactions between perceptions of value and risk, attitudes towards risk and financing constraints, which translate into booms followed by busts'. In his insightful account of the role of financial cycles in macroeconomics, Borio (2014) pays particular attention to the role of property therein and characterises these cycles as having three principal stylised features: Firstly, the financial cycle is most parsimoniously described in terms of credit and property prices. In other words, this is the smallest set of variables needed to adequately replicate the reinforcing feedback relationship between financing constraints (credit) and perceptions of value and risks (property prices). Secondly, financial cycles have a much larger amplitude and occur at a much lower frequency than traditional business cycles (around every 16 years versus every 1 to 8 years, respectively). Finally, the peaks are closely associated with systemic banking crises (Borio, 2014). Borio (2014) further points out that, although the notion of the financial cycle predates the now much more common business cycle, it fell out of favour in recent decades in line with the general neglect of the role of credit in neoclassical economics.

However, a growing number of economists now argue that modern capitalist economies are characterized by a property–credit cycle, rather than the relatively less important but more commonly discussed business cycle (Borio, 2014; Cerutti, Claessens, & Laeven, 2017; Claessens & Fund, 2011; Drehmann, Borio, & Tsatsaronis, 2012). In recent years, a consensus has been shaping in placing housing at the epicentre of financial crises (Bezemer & Zhang, 2014; Borio, 2014; Jordà et al., 2016), as with the most recent GFC in 2008 (see Box 3.3 below). Bezemer and Zhang (2014) find, based on an analysis of data on 37 economies over the period 1970–2012 covering 187 credit booms in total, that the interaction between mortgage credit growth and increasing house prices is a good predictor of a credit boom and that credit booms in which the share of mortgage credit in total bank credit increases more are more likely to go bust and end in credit crunches (Bezemer & Zhang, 2014). Asset price bubbles that are accompanied by credit booms have been found to be more dangerous to economic stability, followed by deeper recessions and slower recoveries that those which are not (Jordà et al., 2015).

Not incidentally, cyclicality also features in Harvey's capital switching theory, described earlier in Section 3.3.1. Harvey (1978) maintains that crises of capitalism are usually 'preceded by the massive movement of capital into long-term investment in the built environment as a kind of last-ditch hope for finding productive uses for rapidly overaccumulating capital (Harvey, 1978, p. 120)', and that there is a strong link between these 'long waves' of investment in the built environment and the structure of the money supply market. For Harvey too, '[t]he role of "fictional capital" and the credit and money supply system has always been fundamental in relationship to the various waves of speculative investment in the built environment' (Harvey, 1978, p. 121).

With regards to an enabling environment, it is widely agreed that a liberalised, *laissez-faire* policy framework concerning bank credit—as has generally been the case in the UK since the 1980s—makes financial cycles more likely to happen (Borio, 2014; Cerutti, Dagher, et al., 2017; Drehmann et al., 2012; Ryan-Collins et al., 2012). The risk that such crises will be repeated in the future is considered to be high within the current deregulated financial market environment as this tendency is, in effect, built into the structure of the system (Edwards, 2015; Kennett et al., 2013). The notion of credit is fundamentally founded on the lender's trust in the borrowers' future ability to repay the debt. This trust is inherently fragile, and so while credit can act as 'oil for the economic machine' (Borio, 2014, p. 188) via creating additional purchasing power, it can also bring about instability. With banks having increasingly turned towards property-related lending, it is no longer clear whether deregulated bank debt provides greater economic benefits than harm (Ryan-Collins, 2021; Ryan-Collins et al., 2017, p. 211).

Box 3.3. The Global Financial Crisis

In much of the Global North, the 1990s and early 2000s was a period of economic prosperity and stable growth. Access to credit widely expanded during this period as a result of market liberalisation, technological advances and institutional change (Rajan, 2005). Central banks and finance ministers were congratulated for having finally found the 'panacea' for economic prosperity, a way to prevent the boom–bust cycles of the previous decades (Ryan-Collins, 2018, p. 62). Following this period, which was labelled the 'Great Moderation' (Bernanke, 2004), the Global Financial Crisis (GFC) took economists and politicians by surprise.

The Great Moderation turned out to be an illusion. In hindsight, it has been dubbed the 'Great Excess' (Aalbers, 2016, p. 64) or the 'Great Asset-Price Inflation' (Ryan-Collins et al., 2017, p. 191) considering the excessive growth in house prices and housing debt in that period. The GFC was initially triggered by the bursting of the US housing bubble in 2006. Housing boom and busts had happened many times before, but what made this one different was the level of financial leveraging through securitisation that had taken place founded on housing mortgages, in particular those issued to borrowers without a strong credit record— 'subprime' mortgages. Mortgage-backed securities based on subprime mortgages had been sold in financial markets globally. With rising mortgage defaults in sub-prime markets, which began in 2006 and peaked in early 2010, the value of these securities plunged and those banks—both in the US and in Europe—whose balance sheets contained substantial sums of these assets began to experience a funding crisis. This both led to and was exacerbated by a sudden rise in the inter-bank rate of interest and shortage of funds in the interbank market, facing the financial system with a liquidity crisis and resulting in governments having to step in and bail out a number of major banks with taxpayer money, which led to substantial government deficits. The economic recession that followed was longer than nearly all others that had followed financial crises (Ryan-Collins, 2018, pp. 64–65).

The key role of excessively leveraged mortgage credit in causing the GFC is now considered an undisputed fact (Hossain & Kryzanowski, 2019). Mainstream economists were unable to predict the GFC because mainstream macroeconomic models tend not to include house prices or housing debt as key drivers (Bezemer, 2009). These 'twin blind spots' (Ryan-Collins, 2018, p. 63) of mainstream economic theory made economists rather unconcerned about extremely high house prices and housing debt stocks relative to incomes (Ryan-Collins et al., 2017, p. 126). A small minority of economists who did include asset prices as well as credit in their models, rather than regarding money simply as a 'veil', managed to warn about the danger of a crisis. Bezemer (2009) carries out a review of studies that did 'see this coming' and reports that their common features included a concern with wealth, debt and credit flows, separate representation of stocks and flows, non-optimising behaviour by economic agents, and an explicit modelling of the financial sector.

Raghuram Rajan, for example, the former Chief Economist of the International Monetary Fund (IMF), famously warned about deregulation and innovative financial instruments contributing to create 'more financial-sector-induced procyclicality than in the past' and 'a greater (albeit still small) probability of a catastrophic meltdown' and that 'we should not be lulled into complacency by a long period of calm' (Rajan, 2005, p. 346). However, such warnings were dismissed as doom-mongering by the established orthodoxy (Ryan-Collins, 2018, p. 62).

In the aftermath of the crisis, however, such ideas were no longer dismissed. Indeed, the previously forgotten works of 20th century American economist Hyman Minsky, in which he had warned of the dangers of financial excess, attracted considerable attention (see Box 3.2). Following the GFC, the previous trend towards deregulation was reversed with governments and regulators imposing more stringent financial regulatory regimes, such as a requirement of banks to hold larger capital buffers—measures which have been found effective in improving the stability of the financial system (Fratzscher, König, & Lambert, 2016). Furthermore, in June 2014, the Bank of England's newly formed Financial Policy Committee recommended that banks limit the share of their high loan-to-income new mortgages and apply an interest rate stress test when assessing their loans' affordability (Bank of England, 2014). Banks have tightened their lending criteria as a result of this more stringent regulatory regime (Ryan-Collins et al., 2017, p. 100). Therefore, despite a continuing climate of low interest rates, the combination of more cautious lending strategies and tighter regulation has made access to mortgage finance more difficult for all but the lowest-risk borrowers (Scanlon & Adamczuk, 2016), making it nearly impossible for many first-time buyers to 'get on the housing ladder'. However, despite tighter mortgage regulation, as seen earlier in Figure 3.3, the banking sector remains largely inclined towards lending against property rather than the productive sectors of the economy.

3.4. Promotion of Homeownership in the UK

Throughout the past decades, homeownership has been actively promoted by successive UK governments on both sides of the political spectrum, while 'renting has been denigrated as an inferior tenure that does not provide a context for household or family stability' (Gallent et al., 2017, p. 2211). The deregulation of mortgage markets discussed earlier in this chapter has arguably been the most important (but not the only) policy towards promoting homeownership. In the next sub-section, we review some of the other major policies targeted towards expanding homeownership since the 1980s. Subsequently, we place this set of policies within the broader framework of the UK's liberal welfare and economic growth models in Sections 3.4.2 and 3.4.3. Finally, we look briefly at the socioeconomic consequences of homeownership in 3.4.4.

3.4.1. Policies Promoting Homeownership

Following the rise to power of Margaret Thatcher's Conservative government in 1979, there was a broad transition from the post-war interventionist political paradigm to a new neoliberal climate based on a monetarist economic paradigm, which is characterised by the retreat of the state from regulating markets, the dismantling of social welfare systems, privatisation, and tax cuts (Fourcade-Gourinchas & Babb, 2002). With this new paradigm in place, in housing too, a *laissez-faire* approach took over where the government no longer intervened in the housing market, which put a stop to the massive house-building programmes by the local governments since after the Second World War (see the decline in new local authority housing in Figure 2.1, p. 23). In this new climate, government housing policy quickly moved towards leaving the provision of housing to the market and there was a broad policy shift from supply-side subsidies to demand-side subsidies (Gibb & Whitehead, 2007; Stephens & Whitehead, 2014), such as the previously discussed Housing Benefit.

A key dimension of this political paradigm has been the promotion of homeownership with the promise of a 'property owning democracy' (Arundel & Ronald, 2020). In this section, I review some of the principal policies implemented towards this promise since 1980. These include Right to Buy, Mortgage Interest Relief at Source (MIRAS), an exemption of primary homes from capital gains tax, and Help to Buy.

3.4.1.1. *Right to Buy*

As a key component of her political campaign involving a property-owning democracy, Margaret Thatcher launched the Right to Buy (RTB) scheme in 1980. RTB encouraged local authorities to sell off council housing units to tenants at discounts of initially between a third and a half of the original price, which were further increased over the 1980s (Hodkinson, Watt, & Mooney, 2013). The scheme was later extended to housing association tenants. This turned out to be 'the most spectacular privatizations of public housing in history, [selling off 1.5 million units of social housing] worth £40 billion in its first 25 years' (Ryan-Collins, 2018, p. 29). In London, from 1998–99 to 2009–10, nearly 85,000 council homes were sold to tenants (MHCLG, 2012). The Right-to-Buy proved to be a hugely popular policy (King, 2010, p. 1) as it drastically increased homeownership at the time, while at the same time reducing public expenditure in maintaining the vast number of council housing units (Ryan-Collins, 2018, p. 29). As it reduced government spending in housing provision and maintenance, the policy is considered part of the neoliberal shift away from supply-side subsidies and towards privatisation (Hodkinson et al., 2013). The sold-off council housing stock was, however, never replaced by housing associations, as originally planned (Kennett et al., 2013). Furthermore, it is estimated that at least 36% of ex-council homes in London are now being let by private landlords (Watt & Minton, 2016).

RTB has been a contentious policy since the beginning, praised by some for widening access to homeownership and housing asset-based welfare (Section 3.4.2) while criticised by others for having led to the rise in homelessness in the 1980s and the residualisation of council housing (King, 2010, p. 2). Because it was mostly the better-off tenants who could afford to buy the properties they were renting, RTB left only the worst-off in the social rented sector, resulting in the residualisation of this tenure type. In addition, the sales were naturally rather skewed towards more popular properties (houses more than flats) leaving only the poorer quality housing available for social renting (Stephens et al., 2005, p. 30).

Following the implementation of RTB, as well as the deregulation of mortgage markets, owner-occupation in Great Britain rose continuously, from 55% in 1980 up until 2002 when it peaked just short of 70%. Since then, however, it has fallen to 63%, exactly where it sat three decades ago in 1987 (MHCLG, 2020a). Thus, perhaps the main issue with RTB was its 'irreplicability', benefitting one particular lucky cohort of tenants while negatively affecting subsequent generations due to the resulting shortage of council housing (Montgomerie & Büdenbender, 2015).

3.4.1.2. *Fiscal Policies Favouring Homeownership*

So far, we have argued that, in the current climate, housing is viewed as much an investment asset as shelter or a place to live. As an investment vehicle, the effective total return on housing depends crucially on the fiscal (tax) regime (Hutchison, 1994). The nature, or sometimes the non-existence, of a few fiscal policies is broadly considered to incentivise homeownership in different ways. These include the erstwhile Mortgage Interest Relief, the infamous Council Tax, and the non-existent Capital Gains Tax on primary residences.

Mortgage Interest Relief

Mortgage interest relief existed in the UK before the 1980s, but in 1983, with the introduction of the new 'mortgage interest relief at source (MIRAS)', the limit at which borrowers could claim the relief was raised from £25,000 to £30,000. Furthermore, unmarried couples with joint mortgages could pool their allowances to £60,000, a provision which remained in place until the 1988. This gave a clear fiscal incentive towards homeownership. Hutchison (1994) estimates that without MIRAS, the average annual return on housing investment would have diminished from 15.10% to 12.09% between 1984 and 1992.

Later in 1994, the rate of this tax relief was gradually reduced until it was fully abolished in 2000. It is, however, still available to buy-to-let landlords, for whom housing is taxed as an investment good (Ryan-Collins et al., 2017, p. 86).

Bramley (1993) shows that, having in mind the low price elasticity of new housing supply, demand subsidies such as MIRAS tend to capitalise in higher prices. He argues that the policy therefore failed to achieve its objective in relation to widening access (Bramley, 1993).

Council Tax

Council tax is a hybrid property and consumption tax on all housing services, levied equally on renters as well as homeowners, which is believed to be a highly ineffective property tax in its current form (Lawton & Reed, 2013; Muellbauer, 2005). The current banding system (linking property values to annual liability) is based on a valuation exercise undertaken nationwide in 1991. In the decades since, house prices and their geography have altered drastically. Today, taxable values do not represent current market values by any margin. The tax is regressive in relation to property values, which means that areas with lower house prices tend to pay higher rates in percentage terms, while high-end properties in Central London, for instance, are far under-taxed (Lawton & Reed, 2013; Muellbauer, 2005). Furthermore, councils are allowed to give discounts of up to 50% for second homes, while homes that are empty for up to six months are exempt from council tax. These discounts, along with the proportionally lower rates for expensive properties, are thought to encourage inefficient use of housing and incentivise housing investment (Gallent, 2016; Lawton & Reed, 2013).

Capital Gains and Imputed Rent Taxes

Capital gains tax (CGT) is charged on profits obtained from the disposal of assets. In the UK, primary residences are exempt from this tax. Homeownership is also exempt from a tax on imputed rent—the 'in kind' income that homeowners enjoy, equal to the rent that would have been paid for a similar property on the market. These exemptions increase the attractiveness of investing in housing with respect to other investments, thus making housing the 'perfect investment vehicle', distorting investment decisions, and attracting excessive capital away from productive sectors of the economy and into the housing market (Barker, 2019; Gallent, 2016; Gibb & Whitehead, 2007). The OECD advocates CGT on primary residences to remove the distortion between housing and other investments (Johansson, Heady, Arnold, Brys, & Vartia, 2008). Through encouraging speculation in the housing market, the lack of a CGT is also argued to have contributed to the UK's relatively high house price volatility (Oxley & Haffner, 2010, p. 23). It may also be considered fairer to treat owner-occupied housing as any other asset and subjected it to CGT. Barker (2019) advocates a limited form of CGT on principal residences to discourage over-investment in housing.

From a practical and political perspective, however, this entails important difficulties, which is why few countries apply CGT to primary residences. In Germany, CGT is only due if a property is sold within 10 years of purchase, and in the US, there is rollover relief so that the seller can defer paying CGT if she/he reinvests the capital gains in purchasing another property, so that in practice the tax is often never paid (Lawton & Reed, 2013; Oxley & Haffner, 2010). One possibility to reduce potential public resistance to such a tax could be to subtract CGT on a lifetime of property trade-ups from a person's estate as part of the inheritance tax, hence allowing often asset-rich, income-poor pensioners to defer the payment until they move house or die and softening the impact on mobility and consumer confidence (Barker, 2014, p. 62).

3.4.1.3. *Help to Buy*

During the years following the 2008 GFC, the stricter standards applied by banks in their lending created an important hurdle for first-time buyers towards 'getting on the housing ladder'. To overcome the restricted access to mortgages and the lower LTVs on offer, in April 2013, the incumbent Coalition government set out to address this increasingly political issue by introducing the 'Help to Buy (HTB)' programme (Scanlon & Adamczuk, 2016). Help to Buy includes a few different schemes, mainly the following: first, a 'Shared Ownership' scheme starting in April 2013, where the government provides an equity loan of up to 20% (or up to 40% in London) of the value of a new home. This scheme, which is only available for new homes, has been extended until 2023. Second, from January 2014 a mortgage guarantee scheme provided a bank guarantee for purchasers with small deposits of as low as 5 percent of home value. This scheme could be applied to buy existing as well as new properties. Third, there is also 'Help to Buy ISA', where the state will add 25% on top of what the buyer saves, and the buyer would earn up to 2.6% interest tax-free on the Individual Savings Account (ISA). This scheme was discontinued in November 2019.

While the programme is explicitly seeking to 'boost housing supply' (HM Treasury, 2014, p. 3), from the outset, HTB was foreseen to push up house prices (Hilber, 2013). Since its introduction, it has been widely criticised for contributing to house price inflation (Hilber, 2015; Scanlon & Adamczuk, 2016). Critics argue that the scheme has priced out a number of households several times larger than the far fewer lucky beneficiaries of the scheme (Archer & Cole, 2014). The policy's backing of high LTV loans has also been questioned for its potential for leading to financial instability, since high LTVs are considered a strong indicator of systemic risk (Scanlon & Adamczuk, 2016). Gallent (2016) highlights the irony in reacting to a demand-side housing crisis by further feeding demand. The harshest critiques have called the program 'help for votes' or 'help to bubble' (Dorling, 2014b). Indeed the programme has been said to have 'a striking resemblance to the American mortgage securitisation programmes Fannie Mae and Freddie Mac, the prime instigators of the financial collapse in the US in 2007-08' (Archer & Cole, 2014, p. 106).

In summary, from an economic perspective, both historically and at present, the UK policy system appears to favour owner occupation over other tenures through its demand-side subsidies and its preferential tax treatment of housing as an asset. This political economy has helped create a seemingly insatiable demand for housing and has contributed to declining affordability, especially in London. Given this policy context, the government has been accused of being a driver of the financialisation of housing and of rent-seeking behaviour by investors and financial institutions through its active promotion and preferential tax treatment of homeownership, as well as deregulation of financial markets and the PRS (Aalbers, 2016). While the promise of homeownership has been an overarching theme in the UK's socio-political scene, at least since the beginning of Thatcher's administration in 1979, four decades past, this promise is now being called a 'false promise' (Arundel & Ronald, 2020). In a recent commentary, Arundel and Ronald (2020) show based on empirical data that all of the implicit elements of the underlying ideology of this promise, 'that homeownership would be *widespread*, *equalising* and *secure*', have now turned out to not hold, with 'declining access to homeownership, increasing inequalities in concentrations of housing wealth and intensifying house-price volatility undermining asset security' (Arundel & Ronald, 2020, p. 1).

3.4.2. Asset-based Welfare

Privileging homeownership in the tax system, along with the deregulation of financial markets (see Section 3.3.1), are considered to be two main axes of the UK's 'asset-based welfare strategy' promoted by successive UK governments throughout the past decades (Montgomerie & Büdenbender, 2015), whereby, rather than relying on state-managed social transfers as during the post-war decades, households are given greater responsibility for their own future welfare needs and encouraged to invest in 'bricks and mortar' as their core strategy for saving and wealth accumulation for retirement income (Doling & Ronald, 2010; Edwards, 2015, p. 20). Households can then tap into this value gain either through 'downsizing' or via home equity withdrawal (see Section 3.4.3). Having in mind the nation's ageing population, the associated pressures on public welfare resources, and the neoliberal retrenchment of spending on public welfare on the one hand, and rising levels of homeownership throughout the 1980s and 1990s on the other hand, the accumulation of private wealth in housing assets has been considered, more or less explicitly, a solution to the fiscal difficulties of welfare provision (Doling & Ronald, 2010). The UK has been called a pioneer in Europe in asset-based welfare (Toussaint & Elsinga, 2009).

However, in an incisive critique of the UK's housing-based welfare strategies, Montgomerie and Büdenbender (2015), argue that gains from residential housing are a one-off wealth windfall to particular (lucky) groups within society, and that the temporal and spatial limits of gains from housing mean that the same conditions cannot be repeated often enough in the way required for residential housing to provide a generalisable welfare function. This irreproducibility of housing asset-based welfare strategy can already be observed in the intergenerational inequality that currently plagues the British economy. 'Baby Boomers' have disproportionately gained from past housing policies targeted at promoting homeownership, whereas the younger generation of 'Millennials' face more economic hardship and barriers to acquiring affordable housing (Hoolachan & McKee, 2019). An asset-based welfare strategy that relies on a continuous upward trajectory of house prices inevitably reinforces existing social inequalities between the housing 'haves and the have-nots' (Montgomerie & Büdenbender, 2015).

3.4.3. Privatised Keynesianism

The government's promotion of homeownership, accompanied by inflation of house prices and significant growth in the level of household's mortgage debt (Section 3.3.3), can be understood as an aspect of the UK's predominant economic growth model which has been dubbed 'privatised Keynesianism' (Crouch, 2009). In this system, growth in house prices—enabled by historically low interest rates and abundantly accessible mortgage credit—is considered a sign of a healthy economy and a 'feature' rather than a 'bug' (see for instance Scanlon and Adamczuk, 2016). House price inflation is arguably regarded as a kind of 'good inflation' (Hay, 2009) which boosts consumer confidence and supports growth in consumption (Aalbers & Christophers, 2014). The link between housing wealth and consumption is especially important in countries with highly developed and liberalised mortgage systems (Aron, Duca, Muellbauer, Murata, & Murphy, 2012; Calza, Monacelli, & Stracca, 2007) which allow households (a) to obtain mortgages with lower deposits (allowing them to save less and therefore spend more) (Ryan-Collins et al., 2017, p. 145), and (b) to release cash for spending by taking on additional mortgage debt against a rise in their property's price (Aron et al., 2012), a feature called home equity withdrawal or mortgage equity withdrawal. In the decades leading up to the GFC in 2007-08, it has been argued that a combination of house price appreciation and lax credit constraints helped keep the economy afloat even through times of recession (Muellbauer & Murphy, 1997; Parkinson, Searle, Smith, Stoakes, & Wood, 2009). Ryan-Collins (2018, p. 95) postulates that it is perhaps because of this broader economic function of house price inflation in supporting consumer confidence and consumption that politicians on both sides of the political spectrum have been reluctant to address its powerful demand-side drivers.

Privatised Keynesianism is central to the Marxian notion of capital circulation. Within the Marxist political economy literature, it is viewed as a way both to fuel the economy by compensating for decades of negligible or even negative real income growth via relying on rapid accumulation of private mortgage debt (Aalbers & Christophers, 2014). An economic system built on a mortgage credit-based house price-driven growth model and housing asset-based welfare strategy (Section 3.4.2) has been dubbed a 'residential capitalism' (Schwartz & Seabrooke, 2008). This model of welfare and economic growth has been criticised for being unsustainable and highly prone to instability (Hay, 2009). The associated high level of household indebtedness is pernicious from a macro-economic perspective and makes the economy vulnerable and exposed to shocks such as a rise in interest rates (Crouch, 2009; Montgomerie & Büdenbender, 2015). The danger is that the debt service burden reaches a point where households can no longer sustain higher levels of real estate investment (Drehmann, Juselius, & Korinek, 2017). This puts a brake on real estate prices as credit becomes scarce and households become cautious in spending. In such a situation, as described by Hay (2009), 'a series of self-reinforcing dynamics are unleashed—as those laid off fail to keep up with their mortgage repayments, cut back their consumption to the bare essentials and, in the process, contribute further both to the shortfall of demand in the economy and to a falling housing market. This is precisely the situation in which the UK economy found itself by mid-2008' (Hay, 2009, p. 472).

An important consequence of the incumbent regime of residential capitalism has been the accumulation of tremendous wealth in the form of residential property. In the UK, net property wealth is the second largest source of wealth (35% of total wealth), closely behind the largest source that is private pension wealth (42%) (ONS, 2019b). An estimate by Savills Estate Agents shows that the total value of private housing in the UK stood at £7.14 trillion in 2018, having increased by 34% (£1.82 trillion) over the preceding decade, with the lion's share of this growth (87%) having occurred in London and the South of England (Savills, 2018). While London has less than 1 in 8 homes in the UK, it accounts for a quarter of the total housing value (vs 19% in 2007). Importantly, the share of the growth due to house price growth (81%) is by far larger than the share attributed to new housebuilding.

3.4.4. Socio-economic Consequences of Homeownership

Perhaps the most serious socio-economic outcome of the promotion of homeownership in the UK has been rising inequality. The Savills report mentioned above also highlights that 'housing wealth is increasingly concentrated in fewer, older hands – notably owner occupiers who own their homes outright and private sector landlords' who together account for 95% of the total equity gain over the 10-year period (Savills, 2018). The ONS also confirms that inequality in property wealth has increased over the 2006/08 to 2016/18 period (ONS, 2019b). Arundel (2017) surveys data from three waves of the Wealth and Assets Survey (2006–2008, 2008–2010, and 2010–2012) and reports a steady divergence in housing equity across deciles, with a clear growth in concentration of housing wealth in the top deciles, as well as growing intergenerational inequalities in housing (Arundel, 2017). The accumulation of wealth in housing is asymmetric, accruing untaxed windfall gains to homeowners while leaving non-homeowners worse-off and facing higher initial deposits needed to buy a home. Equity considerations aside, growing wealth inequality as a result of an accumulation of wealth in over-priced housing is also economically inefficient and negatively associated with economic growth (Islam & McGillivray, 2020).

While it is often presumed that homeownership is beneficial for economic growth and prosperity, the literature on the socio-economic consequences of homeownership is, in fact, inconclusive. In a review of the literature on the consequences of homeownership, Dietz and Haurin (2003) report that a strand of literature suggests that homeowners benefit from better health outcomes than renters, and that homeownership leads to greater participation in neighbourhood social networks and local political activity. However, other studies argue that homeowners tend to be less mobile than renters and therefore less able to respond to changes in the local labour market. This can hamper the matching process between jobs and the labour force and increase unemployment (Blanchflower & Oswald, 2013).

Furthermore, a higher level of homeownership may lead to a higher prevalence of NIMBYism (Not In My Backyard), which has been referred to as 'a rational response to the uninsured risks of homeownership' for homeowners whose most sizeable asset is usually their house (Fischel, 1991). NIMBYism can restrict new housing supply and impede economic development (Ryan-Collins, 2018, pp. 121–122).

As mentioned earlier, however, for almost two decades now, the balance of the UK population has been shifting from a majority homeowner population to a majority of renters. In London in particular, we saw in Section 1.1.3 that owner-occupiers have lost their tenure majority since 2012, with a growing share of private renters about to reach 30%. A 2014 YouGov poll found that half of Londoners want house prices to fall, while only one in six hope for them to keep rising (Cecil, Chu, & Prynn, 2014). Policy will need to adapt to this new demography which will naturally favour policies towards reducing the concentration of wealth in property and towards encouraging higher quality and longer tenure rights in the PRS.

3.5. Causal Loop Diagram

In this section, as with the previous chapter, I am going to use a set of CLDs to synthesise the notions, relationships and mechanisms introduced in this chapter. The first sub-section presents a CLD of demand-side dynamics and financialisation of housing. In the second sub-section, I will combine this CLD with the one on supply-side dynamics introduced in the previous chapter to make an integrated CLD of the whole system, covering both supply and demand sides.

3.5.1. Causal Loop Diagram: Demand-side Dynamics

I am going to present the full demand-side CLD in a step-by-step fashion to facilitate understanding, while highlighting in bold the new variables, links and loops added at each step. I shall begin right at the centre of the diagram with the *house prices* variable. As we saw earlier in this chapter, on the demand side *house prices* are influenced both by utility-based demand and investment demand. Total *household disposable income* is considered to be a good proxy for utility-based demand as it captures at the same time both the number and the average purchasing power of households (Cheshire, 2018). On the investment demand side, as *house prices* rise, *expected house prices* in the future also rise, instigating an increase in *expected housing return on investment*, which comes back to push *house prices* further up, closing the major reinforcing feedback loop *R4: Investment Loop.* [12] The existence and extent of the *capital gains tax*, as a policy variable, can mediate the operation of this reinforcing loop via negatively affecting the *expected housing return on investment*. In particular, as discussed in Section 3.4.1.2, removing the exemption of primary residences from this tax can restrain the operation of this loop.

[12] I have continued the numbering of the loops from those presented in the previous chapter (where we already saw *R1*-*R3*) because the supply- and demand-side CLDs will be combined in the next section.

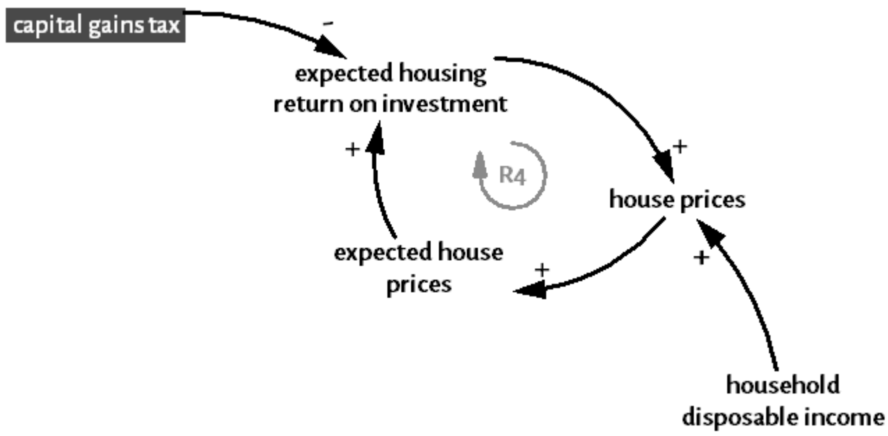

Figure 3.6 – Demand-side CLD 1) R4: Investment Loop

As *house prices* increase, *house price to income ratio* goes up proportionally (Figure 3.7), which leads to a growing slice of the population being priced out of buying their own homes into the PRS, pushing up *privately rented tenure share* and *private rents* along with it. Also contributing to the rise in *private rents* has been *PRS deregulation* as a policy choice, as we saw in Section 3.2.2 where we talked about how the rise in *private rents* has been stimulating investment demand via boosting *expected housing return on investment*. This completes the next reinforcing feedback loop, *R5: Priced Out Loop* (Gibb, Pawson, & Hulchanski, 2019, p. 58). Note that the previous mechanism (*R4*) involved asset price appreciation, whereas *R5* involves income (rents) generated by property assets, both adding up to give the total gross return on housing as an investment asset.

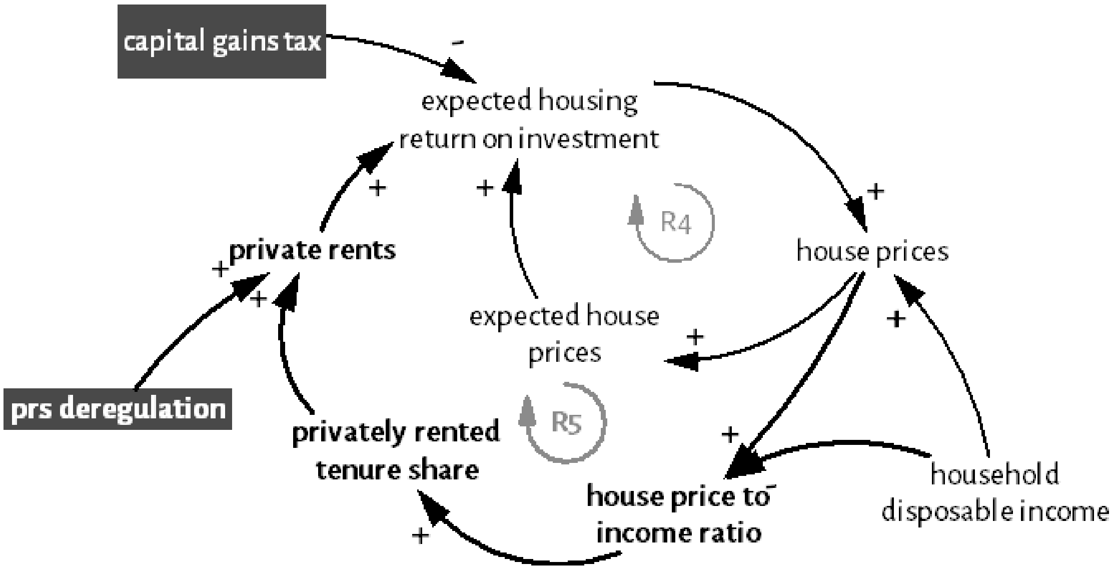

Figure 3.7 – Demand-side CLD 2) R5: Priced-out Loop

In addition to that, a rising *house price to income ratio* also increases demand for *new mortgage advances* (Figure 3.8), which in turn boost demand for housing and further contribute to rising *house prices*, as elaborated in Section 3.3.2, making housing yet more unaffordable (De Greef & De Haas, 2000) (loop *R6*). As *house prices* grow, *housing* wealth—i.e., the total value of the housing stock—also rises, expanding the available collateral which homeowners can leverage to get new or re-mortgages, especially in countries with more developed and flexible mortgage markets, such as the UK (Calza et al., 2007). This can put further upward pressure on *house prices* and thus completes the reinforcing *R7: Collateral Loop*. A further stimulant of expansion in mortgage lending can be the rise in *private rents*. As *rents* go up, banks become more eager to issue BTL mortgages relying on the stream of rental income growing stronger. This closes the reinforcing feedback *R8: Lending Against Rental Income*, which can be another driver of rising prices and mortgages in a boom period. Collectively, I refer to the reinforcing loops *R6, R7* and *R8* introduced in Figure 3.8 as the set of *Housing-Finance Feedback Loops*.

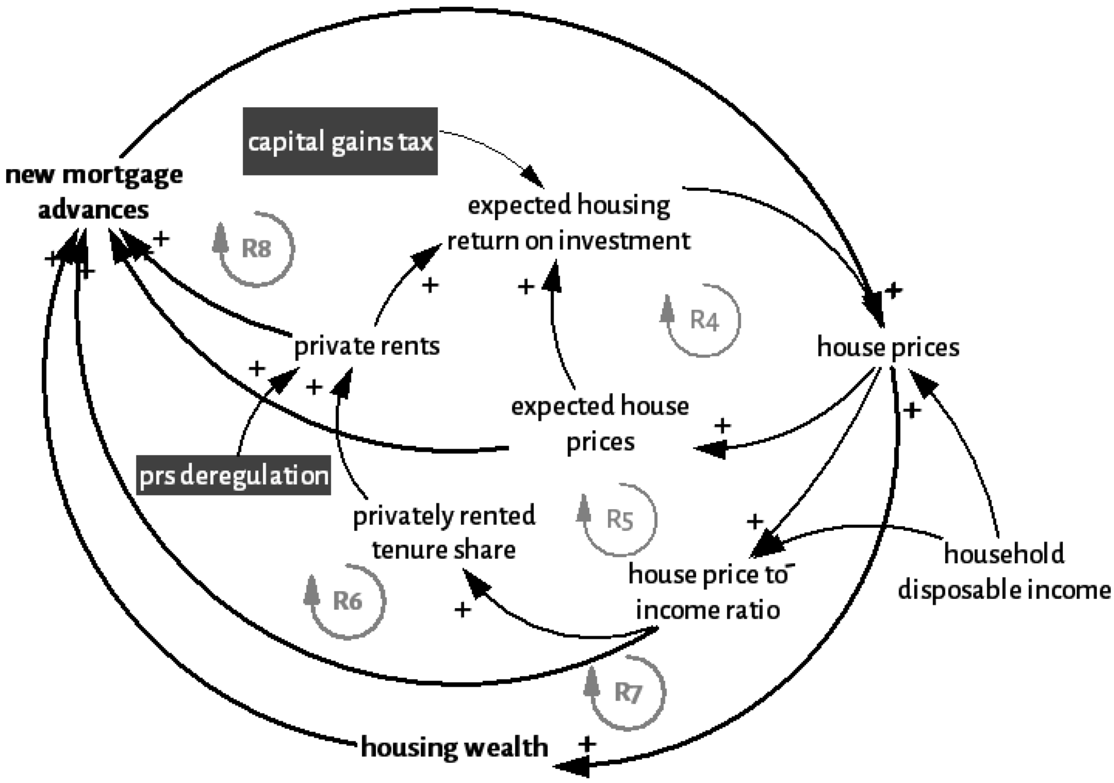

Figure 3.8 – Demand-side CLD 3) R6: Housing-Finance Loop, R7: Collateral Loop, R8: Lending Against Rental Income.

Meanwhile, increasing *house prices, ceteris paribus*, raises the *average deposit to income ratio* (Figure 3.9), which means fewer people can afford to put up the required deposit for a mortgage loan. This has a balancing effect on the demand for *new mortgage advances* and pushes *house prices* down in the opposite direction of the other forces henceforth described, thus establishing the balancing loop *B2: Affordability Loop*. However, as elaborated at length in this chapter, *financial deregulation* has in the past made mortgages with more generous *loan to value ratios* possible and has increased *new mortgage advances*, both directly and via a variety of other channels, including securitization, as well as enabling a more varied portfolio of mortgage products including *BTL mortgages*. The more recent *Help to Buy* policy has also both directly increased *new mortgage advances* by helping households put up the required deposit via the equity scheme and pushed *average loan to value ratio* higher via the mortgage guarantee scheme.

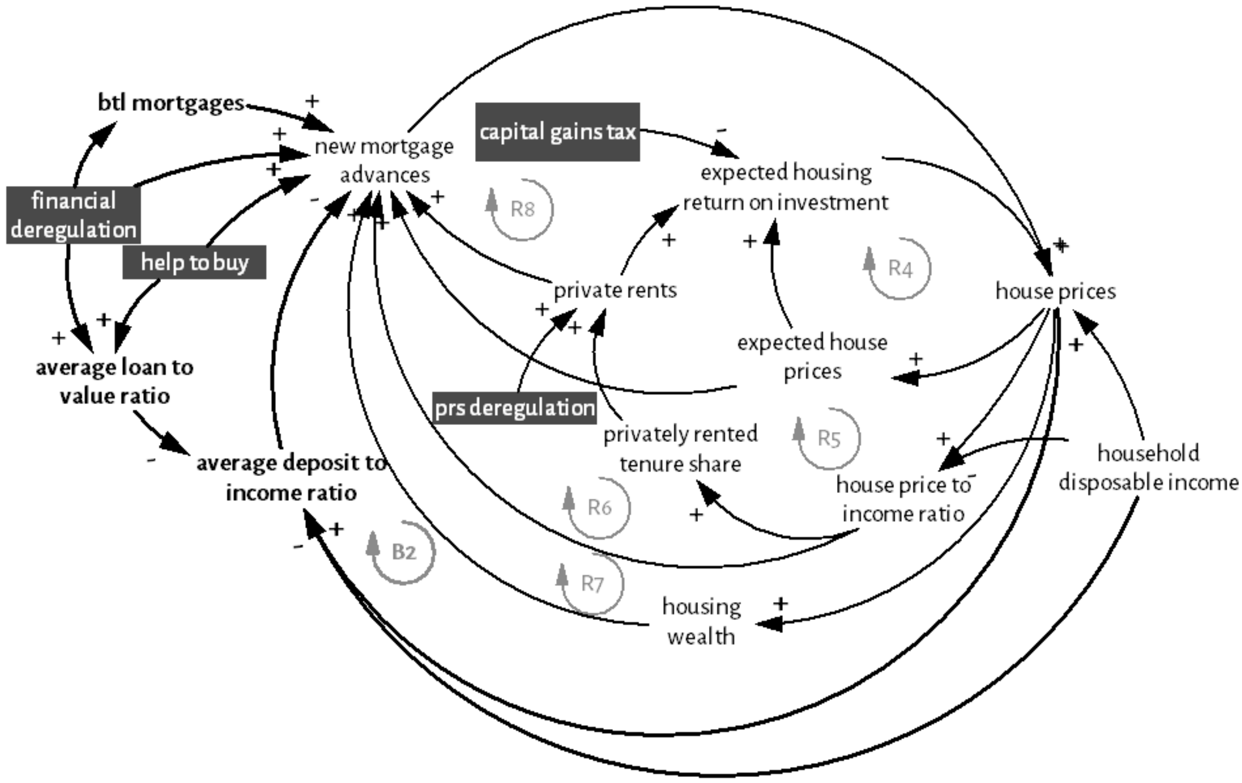

Figure 3.9 – Demand-side CLD 4) B2: Affordability Loop

Concurrently, as we saw earlier in Figure 3.3, banks have turned to mortgage lending as the main component of their business, at the expense of reducing the share of loans going to non-housing businesses. Chakraborty, Goldstein and MacKinlay (2014) find, based on US data between 1988 and 2006, that banks which were active in strong housing markets increase mortgage lending while decreasing lending to firms, and that those firms relying on such banks for investment get significantly less credit. This is evidence for a 'crowding out' effect against lending to non-financial businesses, establishing a 'success to the successful' systems archetype (Wolstenholme, 2003) where residential property keeps attracting the lion's share of bank credit in the economy. This negative impact on *credit issued to (non-housing) businesses* threatens the *viability of (non-housing) businesses,* which can negatively impact *household disposable income* (Bezemer et al., 2016), further raising *house price to income ratio* and with that the demand for *new* *mortgage advances*, putting additional pressure on any *credit issued to (non-housing) businesses* (Loop *R9: Crowding Out in Credit Allocation*).[13]

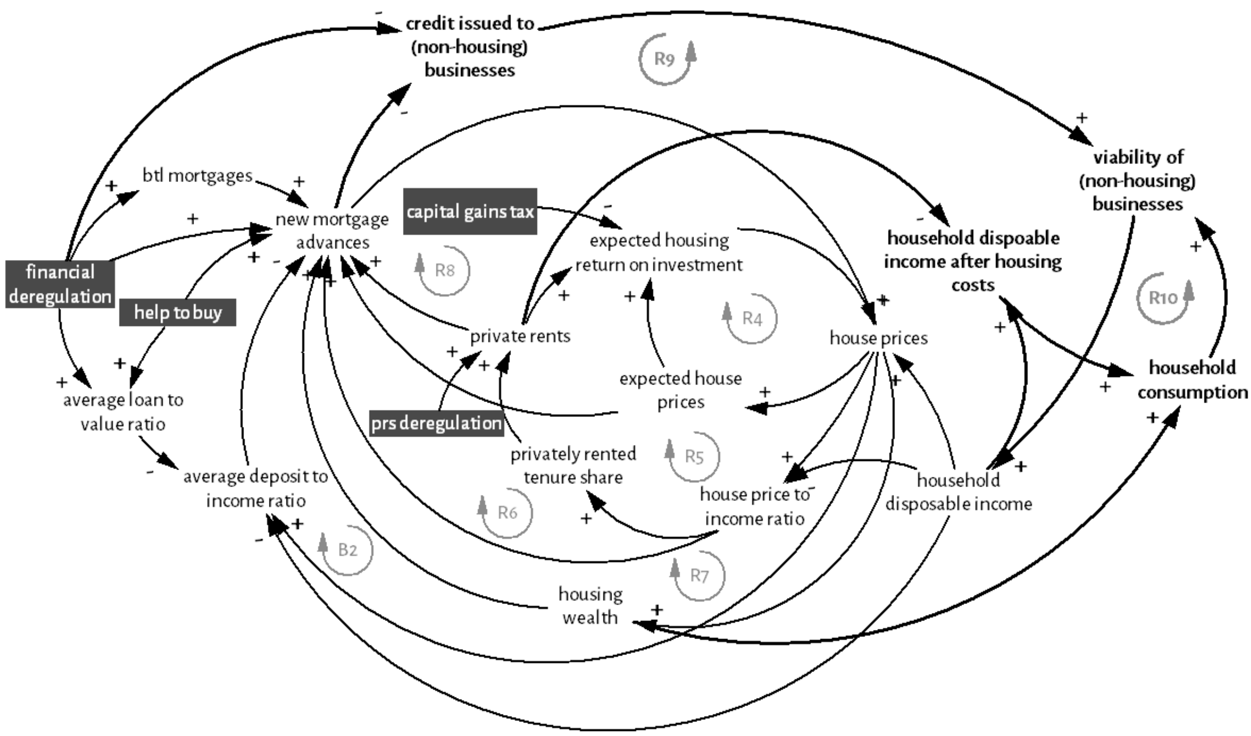

Figure 3.10 – Demand-side CLD 5) R9: Crowding Out in Credit Allocation, R10: Consumption and Economic Prosperity

Viability of businesses is also affected by *household consumption* which is itself a function of *household disposable income after housing costs* (Mankiw & Taylor, 2020). This latter variable is determined after accounting for the impact of *private rents* (and later of *debt service burden*) on *household disposable income*. These additional links introduce another important reinforcing loop called *R10: Consumption and Economic Prosperity*, travelling (in

[13] It must be noted that the importance of residential property as collateral for bank lending means that there can also be a potentially positive impact from house price growth to lending to businesses. Hofmann (2004) analyses the determinants of bank lending to the private non-financial sector in 16 industrialized countries using a cointegrating vector auto-regression model and finds that property prices have a significant and persistent positive dynamic effect on bank lending to businesses. This potential impact is not included here in the CLD.

a visually twisted way) from *household consumption* to *viability of (non-housing) businesses*, to *household disposable income*, to *household disposable income after housing costs,* and back to *household consumption* (Figure 3.10). This describes how a bias towards property lending can deprive non-housing economic firms of much-needed credit, potentially leading to lower employment and wages, restricted consumption, and a further strain on businesses. The self-reinforcing mechanisms described in loops *R9* and *R10* demonstrate how an overgrowth in credit for housing can ultimately leave households with stagnating wages, while at the same time threatening economic firms with lower demand for their products as well as restricted availability of credit (Bezemer & Hudson, 2016; Ryan-Collins, 2018, p. 40). A possible additional link (not included in the diagram) involves economic productivity and growth being further constrained by increasing household investment in bricks and mortar rather than in human capital or in entrepreneurship (Maclennan & Miao, 2017).

Note also the positive link from *housing wealth* to *household consumption* and economic activity in general, which has been the topic of considerable attention (Aoki et al., 2002; Burrows, 2018; Calza et al., 2007; Parkinson et al., 2009). This link has to do with the notion of privatised Keynesianism previously discussed in Section 3.3.3. This establishes a further reinforcing loop (not separately named in the diagram) that goes from *house prices* to *housing wealth,* to *household consumption*, *viability of (non-housing) businesses, household disposable income*, and back to *house prices.* Essentially, this describes another self-sustaining engine of growth in *house prices* which operates through the channel of *housing wealth.*

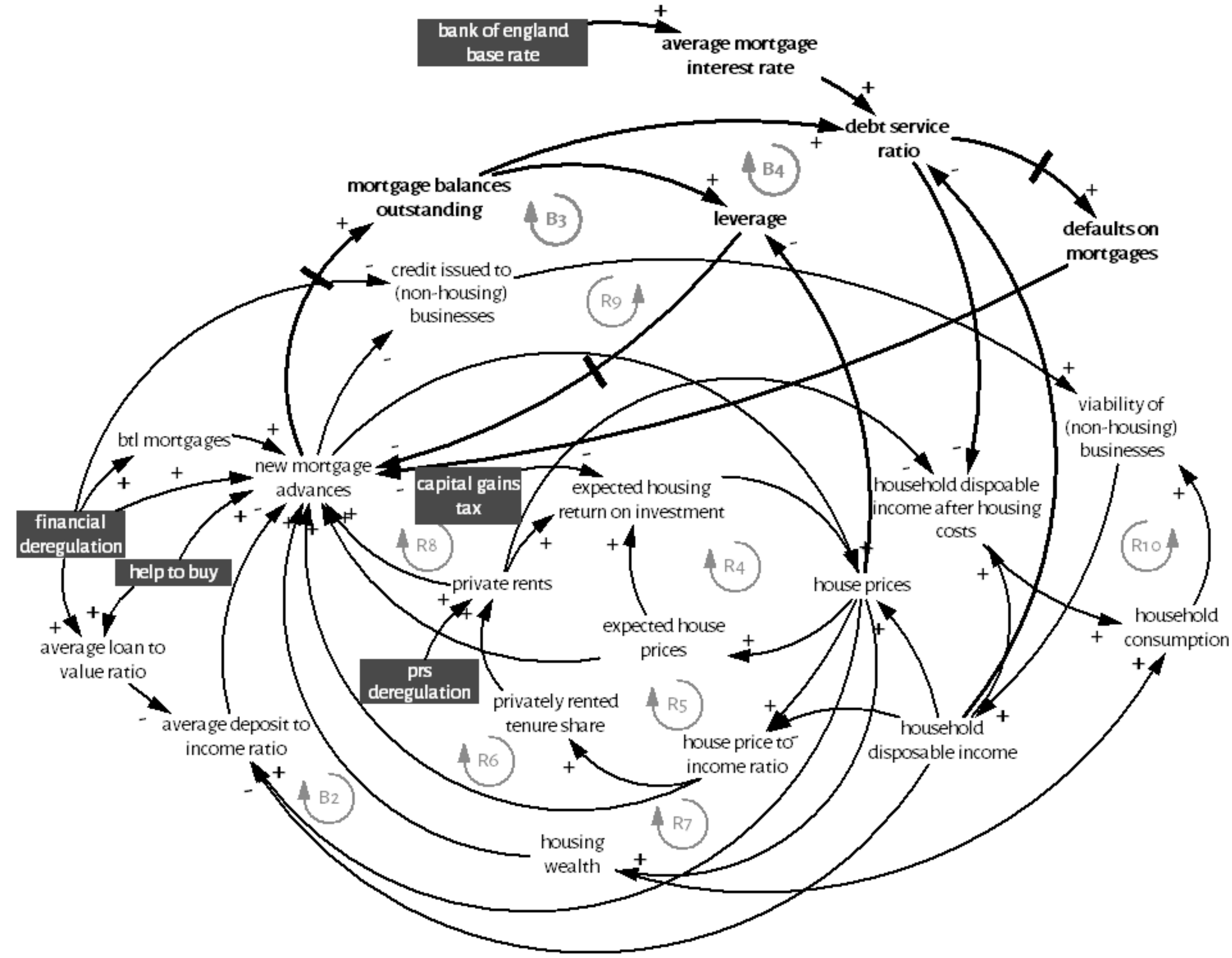

Figure 3.11 – Demand-side CLD 6) B3: Leverage Loop, B4: Debt Burden Loop.

So far, most of the mechanisms described are reinforcing loops working towards inflating *house prices* along with the volume of *new mortgage advances*. But no real system consists solely of reinforcing loops as nothing can grow forever. As more and more *new mortgage advances* are issued, as discussed previously in Section 3.3.3, this lending accumulates over time in a rapidly growing stock of *mortgage balances outstanding* (Figure 3.11). Note the delay sign on the arrow from *new mortgage advances* to *mortgage balances outstanding*, which indicates that the stock builds up gradually over time. This delay also implies an inherent 'inertness' in relation to the stock of *mortgage balances outstanding*, meaning that the stock of debt continues to grow even after the peak in *new mortgage advances* (Drehmann et al., 2017), and that any substantial decrease in the stock can only take place with long delays.

As the stock of *mortgage balances outstanding* rises, *leverage*—defined as the ratio of this debt to property value—also goes up. This is broadly considered to be a predictor of a future credit crunch and recession and can restrict the amount of future bank lending (Mian & Sufi, 2010), hence the negative-polarity link back to *new mortgage advances* with a delay sign, which closes the balancing *B3: Leverage Loop*. Delays tend to embed oscillatory tendencies in systems because, if corrections take long to take effect, it can lead to an overshoot in the variable to be controlled (in this case *new mortgage advances*). Likewise, the correction can keep going on for well after the control variable has reached its desired level, subsequently resulting in an undershoot.

Another direct effect of the rising stock of *mortgage balances outstanding* is a growth in *debt service ratio* (DSR), also determined by the *average mortgage interest rate*, which is itself driven by *Bank of England's base rate*—a policy decision. DSR is defined as the amount of mortgage repayment (consisting of principal and interest) divided by *household disposable income* and is a measure of the burden of debt (Drehmann et al., 2017). Like *leverage*, a high DSR has been found to be an early warning signal of *defaults on mortgages* and banking crises (Drehmann & Juselius, 2012). This signifies another mechanism whereby an over-accumulation of households' mortgage debt will inevitably lead to an eventual imploding of the debt overhang and a future shortage in *new mortgage advances* (*B4: Debt Burden Loop*).

As alluded to earlier, a rising DSR along with rising *private rents*, negatively affect *household disposable income after housing costs* for mortgaged homeowners, pushing the *R10: Consumption and Economic Prosperity* loop against its desirable direction, turning it from a potentially virtuous to a vicious cycle (Hay, 2009).

The twin balancing loops *B3* and *B4* will ultimately put all the numerous reinforcing loops previously described in reverse gear, initiating the 'bust' period of every credit-induced housing-finance cycle, involving potentially drastic falls in *house prices* and *new mortgage* *advances*, a general credit shortage in the economy, and the ensuing decline in *household consumption* and overall economic slowdown. In particular, having in mind the important *R4: Investment Loop*, just as house prices can rise rapidly during a boom period, they can also fall precipitously as speculative investors engage in fire sales of property with distressed debt (Shleifer & Vishny, 2011).

Balancing loops that involve significant time delays (such as *B3* and *B4*) are a known cause for oscillatory behaviour in systems (Sterman, 2000, p. 114). The coupling of such loops with all the outlined reinforcing loops can lead to an exponential-like growth superimposed by periodic oscillations, as seen in the housing-finance system during recent decades. This happens as a result of 'shifting loop dominance' (Richardson, 1995), as the strengths of the coupled feedback loops change over time and dominance alternates between reinforcing loops—which drive growth—and balancing loops—that counteract it—leading to oscillation in the system. Therefore, the CLD presented above theoretically supports the idea that the financial cycle is effectively built into the structure of the system, and instability in such a system is inevitable. Furthermore, it also suggests that cycles recur endogenously, rather than being a result of external shocks. This is in line with Minsky's (1992) Financial Instability Hypothesis and much of the post-Keynesian economics literature that builds upon it (Borio, 2014; Keen, 1995; Ryan-Collins, 2019), and in contrast with neoclassical economics theory which assumes that instabilities are caused by external shocks and that the system recovers to an equilibrium following such episodes.

3.5.2. Causal Loop Diagram: Demand- and Supply-side Dynamics

In this section, the demand-side CLD just described is combined with the supply-side diagram shown in the previous chapter to form a complete map of causal interconnections and feedback loops of the whole system—within the scope of this study, of course (Figure 3.12). This coupling adds new links and feedback loops to the picture which involve both demand and supply side variables.

Perhaps most notably, the demand-side picture allows us to endogenize *housing market volatility*—an important influence on key variables such as *housebuilding industry consolidation*, *land banking and speculation*, *housebuilders risk aversion*, and therefore on *housing completion rate*. *Volatility* is driven by financial instability, proxied by *defaults on mortgages*, itself a function of over-accumulation of *mortgage balances outstanding* and of the *debt service ratio* growing to unaffordable levels for households, as we saw earlier in this chapter. The loop counting feature of *Vensim®*, the software used to draw the CLD, indicates that in this whole system diagram, *housing market volatility* is implicated in 190 feedback loops. For obvious reasons, it is not possible to enumerate all these loops individually. In broad terms, however, many of these loops have to do with the different ways *housing market volatility* inhibits new housing supply, thus pushing house prices further up, encouraging more and more accumulation of housing debt, and therefore making the housing-finance system more vulnerable to instability.

Another important link that emerges after combining the demand- and supply-side CLDs is the stimulating effect of *new mortgage advances* on new dwelling construction starts and therefore, with a delay, on *housing completion rate*. Mortgage availability provides developers with assurance that they can sell their products. Empirical studies indicate an effect from mortgage credit availability on construction starts (Jaffee *et al.*, 1979; Dokko, Edelstein and Urdang, 1990; see also Section 5.3). This establishes an important balancing loop, labelled *B5: Mortgages Support Housebuilding*, which can serve to restrict the growth of *house prices* below what it otherwise could have been. At the same time, however, *housing completion rate* increases the level of physical *housing wealth*, providing further collateral towards the expansion of mortgage lending, strengthening the *R7* loop described earlier.

Looking at the policy variables identified with a dark background, it is worth noting how government policies in recent decades have predominantly contributed to a vast expansion in *new mortgage advances* and investment demand for housing.

Table 3.1 lists all feedback loops identified in this section. Although the combined CLD shown below is a highly simplified representation of the real system, it already reflects the daunting dynamic complexity of the system surrounding house prices, investment demand, and the housing-finance nexus. It is important to stress again that the loops highlighted in the diagram are in no way exhaustive: if we count all possible trajectories in the graph, there are, for example, 262 loops going through *house prices* and 269 loops going through *new mortgage advances*. The ten reinforcing and five balancing loops named in the diagram are only a fraction of total feedback loops that are perhaps most salient.

Table 3.1 – List of feedback loops

Reinforcing loops		
R1	*Housing-Land Prices Loop*	house prices $\rightarrow^{+}$ land prices $\rightarrow^{+}$ house prices
R2	*Consolidation Restricts Supply*	housebuilding industry consolidation $\rightarrow^{-}$ housing completion rate $\rightarrow^{-}$ house prices $\rightarrow^{+}$ land prices $\rightarrow^{+}$ housebuilding industry consolidation
R3	*Speculation Drives Volatility*	land banking and speculation $\rightarrow^{+}$ housing market volatility $\rightarrow^{+}$ land banking and speculation
R4	*Investment Loop*	house prices $\rightarrow^{+}$ expected house prices $\rightarrow^{+}$ expected housing return on investment $\rightarrow^{+}$ house prices
R5	*Priced-out Loop*	houses prices $\rightarrow^{+}$ house price to income ratio $\rightarrow^{+}$ privately rented tenure share $\rightarrow^{+}$ private rents $\rightarrow^{+}$ expected housing return on investment $\rightarrow^{+}$ house prices
R6	*Credit Creates Its Own Demand (Housing-Finance Loop I)*	new mortgage advances $\rightarrow^{+}$ house prices $\rightarrow^{+}$ house price to income ratio $\rightarrow^{+}$ new mortgage advances
R7	*Collateral Loop (Housing-Finance Loop II)*	new mortgage advances $\rightarrow^{+}$ house prices $\rightarrow^{+}$ housing wealth $\rightarrow^{+}$ new mortgage advances
R8	*Lending Against Rental Income (Housing-Finance Loop III)*	houses prices $\rightarrow^{+}$ house price to income ratio $\rightarrow^{+}$ privately rented tenure share $\rightarrow^{+}$ private rents $\rightarrow^{+}$ new mortgage advances $\rightarrow^{+}$ house prices
R9	*Crowing Out Effect in Credit Allocation*	new mortgage advances $\rightarrow^{-}$ credit issued to (non-housing) businesses $\rightarrow^{+}$ viability of (non-housing) businesses $\rightarrow^{+}$ household disposable income $\rightarrow^{-}$ house price to income ratio $\rightarrow^{+}$ new mortgage advances
R10	*Consumption and Economic Prosperity*	household consumption $\rightarrow^{+}$ viability of (non-housing) businesses $\rightarrow^{+}$ household disposable income $\rightarrow^{+}$ household disposable income after housing costs $\rightarrow^{+}$ household consumption
Balancing loops		
B1?	*Supply Loop*	housing completion rate $\rightarrow^{-}$ house prices $\rightarrow^{?}$ housing completion rate
B2	*Affordability Loop*	average deposit to income ratio $\rightarrow^{-}$ new mortgage advances $\rightarrow^{+}$ house prices $\rightarrow^{+}$ average deposit to income ratio
B3	*Leverage Loop*	new mortgage advances $\rightarrow^{+}$ mortgage balances outstanding $\rightarrow^{+}$ leverage $\rightarrow^{-}$ new mortgage advances
B4	*Debt Burden Loop*	new mortgage advances $\rightarrow^{+}$ mortgage balances outstanding $\rightarrow^{+}$ debt service ratio $\rightarrow^{+}$ defaults on mortgages $\rightarrow^{-}$ new mortgage advances
B5	*Mortgages Support Housebuilding*	new mortgage advances $\rightarrow^{+}$ housing completion rate $\rightarrow^{-}$ house prices $\rightarrow^{+}$ new mortgage advances

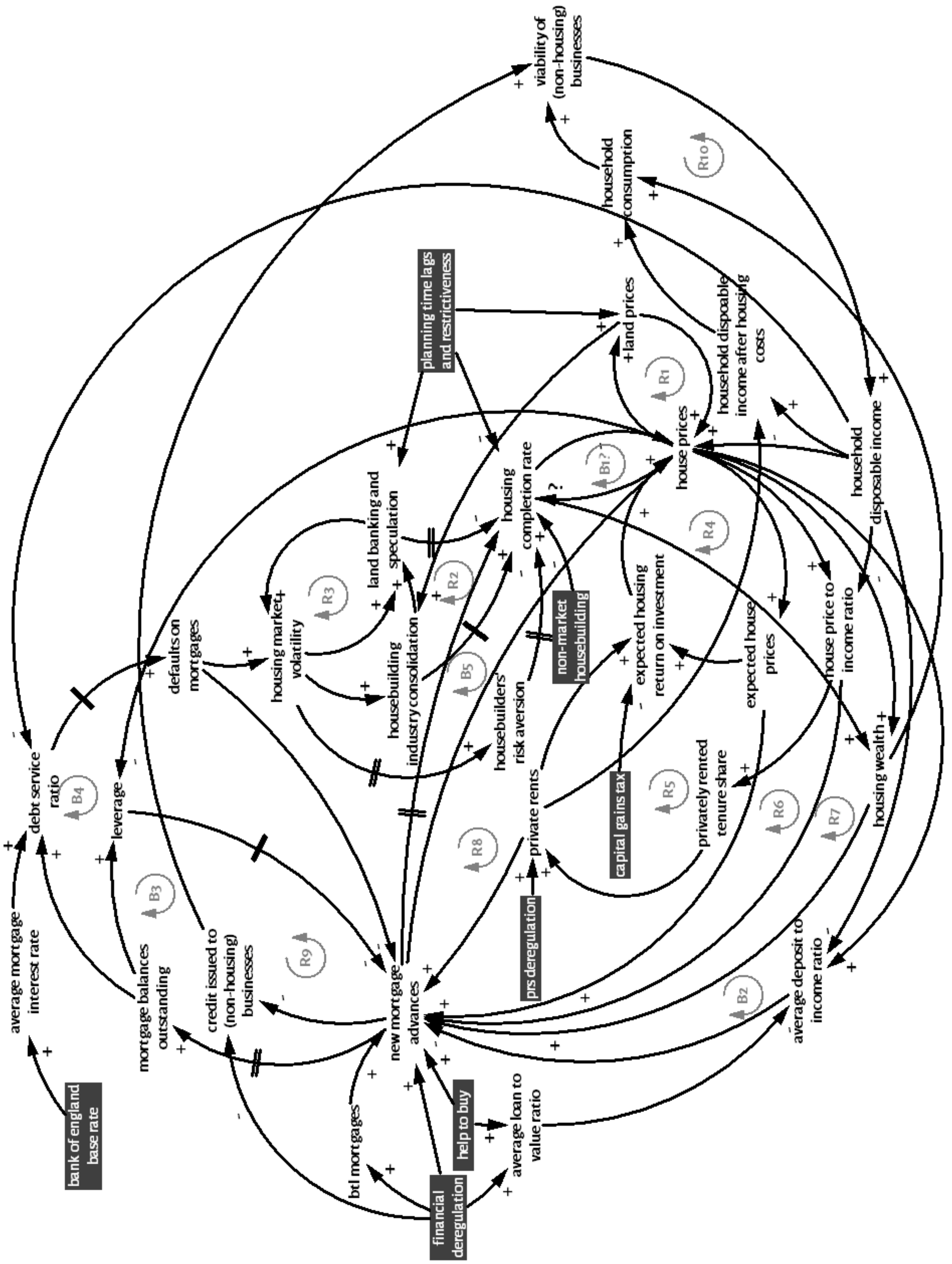

Figure 3.12 – Whole system causal loop diagram

3.6. Chapter Summary

In this chapter, I outlined various aspects related to the demand for housing in the London/UK context, including utility-based demand, investment demand, the role of finance and financial deregulation. Housing has become an increasingly desired investment asset throughout the past decades as a result of its superior long-term return on investment, especially within the context of London, where the expectation of long-run price increases is widespread and to a great extent self-fulfilling. We also saw how the deregulation of financial markets in the last quarter of the 20th century brought about a 'lending frenzy' (Slater, 2016) in the UK, inundating the housing market with an overly abundant flow of credit money and ever more competitive deals from lenders, and thus boosting demand and house prices against limited housing supply (i.e., both existing and new build properties) (Edwards, 2016a; Kennett et al., 2013). Following the liberalisation of financial markets, the growth of property assets in London has far exceeded fixed capital formation in the building stock, indicating that the flows of money into the housing market have driven prices up to a much greater extent than they have provided new homes (Edwards, 2016b).

We also saw that following the financial deregulation, banks have turned to mortgage lending and property-related financial instruments as their main business, with a decreasing share of their lending going towards productive sectors of the economy. This trend took on further momentum following the advent of securitisation and the rise of residential mortgage-backed securities, which allowed banks to package loans of various risk estimates and sell them on to investors looking for stable long-term returns, passing on to the buyers the risk of defaults on such loans and enabling the banks to issue more and more loans. Irresponsible and reckless lending by banks, enabled as a result of financial deregulation, eventually led to the 2008 GFC triggered by a wave of defaults on subprime mortgages in the US market, which quickly escalated to a global scale because securitisation had helped to convert housing into a liquid and globally traded financial instrument. Financial institutions worldwide found themselves heavily invested in RMBS built upon loans of questionable quality which were suddenly rendered nearly worthless.

As a consequence of financial market liberalisation, a self-reinforcing and inflationary feedback loop has been established between housing and the mortgage market, leading to an upward spiralling of mortgage loans and house prices. We are facing a situation where unrestricted bank lending has completely decoupled house prices from earnings (Gallent et al., 2017). We saw in Section 3.3.3 how the stock of housing debt has grown exponentially since the 1980s. This ‘Damocles sword’ of debt overhang is a menace to financial and economic stability, as any fall in incomes or increase in interest rates—leading to a rise in debt service ratio—could reverse the numerous reinforcing feedback loops described in the previous section towards the direction of economic downturn and financial collapse. With that in mind, and as argued by Ryan-Collins *et al.* (2017), the key challenge facing policy makers today is reining in the positive feedback loops between the financial system, house prices and the wider economy that expose the economy to systemic financial instability (Ryan-Collins et al., 2017, p. 190).

The fourth section of this chapter highlighted the transition of Britain’s housing policy framework in recent decades from a post-war welfare state approach with an active role for the government in housing provision to a neoliberal market-oriented framework aiming to minimise government intervention in housing. The government’s main involvement is limited to providing a generic Housing Benefit to the growing slice of the population who are unable to secure themselves adequate housing. In 3.4.1, we reviewed how, ever since the 1980s, housing policies in all domains, from planning to fiscal and financial, have been biased towards promoting homeownership. Ironically, all government policies ostensibly targeted towards mitigating the housing crisis appear to have been adding fuel to the fire by feeding demand. As a result of this policy framework, not only has affordability declined drastically since the 1980s, but also homeownership—the yardstick to measure the success of this policy framework—has been in decline since the early 2000s. Furthermore, this policy regime is believed to have brought about the 'rentierization' of the UK economy, i.e., increasing dominance of rent extraction in the economy (Christophers, 2019).

In the section on Asset-based Welfare, we saw that in the UK, the provision of welfare has been closely intertwined with private housing wealth. With the rise of the neoliberal regime, the burden of welfare provision, particularly for pensioners, has been increasingly transferred from the state to the individual, with particular reliance on housing wealth. Young people in the UK aspire to 'get on the housing ladder' and progressively grow their housing assets over their working years so that, once they become pensioners, they can downsize and enjoy a comfortable retirement. Critics of this strategy have highlighted the temporal and spatial irreproducibility of it and its tendency to drive inequality, both between generations and between homeowners and renters.

In the section on Privatised Keynesianism, we discussed how the UK's economic growth model has been dependent on rising house prices for the past few decades, with growth in house prices boosting consumer confidence and supporting growth in consumption. Thus, various commentators have argued that growth in house prices has been actively sought by subsequent governments via a fiscal policy framework that advantages homeownership and a deregulated financial sector (Crouch, 2009; Hay, 2009). This model of economic growth, which is closely tied to the asset-based welfare strategy, has also been criticised for relying on an excessive accumulation of private housing debt and therefore being highly prone to instability, for being linked to an inherently volatile housing market, and for being economically inefficient (Ryan-Collins et al., 2017, p. 187).

Perhaps the most significant socio-economic outcome of asset-based welfare and privatised Keynesianism is worsening inequality, as the accumulation of wealth in housing is asymmetric and tends to accrue more wealth to those who already have it. Nonetheless, as the balance of the UK population is moving towards a majority of renters, policy will inevitably need to adapt to the changing constituency and address the widening gap between the housing haves and have-nots.

Finally, as mentioned in Chapter 1, while our current understanding of the housing crisis is still largely fragmented, with commentaries often focusing on one or a few of the causal links presented in previous section, the whole-system CLD constructed step-by-step in this thesis serves to integrate our existing knowledge of the topic in a visually compelling fashion and, with its numerous feedback loops, demonstrates the formidable complexity of the housing problem currently facing London and the UK. However, as will be discussed in the following chapter, the complete inability of the human mind to correctly infer the behaviour of such higher order dynamic systems with hundreds of feedback loops through 'mental simulation', as widely documented within the system dynamics literature (Sterman, 2000, p. 29), poses an important obstacle towards generating policy recommendations based solely on this qualitative picture. Therefore, there is a need for dynamic simulation models that capture these complex feedback structures in order to better understand past developments in the system, as well as to anticipate its future behaviour under different scenarios and policies. This prohibitive complexity clearly motivates the formal system dynamics modelling and analysis carried out in the remaining chapters of this thesis. In Chapter 5, I will present a quantitative system dynamics model, built on the foundation of the whole-system CLD just presented. Although not quite as comprehensive as the CLD, as we shall see, the model will capture most of the key feedback loops identified in this and the previous chapters. Through computer simulation, the model will allow us to investigate whether the 'dynamic hypothesis' expressed in the form of the whole-system CLD does indeed generate the patterns of behaviour observed in the real system in the past, as well as to explore the future pathways that can be expected in the system under different policy assumptions. Before delving into the quantitative model (Chapter 5), however, it is useful to give a brief introduction to system dynamics and its past application within housing studies, which is the topic of the next chapter on Methodology.

Chapter 4. Methodology

Chapter 4. Methodology

We use models every day, whether we know it or not. If not formal models, our decisions are otherwise always based on our mental models of how the world operates (Sterman, 1991). However, it has been argued that mental models cannot be trusted to design strategies in complex domains, such as the economics of housing. Psychologists have identified the many cognitive biases and limitations of the mind when making judgments and have demonstrated that we can take only a few factors into account in making decisions (Tversky & Kahneman, 1974). Also, the human mind is shown to be incapable of correctly inferring the behaviour of even the simplest possible feedback systems (Sterman, 1994), let alone that of highly complex systems such as the housing system with countless feedback loops (see Section 3.5.2). Therefore, our 'bounded rationality' (Simon, 1972) limits not only the scope and complexity of our mental models but also our ability to use them to anticipate the behaviour of the system (Sterman, 1994).

Given the 'dynamic complexity' (Sterman, 2000, p. 22) of the housing system so far demonstrated, this chapter justifies my choice of methodology and covers some of the more theoretical aspects of system dynamics. I am first going to present a short critical overview of existing UK housing evidence from a methodological perspective. Next, I will briefly introduce system dynamics and argue why I believe it offers a highly suited approach to the problem of London's housing crisis. Section 4.2.2 gives a review of the existing system dynamics work within the field of housing. The third sub-chapter discusses the notion of model validity and validation from a system dynamics perspective. Next, I will briefly report on the sources of quantitative data that I have used to parametrise, calibrate, and validate my model. Finally, I will close with a summary of my methodological approach. As for the model itself, it will be described in detail in the following chapter (Model Documentation), while formal validation tests will follow in Chapter 6.

4.1. Critical Overview of Existing Housing Evidence: A Methodological Perspective

As just pointed out, bounded rationality leaves us with little choice other than to use computer simulation models for designing effective policies to manage complex systems (Sterman, 1991) such as the housing system. The natural question that follows is which type of model from the modern toolbox of methods best fits our particular purpose.

Based on their review of the housing literature in various disciplines, Stockhammer and Wolf (2019, p. 44) observe that in 'most baseline macroeconomic models, including the mainstream versions as well as the Post-Keynesian (PK) or Marxist versions, there is no housing market' at present, which they find surprising given the central role of housing in economies. The predominant modelling work that *has* included housing has been within the field of neoclassical macroeconomics, with the vast majority of modellers using various types of econometric models (see for example Meen, 1996, 2011; Muellbauer and Murphy, 1997; Cook, 2006). As a prominent example, following the publication of the Barker Review (Barker, 2004), the UK Government commissioned the construction of the 'Affordability Model', an econometric regional housing model with the aim of investigating the effects of different rates of housebuilding on long-run affordability (Meen, 2011). Since 2005, this model has been regularly used as part of the policy process in the field of housing in England (Meen, 2011).

Econometric house price models primarily set out to compute a 'fundamental' price, as determined by demand side factors (e.g., real disposable income, real interest rates and demographic developments) and supply side factors (e.g., the available housing stock). The predominant time-series co-integration models provide an estimate of 'equilibrium' or long-term house prices, against which current prices are evaluated to determine the presence of a 'bubble' (Girouard, Kennedy, Van Den Noord, & André, 2006). Such analyses have, however, been subject to criticism. In a survey of econometric tests of asset price bubbles, Gürkaynak (2008) shows that, despite advances, econometric detection of asset price bubbles cannot be achieved with any certainty, and that we are still unable to distinguish bubbles from time-varying or regime-switching fundamentals. Moreover, as discussed in the previous chapter (Section 3.3), mainstream economic models commonly ignore the role of credit which has been instrumental in shaping 'bubbles' and the boom-and-bust cycles of the past decades (Borio, 2014; Muellbauer & Williams, 2011).

Methodologically speaking, the main weaknesses of neoclassical econometric models are related to the economic theory on which they are based and the erroneous assumptions of this theory, such as equilibrium, maximisation behaviour, rational choice, and availability of complete information (Keen, 2011; Simon, 1972). Neoclassical models 'describe self-sustaining equilibria of supply and demand when capitalist economies are striking for their growth and instability' (Kunkel, 2014). Housing markets are particularly unlikely to ever be in equilibrium due to the tendency of price inflation to feed back and drive housing asset demand (Maclennan, 1979). Moreover, Stockhammer and Wolf (2019) argue that the assumptions of rationality and life cycle optimisation behaviour which are at the core of mainstream economics are not conducive to a systematic treatment of financial drivers and speculative investment effects on housing asset prices which, as we saw in the previous chapter, have been instrumental in shaping developments in housing in the UK and other advanced economies (Ryan-Collins, 2018). Borio (2014), in his widely cited article on the financial cycle, recommends moving away from rational expectation and complete information assumptions and from a heavy focus on equilibrium methods if we want to understand the underlying dynamics leading to periodic instability in the financial system (and therefore, relatedly, in the housing system). He proposes applying 'a top-down and holistic perspective' and 'to rediscover the merits of disequilibrium analysis' (Borio, 2014, pp. 183, 188).

Furthermore, mainstream economic models commonly ignore dynamic processes, feedback relationships, delays between actions and results, and disequilibrium behaviours (Sterman, 1991). The falsehood of some of the basic assumptions of neoclassical economics theory is now recognised by a growing number of prominent economists. Herbert Simon, for instance, said in his Nobel Prize acceptance speech in 1979 that:

> *There can no longer be any doubt that the micro assumptions of the theory—the assumptions of perfect rationality—are contrary to fact. It is not a question of approximation; they do not even remotely describe the processes that human beings use for making decisions in complex situations.* (Simon, 1979, p. 510)

French economist and best-selling author, Thomas Piketty (2014), has also harshly criticised the mainstream discipline of economics for a 'childish passion for mathematics and for purely theoretical and often highly ideological speculation' (Piketty, 2014, p. 32). Piketty asserts that this 'obsession with mathematics', evident in the prevalent use of ever more sophisticated econometric models, is 'an easy way of acquiring the appearance of scientificity without having to answer far more complex questions posed by the world' (ibid). In his criticism, Piketty echoes Nobel Prize-winning economist Wassily Leontief who, in his acceptance speech, raised similar objections about the obsession with mathematics in economics. Leontief (1971) speaks of 'the palpable inadequacy' of the scientific means available to economics, and states that the slowly growing empirical evidence does not support what he calls 'speculative' economic theory (Leontief, 1971, p. 1). In his view, the use of more and more sophisticated statistical techniques is part of the economics community's tendency to prioritise mathematical reasoning over empirical analysis and an attempt to make up for the 'glaring weakness of the data base available to [economists]' (Leontief, 1971, p. 2).

This is, of course, not to say that all models within the field of economics still adhere to the conventional restrictive assumptions of neoclassical economics. Scholars within the post-Keynesian branch of economics, for example, typically depart from assumptions of equilibrium (Keen, 2013) and include the crucial element of credit (Muellbauer & Murphy, 1997, 2008), as well as some key feedback relationships (Juselius & Drehmann, 2020), in their econometric models. This greatly improves the capacity of these models to explain the large-scale boom-and-bust cycles of the past—which neoclassical models have failed to capture (Borio, 2014; Drehmann et al., 2017). However, due to the limitations of econometric methods, such models typically do not include more than a few feedback loops at best, while, as shown in the previous chapter (Section 3.5.2), the number of loops necessary to capture the complexities of the housing system far exceeds that.

Within the UK housing domain, as mentioned in Chapter 1, Maclennan and More (1999) have criticised a predominance of sector-specific, cross-sectional and qualitative methods within UK housing studies and suggest that the evidence required to support housing policy demands improved analytical frameworks and multi-disciplinary approaches (MacLennan & More 1995). More recently, Bramley and Watkins (2016) have noted the crucial 'lack of whole-system simulation models, as opposed to models focused on a particular variable' (Bramley & Watkins, 2016, p. 4). Bramley (2013) further criticizes existing economic models of housing for not having given enough attention to the role of lax financial regulation in generating high house prices (Bramley, 2013). As reviewed in the previous chapter, this criticism is increasingly echoed by several other authors (Borio, 2014; Drehmann et al., 2017; Muellbauer & Williams, 2011; Ryan-Collins, 2019).

The UK housing literature, as reviewed in the previous chapters, is rich in evidence on causal relationships and complex feedback structures of the housing system. However, as of yet, there are no quantitative dynamic simulation models of developments in London's (or the UK's) housing system; a model that includes key variables from the supply side, the demand side, and the housing finance sector as well as the feedback relationships between them. This is perhaps primarily because the discipline of economics lacks the appropriate modelling methods in its toolbox.

Having in mind this methodological gap, and in line with the above recommendations (Borio, 2014; Bramley & Watkins, 2016; Maclennan & More, 1999), the main methodology chosen for this thesis is *system dynamics* (sometimes abbreviated to *SD*). SD has been extensively used for the analysis of economic problems (Forrester, Mass, & Ryan, 1976; Sterman, 1986), and has also been applied to problems of housing (Eskinasi, 2014; Eskinasi, Rouwette, & Vennix, 2009; Zhang, Geltner, & de Neufville, 2018). In the next section, I will provide a brief introduction to system dynamics and argue why I believe it is a highly suited method for investigating my research questions.

4.2. System Dynamics and the Study of Housing

System Dynamics is a methodology for better understanding complex social systems via combining qualitative and quantitative information available in the form of numerical data, written description, and mental models into computer simulation models (Forrester, 1961). The method was first developed in 1957 at MIT Sloan School of Management by Jay Wright Forrester. As shown in the figure below, taken from Forrester, Mass and Ryan (1976), SD is described in terms of the background threads on which it is built (Figure 4.1). These comprise traditional management of social systems, feedback theory, and computer simulation (Forrester et al., 1976). The first thread, of course, applies to the earlier days of system dynamics, when it was used primarily for tackling business management problems. Since then, however, SD has been applied to an extremely wide variety of topics in not only management but also economics, environmental sciences, life sciences and other fields.[14]

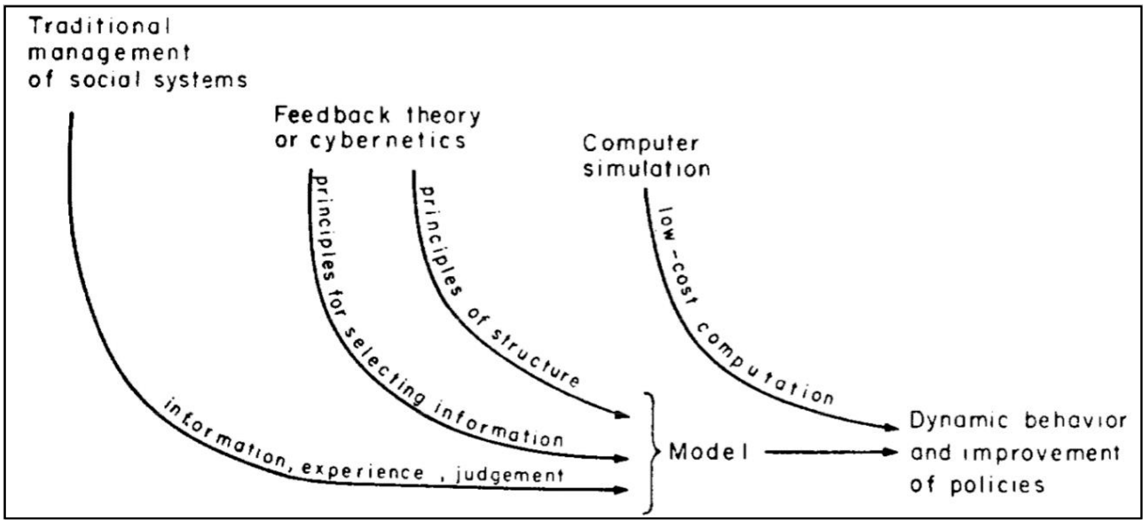

Figure 4.1 – Background of system dynamics

Source: Forrester e al. (1976)

As a modelling methodology, SD does not impose models but rather formalises and improves on the mental models that would otherwise be used to manage human affairs. In the case of this dissertation, for example, the information used for building the system dynamics model of London's housing has been thoroughly taken from existing literature and integrated into a quantitative simulation model. An SD model is more explicit than a mental model, can be communicated with less ambiguity, and relates underlying structural assumptions to system behaviour. Such model is simulated on a computer and therefore, unlike mental models, 'its behavioural implications can be determined precisely' (Forrester et al., 1976, p. 55).

[14] For a high-quality collection of applications of system dynamics see the *System Dynamics Review* journal published by Wiley Online Library.

SD models are built upon the stock and flow structure of real systems. Stocks represent real-world level variables, which can go up or down depending on the strength of flow variables feeding into or originating from them. Thus, flows determine the level of stocks, and stocks, often through intermediary 'auxiliary' variables, determine the strength of the flows. The stock-flow distinction is an important one because stock variables that determine the state of the system at any point in time have accumulated over time and cannot be changed instantaneously. Stocks are the main source of disequilibrium behaviour in complex dynamic systems (Mass, 1977). The various stock and flow variables are interconnected based on substantiated causal relationships that often follow circular causal chains to establish feedback loops. Importantly, in formulating the variables, real-world delays and non-linearities that are key in generating the observed modes of behaviour can be captured. More details and concrete examples based on London's housing system will be given in the next chapters when the model is described and analysed.

A core purpose of SD models is to provide *foresight*—i.e., anticipating how a system might behave in the future if certain conditions occur—rather than to provide *forecasts*, or in other words point prediction of the future (Sterman, 1991). This makes SD models powerful tools for policy analysis. Once sufficient confidence is built in a model via various behavioural and structural tests (see Section 4.3 in this chapter), then the model can be used for *what if* analysis of different scenarios or policy decisions. This enables the analyst to offer an evaluation of available policy options based on given metrics. In complex socio-economic systems such as the housing system, this kind of *what if* analysis using simulation is virtually the only way for policies to be tested and for learning to occur in a safe 'laboratory' environment.

4.2.1. What Makes System Dynamics Suited to the Study of Housing

The real world consists of immensely complex webs of cause-and-effect relationships, which interact to determine the paths taken by social and natural systems, without any narratives guiding the interactions or the resulting behaviours. Humans, however, use stories and narratives to make sense of the world around them. Stories are believed to be what enable societies to cooperate effectively in massive numbers towards common goals (Harari, 2014). We need stories to collectively make better sense of and be able to manage the world around us more effectively. In my view, system dynamics is above all a powerful story-telling tool.[15]

Feedback loops, for instance, are powerful visual tools in constructing narratives of dynamics in real-world systems. In the preceding chapters, we saw examples of how feedback loops can frame rich narratives of the observed mechanisms in the housing system. With regards to quantitative modelling, the power of simulation to investigate the past behaviour and infer the future behaviour of a system is not an exclusive feature of system dynamics. What sets system dynamics apart, however, is its power of storytelling, which is, I believe, one of its greatest advantages. An observed outcome of an SD model need not simply be taken at face value but can rather easily be traced back along the causal chain of effects and narratives can be constructed based on such chains (and often loops) of causality. On the other hand, econometrics leans towards 'black box' modelling on the spectrum of mathematical modelling approaches (Karplus, 1977). In econometrics, the inputs and outputs are known but the causal structure leading from the inputs to the outputs is usually obscure, hence offering little understanding into the processes that produce the model's emergent behaviour.

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[15] See for instance the Storytelling feature of the SD software *iThink®* (isee systems, 2009).

The SD approach owes its storytelling power not only to the 'systemic' aspect of its worldview, but equally to its 'dynamic' perspective. Time is the indispensable dimension of any story, and static methods are therefore unable to tell interesting stories. Any feedback loop represents a narrative that unfolds over time. Feedback loops, by definition, require a temporal dimension to be meaningful: every feedback loop must include at least one stock (level) variable (Pruyt, 2013, p. 37) which represents either a process of accumulation or a time delay. Neoclassical econometric models, in contrast, are typically incapable of capturing feedback relationships, which is another reason why they do not lend themselves easily to being used to construct insightful narratives.

In terms of potential impact on policy, arguments are not judged solely by their technical merit but also, importantly, by their convincing power. In the words of Guhathakurta (2002), 'factual arguments that are not persuasive seldom play a significant role in public debate' (Guhathakurta, 2002, p. 896). Narratives and stories are considered crucial in this regard, especially when making decisions under conditions of uncertainty and complexity (Guhathakurta, 2002). SD models can be used to generate compelling factual narratives that are based both on evidence on the causal structure of the system and on empirical data on the system's history. This is one of the key motives justifying the choice of methodology for this study.

The following bullet points summarise some additional characteristics of SD which make it a powerful approach for a complex socio-economic problem such as London's housing crisis.

- *Ability to capture dynamic complexity:* Real world socio-economic systems are complex not just because of the sheer number of variables but more importantly in the ways these variables interact to determine the system's behaviour. This 'dynamic complexity' includes elements such as feedback loops, time delays and non-linearities (Sterman, 2000, p. 21). In the housing system, policy levers usually involve long time delays and the housing system often responds to policies in unpredictable ways (Ryan-Collins et al., 2017, p. 193). These qualities, among others, are testimony to the dynamic complexity of the system, which calls for a modelling tool that is capable of capturing them.

- *Disequilibrium behaviour*: Unlike conventional economic models, in SD no assumptions of market clearing or equilibrium are made. Inherent characteristics of the housing system render such assumptions absurd (Harris, 2003, p. 7). SD models include pressures that may or may not lead to equilibrium, including delays and accumulations (Forrester et al., 1976; Mass, 1977).
- *Broad information base:* A typical SD model incorporates qualitative as well as quantitative variables which influence the future course of the system (Forrester et al., 1976). The SD approach to modelling is based on 'operational thinking', in that SD models are built upon the physical stock-flow structure of the system, and that, unlike econometric models (Zhang et al., 2018), the production of knowledge and learning in SD does not rest solely on time-series data but on qualitative information about how the real system operates (Olaya, 2016; Richmond, 1994). Restricting the sources of information to strictly quantitative data, as often happens in econometric modelling, excludes an overwhelming body of information on which the real world operates (Forrester, 2003).
- *Focus on policymaking rather than prediction*: Social systems, such as London's housing system, are subject to numerous random influences. The presence of such random disturbances precludes forecasting the state of the system far enough ahead in time to allow for effective action. In other words, the behaviour of the system in the short window of time where it could be reliably forecast is already determined by the existing inertia in the system, and if

sufficient time is allowed for any changes in policy to take effect, then the behaviour of the system can no longer be meaningfully 'predicted' due to the presence of random disturbances. In Forrester's words, 'with only a little exaggeration, [...] one can forecast in the time zone in which one cannot act, and can act in the time zone in which one cannot forecast' (Forrester, 2003, p. 34). On the other hand, even if the future condition of an economic system cannot be accurately forecast, the effectiveness of different policy options in improving the state of the system can certainly still be compared. This is what Sterman (1991) calls the generation of *foresight* as opposed to *forecast*. Incidentally, this also resonates with the UK Government's Foresight Future of Cities project (2013–2016) which considers a long-term view to the future of cities essential since policymakers 'need be able to navigate complex decisions, in a constantly changing environment, which will have impacts over a long timeframe' (UK Government, 2016, p. 7).

- *Endogenous behaviour:* In a well-constructed SD model, key features of the resulting behaviour are driven by the internal dynamics of the model, rather than being primarily driven by exogenous time-series fed into the model. In other words, through modelling the physical and information structure of the system at the micro level, the macro level dynamics of the system emerge naturally out of the interactions of the system components (Richardson, 2011). This feature is key in meaningfully modelling cyclical behaviour such as in financial and housing markets. Borio (2014) highlights how modelling the financial cycle poses major methodological challenges for the prevailing paradigm of economic/econometric models because, as he argues, the method needs to be able to capture 'booms that do not just *precede* but *generate* subsequent busts' (Borio, 2014, p. 195, emphasis added).
- *Bounded rationality:* Modelling decision-making in SD models rest on the theory of bounded rationality (Simon, 1972; Sterman, 1986). When

perceptions or decisions are based on embedded heuristics or 'rules of thumb', such processes are modelled as they are, and not as they should be.

This section outlined the strengths of system dynamics which make it a powerful method for housing studies. Like any other method, SD has its limitations which make it unsuitable for certain types of problems. For example, SD is not best placed to tackle problems with an important spatial dimension which call for fine spatial disaggregation. Furthermore, due to the amount of time and resources required for data collection and model building, parametrisation and calibration, quantitative SD modelling is not most appropriate for generating quick solutions to short-term problems. Similarly, it is typically not used for short-term forecasts.

SD has been amply used in housing-related studies in the past. In the next section, I review some of the most important works in this category.

4.2.2. Review of SD Literature in Housing

This section will start by briefly reviewing *Urban Dynamics* (Forrester, 1970) which is arguably the most seminal publication in the nexus of system dynamics and the broader fields of housing and urban planning. Next, I will review Eskinasi's (2014) PhD thesis, *Towards Housing System Dynamics*, which is the most prominent recent work in housing-related SD literature. In the final sub-section, I will cover other relevant publications in the intersection between system dynamics and housing.

It must be stressed that this section is not intended to be a comprehensive review of the SD literature in housing. The literature reviewed here is chosen subjectively based on relevance and usefulness to the topic of this thesis. For instance, the SD literature contains studies that have taken a more micro view to housing, such as Hong-Minh and Strohhecker (2002) and Hong-Minh (2002) who develop an exploratory SD model of the UK housing supply chain and conclude that the UK private house building industry can improve its performance by implementing some supply chain management principles. Since the housing supply chain is not a focus of this thesis, these conference papers are not reviewed in further detail.

4.2.2.1. *Urban Dynamics* (Forrester, 1970)

The first and the most influential piece of work in the SD literature within the broad context of urban planning is Forrester's *Urban Dynamics* (1970). *Urban Dynamics* is a cornerstone of the SD literature. It is the study of a city's processes of growth, stagnation and decline as a result of the interplays between housing, population, and industry.

The model on which the book is based examines the growth of an urban economy from a small town with little physical constraints to a large city constrained by land. The model includes three sectors: housing, industry, and population. The results from the model's generic structure shows how a city goes through an initial phase of rapid growth while attracting more and more residents and business to a new, flourishing, and limitless environment. After several decades of exponential growth, when available land is exhausted, the ageing and declining processes become dominant, and the city goes into a stagnation phase. The industry will start to be dominated by declining businesses, the housing stock will become dominated by old low-quality housing and the population will shift towards an underemployed status. Perhaps the principal message of *Urban Dynamics* is, in Forrester's own words, that 'unless there is continuing renewal, the filling of the land converts the area from one marked by innovation and growth to one characterized by ageing housing and declining industry' (Forrester, 1970, p. 1). According to *Urban Dynamics*, two key factors causing urban decay are (a) an increasing share of old residential and industrial structures, and (b) a too high share of housing in the total land area, leading to a too high ratio of population to jobs. Forrester (1970) suggests that a city can only maintain its socioeconomic vitality by continuously implementing policies focused on encouraging new businesses and discouraging too much housing construction.

Urban Dynamics sparked up a significant level of controversy because it implied that most urban policies followed in the 1960s and 1970s in the U.S. were detrimental to urban economies (Eskinasi, 2014, p. 48). Forrester (1970) argues that many well-intended short-term policies in urban policymaking, such as financial aid, job-training programmes, and low-cost housing, are detrimental in the long-term, because they attract a higher proportion of under-employed population to the city without expanding available job opportunities in parallel.

The work was at the same time acclaimed for 'ingenious' (Babcock, 1972, p. 144), 'brilliant and beautiful' (Kadanoff, 1971, p. 262) modelling, and for being an extremely useful educational tool thanks to its extensive documentation (Belkin, 1972), as well as criticised for not building upon existing data from real cities (Averch & Levine, 1971). Critics have argued that Forrester's recommendations are not counterintuitive and simply follow from his assumptions and intuitions (Babcock, 1972; Kadanoff, 1971), and that his conclusions are sensitive to his assumptions about parameter values (Babcock, 1972). In a review of the impact of *Urban Dynamics*, Alfeld (1995) notes that, in the first 25 years after its introduction, *Urban Dynamics* has not been received very well and 'has become a curiosity, a relic of the past that few have heard of and most dismiss' (Alfeld, 1995, p. 211).

Although *Urban Dynamics* is not based on data from any particular city and is rather the story of a fictitious city with fictitious people, as good modelling efforts do, it still manages to tell a meaningful story of possible developments in an urban context and provides 'profound insights about the long-term changes that may be expected in many real cities' (Guhathakurta, 2002, p. 900). On some occasions, model application to urban problems in specific cities and towns are reported to have led to significant consensus for action and successful implementation of urban policies (Alfeld, 1995). *Urban Dynamics* continues to be an influential book within the field of system dynamics.

4.2.2.2. *Towards Housing System Dynamics (Eskinasi, 2014)*

The most recent and most comprehensive review of the SD literature in the area of housing has been done by Martijn Eskinasi (2014) for his PhD thesis. Towards this effort, he ran a search with the key words 'urban', 'hous*' and 'real estate' in the bibliography of the System Dynamics Society, obtaining a total of 154 entries. In his search, he finds only 8 journal articles published since 1981, with the vast majority of papers since then consisting of conference papers (Eskinasi, 2014, p. 45). Based on his systematic review of housing-related SD literature, Eskinasi contends that 'system dynamics produced a significant but fragmented knowledge base on housing, real estate and urban development, containing over 150 studies, which was largely unnoticed by the housing research community' (Eskinasi, 2014, p. 41). He argues that this may be related to the 'methodological specialisation' common in SD works, which means that SD modellers are experts in the method but often fail to adequately ground their work in the literature of the field they write about (Eskinasi, 2014, p. 41).

In another part of his thesis, Eskinasi (2014) builds a simple SD model of DiPasquale and Wheaton's (1992) influential four-quadrant model (4QM). The 4QM (Figure 4.2) is a stock-flow model of long-run equilibrium in the rental property market (which can be adapted to represent the owner-occupied market by conceptually replacing 'rent' with 'imputed rent'), that captures the balancing 'supply loop' (see Section 2.6.2) and how it can lead to periodic oscillations in the property market due to the inherent lag in supply (DiPasquale & Wheaton, 1992; Wheaton, 1999). Eskinasi (2014) modifies this theoretical model step by step to capture more complexities of the reality of housing markets, including for example fiscal mortgage support, land use planning, residual land pricing, and speculation. He runs a few hypothetical simulations after each step to investigate the effect of every added piece of structure on model behaviour.

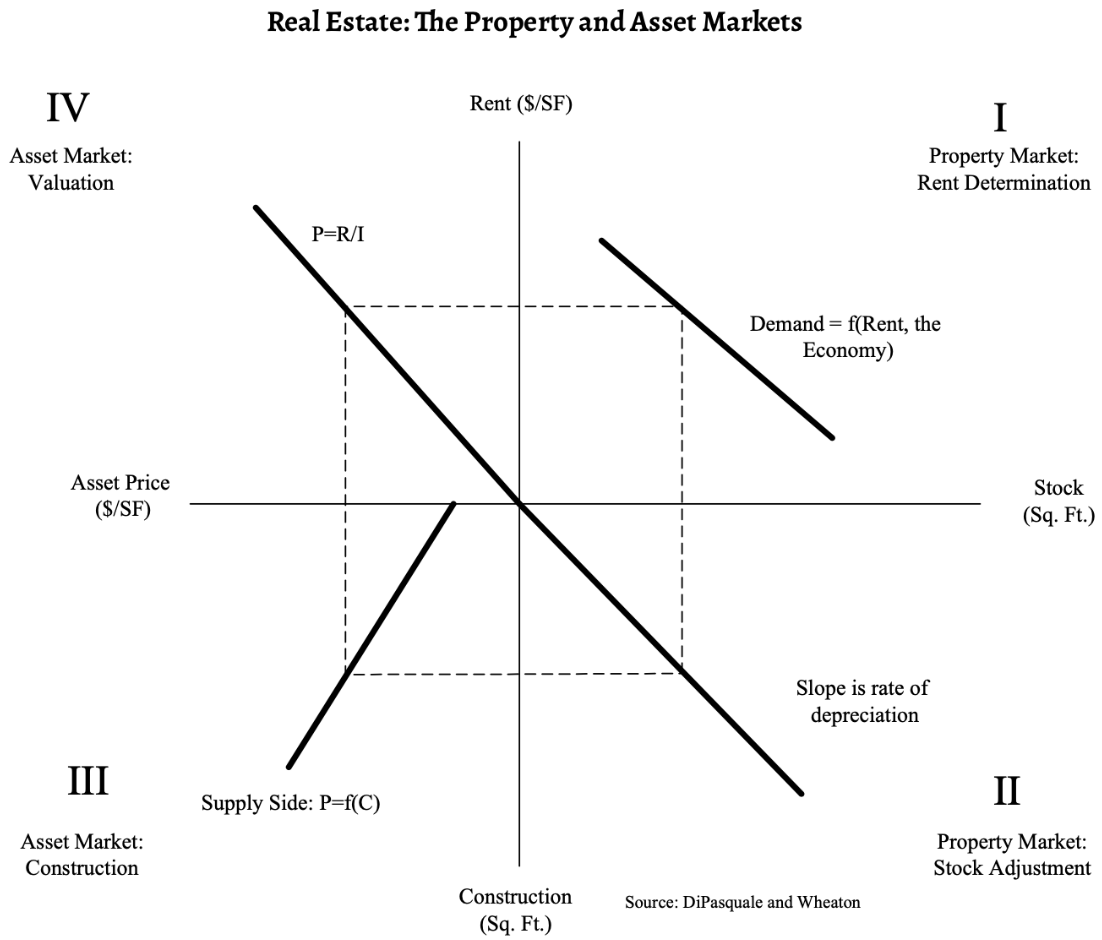

Figure 4.2 – DiPasquale and Wheaton's (1992) four-quadrant model (4QM) of real-estate markets

Eskinasi's (2014) simulations are driven to a large extent by exogenous inputs. The behaviour modes that his model generates after several rounds of structural adjustment do not come close to the reference modes of behaviour which he wishes to replicate, not even in terms of the general mode of behaviour. For example, in the reference mode of behaviour which he is attempting to explain (Eskinasi, 2014, p. 34), the housing stock is gradually increasing while in his final version of the theoretical model the housing stock is falling and pushing up prices (Eskinasi, 2014, p. 40). He does recognise the limitations of his modelling, emphasising that 'in a realistic research project, the model should undergo far more testing and sensitivity analysis, stand in much closer comparison to empirical data, [and] may possibly need further adjustment to fit a particular national context [...]' (Eskinasi, 2014, p. 40).

Eskinasi (2014) further presents three applications of SD to three distinct projects within the Dutch housing market, with a focus on housing associations. Based on his account, the Dutch housing system is similar in many respects to the UK system, including a recent shift from the post-war state interventionist approach in the provision of housing towards deregulation and liberalisation, albeit one or two decades later than in the UK. Moreover, in the Netherlands, just like in the UK, the housing construction has moved in the opposite direction of house prices, a phenomenon that is in contradiction with mainstream microeconomic theory. Eskinasi (2014) presents an explanation for the unresponsiveness of construction to rising prices, relating it to residual land pricing, which drives land prices up alongside house prices, obstructing the reactiveness of construction to house prices. While this reasoning may play a part in the observed behaviour in both the UK and the Dutch housing systems, it is almost certainly not the whole story as the behaviour that Eskinasi's model generates is not representative of reality. A key driver that he does not include in his quantitative model is the role of housing credit in driving prices, although he does recognise the importance of it in a qualitative causal diagram (Eskinasi, 2014, p. 55).

In his conclusion, Eskinasi (2014) notes that many contemporary housing research issues revolve around dynamic structural complexities and highlights SD as a suitable method for modelling realistic market processes and institutional and behavioural feedback loops. He further argues in favour of the usefulness of SD referring to its capability to go beyond the *a priori* equilibrium assumptions found over-restrictive for housing research (Eskinasi, 2014, p. 42).

4.2.2.3. *Other System Dynamics Works in Housing*

In this section, I present a brief review of some other SD work in the housing domain.[16] Studies are divided into those focusing on market cyclicality, on the interaction between real estate and financial markets, and on the Chinese and South Korean contexts.

Market Cyclicality

In the most widely cited SD textbook, Sterman (2000, pp. 698–707) argues that the poor understanding of real-estate market actors of the delays and other elements of dynamic complexity in the system, and the tendency of developers and investors to extrapolate current trends without accounting for the 'under construction' projects in the pipeline are the key contributing factors to the recurrent nature of real estate cycles. In this, as noted by Eskinasi (2014, pp. 52–53), Sterman's position is similar to Wheaton (1999) in arguing that both supply lags (or material delays) and improper actor understanding of the real estate system (or 'myopic expectations' as phrased by Wheaton (1999)) are necessary for cycles to occur.

Barlas, Özbaş and Özgün (2007) reach similar conclusions in their SD study of the oscillations in Istanbul's real estate market from the perspective of a major construction company. They attribute this oscillatory behaviour to the inevitable delays in construction and in the perception of the state of the market by market actors. They argue that since developers tend to base their construction decisions on a forecast of past prices (labelled 'adaptive expectation of prices'), this can lead to an overshoot in

[16] As noted earlier, Eskinasi (2014) includes a more systematic review of the SD literature in housing. I have only included the most relevant and the higher quality articles.

construction and bring about oscillatory booms and busts. Barlas *et al.*'s (2007) model does not include the dynamics on the demand side.

Mashayekhi, Ghili and Pourhabib (2009) apply a small SD model to investigate cycle-producing mechanisms in the owner-occupied housing market. They position their paper within existing literature on housing economics and refer to Wheaton's (1999) office rental model which finds the lag in supply as the main driver of oscillations in the housing market. Mashayekhi *et al.* (2009), however, demonstrate that the model they have constructed shows oscillations even without the supply lag. They find that in the owner-occupied market, 'in addition to supply lag, which produces cycles through creating overbuilding and underbuilding periods, alternating dominance shift between accumulation mechanism (which pushes supply and demand away from each other) and price mechanism, [which pulls supply and demand towards each other] causes oscillations in the market' (Mashayekhi et al., 2009, p. 16). This dynamic is due to the durability of owner-occupied housing as a consumption good. The modelling in Mashayekhi *et al.* (2009) is in line with Mass (1977) who recommends modelling supply explicitly as a stock variable—rather than a flow variable as is common practice in economics—in order to be able to capture disequilibrium dynamics. These findings are also in line with the housing economics literature which, as mentioned in the previous chapter (Section 3.3.4), highlights how 'excess speculation during real estate market upswings' (Clayton, 1997, p. 341) can lead to boom-and-bust cycles.

In short, within the SD literature, with its focus on accumulation, delays, and feedback as elements of dynamic complexity, the cumulative nature of vacant housing and the numerous time lags involved in construction, sales and occupancy are seen as important sources of oscillation in the housing market.

Real Estate and Financial Markets

A few SD researchers have focused on the interlinkages between the financial market and housing. Atefi, Minooei and Dargahi (2010) analyse housing affordability and relate the lack of affordability of housing in Iran to the relative underdevelopment of financial systems which means that most house purchases are carried out primarily in cash. They define their own affordability ratio by dividing the number of households in owner-occupation to those not owning a house, which seems to confound the notion of affordability with that of tenure. Unfortunately, the authors fail to sufficiently ground their modelling work in existing literature and time-series data or to present a compelling argument based on the feedback structure of their model.

Mukerji and Saeed (2011) develop and experiment with an SD model of households to compare the contribution of different factors that have been cited in the literature to be responsible for the US housing market crisis in 2007–2008. Their model is exploratory and not calibrated against historical data. Nevertheless, its structure is well grounded in economic theory. They use the model to experiment how each factor would affect a system in equilibrium, while layering factors one by one on top of each other. Among their experimental findings is that lowering interest rates actually mitigates the boom to some extent through disincentivising household savings, but this also exacerbates the bust and leaves households low on savings and ill-equipped to face the crisis. They find laxer requirements for household borrowing to be the only factor that can cause both the boom and the bust on its own due to over-investment in housing and over-accumulation of debt (Mukerji & Saeed, 2011). Their results match Borio's (2014) theory of endogenous financial cycles where the boom does not just precede but also causes the bust. Their dynamic hypothesis is also very much in line with the one developed in this thesis (presented in the form of the CLD in Section 3.5.2).

Rammelt (2019) presents a simplified SD version of Keen's (2013) Goodwin-Minsky model (briefly alluded to in Chapter 3, Box 3.2), which he describes as 'over-specified [and] highly sensitive to initial conditions' (Rammelt, 2019, p. 140). Rammelt's model still reproduces key features of Keen's Model's behaviour, i.e., dampening cycles in the short run and widening cycles in the long run, while containing fewer variables and parameters.

Hwang, Park and Lee (2013) build an SD model to analyse the expected effects of new policies announced by the South Korean government that aim to limit the loan-to-value (LTV) and debt-to-income (DTI) ratios in the aftermath of the 2008 crisis, in an effort to stabilise house prices. They find that such policies would indeed help bring the growth of house prices in control. Through sensitivity analysis, they demonstrate the high leverage of LTV and DTI regulation in controlling house price growth. A limitation of their model is that it assumes a 'textbook definition' of the role of banks as intermediaries who can only issue loans out of a stock of available 'funds'. This, however, does not correspond to the modern-day reality of the banking system which creates new money rather than recycle existing funds (Ryan-Collins et al., 2012).

Chinese and South Korean Contexts

There appears to be a growing interest in using SD for housing studies in in China and South Korea (Hwang, Lee, Yi, & Kim, 2019; Hwang et al., 2013; Mou, Li, & Dong, 2021; Zhang et al., 2018). In South Korea, besides studies on the impact of Korean financial policies on the housing market (Hwang et al., 2013; Hwang, Park, Lee, Yoon, & Son, 2010), another more recent study by Hwang *et al* (2019) models the supply and demand for public rental housing and simulates different policies towards minimising vacancy rates (Hwang et al., 2019).

In the Chinese context, Zhang, Geltner and de Neufville (2018) continue the tradition of SD housing models building on the foundation of DiPasquale and Wheaton's (1992) canonical 4QM model. As done in other publications previously reviewed (Barlas et al., 2007; Eskinasi, 2014; Mashayekhi et al., 2009), Zhang *et al.* (2018) translate 4QM into an SD model and superimpose enhancements on the original model to reflect the Chinese urban housing market, with an emphasis on speculative demand and the local governments' land financing scheme. Zhang *et al.* (2018) highlight the common themes between urban economic theories, such as the 4QM model, and SD models of housing, in that both 'target similar issues by using stock-flow theory of highly durable goods as well as the myopic behavior of real estate developers to explain the housing market dynamics' (Zhang et al., 2018, p. 481). However, they also note that 4QM is primarily a static equilibrium model while SD models are inherently dynamic and disequilibrium oriented.

In another China-related study, Mou, Li and Dong (2021) build an SD model with a highly detailed demographic dimension to simulate the impact of population ageing and changing family structures on housing demand in China. As far as relates to this thesis, among the policy recommendations based on their analysis is imposing a real estate tax in order to curb excessive speculative investment demand which negatively impacts affordability (Mou et al., 2021).

To sum up, with the exception of some (Mou et al., 2021; Zhang et al., 2018), past SD work in the area of housing has been largely based on theoretical and experimental models (Barlas et al., 2007; Eskinasi, 2014; Forrester, 1970; Hwang et al., 2019, 2013; Mashayekhi et al., 2009; Mukerji & Saeed, 2011) that have been used to investigate the consequences of the assumptions in the model on the dynamic behaviour deriving from those assumptions. This means that the modelling has been usually rather abstract and not firmly grounded in real historical data. This, in my view, undermines the usefulness and persuasive power of such models for the practical purpose of affecting policy in the real world. Also, with the exception of a few high-quality papers reviewed above, most SD work in the field of housing during recent decades is fragmented and consists of papers of limited quality that are not very well grounded on existing literature and data, leading Eskinasi (2014) to conclude, based on his extensive literature review, that 'system dynamics operates in isolation of most other social sciences [with some notable exceptions]' (Eskinasi, 2014, p. 120). This has led to SD remaining relatively unknown in the field by both academics and practitioners (Zhang et al., 2018).

Thus, Eskinasi (2014, p. 127) proposes to 'embed' SD studies in the theories and findings of the respective field of application. Broadly, the issues of quality and firm grounds in subject literature link to discussions around model validity, which is the topic of the next section. As will be discussed, the SD approach to model validation, if carefully followed, adheres to rigour of the highest standard, not least thanks to its emphasis on both behavioural and structural validation methods.

4.3. Model Validation in System Dynamics

In system dynamics, model validity is closely dependent on the nature of the problem and the purpose of the model. Validation is seen as a gradual process of building confidence in the usefulness of a model with respect to its purpose (Barlas & Carpenter, 1990; Forrester & Senge, 1980). This happens in an iterative process as the model passes more tests and is increasingly found to be representative of the real system, with its structure and its behaviour corresponding empirical evidence on the structure and behaviour of the real system (Forrester & Senge, 1980).

From the SD perspective, rather than being true or false, models lie on a 'continuum of usefulness' (Barlas & Carpenter, 1990, p. 157). This view to model validity is based on a relativist philosophy which maintains that knowledge is relative to a given society, epoch, and scientific worldview. Accordingly, model validation becomes an inherently social, conversational, and judgmental process (Barlas & Carpenter, 1990; Schwaninger & Grösser, 2020). This contrasts with the view of the prevalent neoclassical school of economics, with its constant pursuit of mathematical scientificity (Leontief, 1971, p. 2; Piketty, 2014, p. 32), which fits better with a positivist, logical empiricist philosophy (Radzicki, 1990).

In econometrics the single most commonly used validity metric is the goodness of fit to historical data. However, a statistically good fit with data does not necessarily mean that the model is structurally robust or that the relationships embedded in the model causally represent the way the real system works. In such 'black box' models, the emphasis is on prediction rather than explanation (Kleijnen, 1995). This emphasis on prediction, without a strict requirement for explanation, can lead to overspecification and a lack of robustness, which often demonstrates itself in the poor predictive power of econometric models (Sterman, 1991).

Lane (2015) stresses that SD is, nevertheless, not unique in its perspective on validation. Indeed, the focus on the notion of 'confidence' is in line with other simulation approaches, in particular in the operations research and management science fields. Also, similar to the concept of confidence in SD is Phillips' (1984) notion of a 'requisite model' in the world of decision analysis which is defined as a model whose form and content are sufficient to solve a particular problem. This notion suggests that what needs to be in a model is simply what is required by a specific group of people to solve a specific problem at a specific time (Phillips, 1984).

A model's usefulness is necessarily gauged with regards to a specific purpose without which usefulness loses its meaning. Sterman (1991) highlights a clear purpose as 'the single most important ingredient for a successful modelling study' (Sterman, 1991, p. 5). This relates to the SD principle of modelling a 'problem' rather than a 'system'. The usefulness of any model is in simplifying reality by excluding what is not relevant to the problem at hand. In the words of Meadows *et al.* (1992), '[t]he art of modelling [...] is to include just what is necessary to achieve the purpose, and no more' (Meadows et al., 1992, p. 108). Otherwise, as aptly put by Sterman (1991), 'a truly comprehensive model of a complete system would be just as complex as that system and just as inscrutable. The map is not the territory—and a map as detailed as the territory would be of no use' (Sterman, 1991, p. 5).

In a context of public policy, such as that of housing, a useful model should explain the causes of the problem and provide a basis for designing better policies to improve the behaviour of the system in the future. Thus, validation also involves a transfer of confidence in the model from the model builder to the model's target audience (government policymakers in this context), which is a prerequisite for the model to lead to any improvement in policy, as well as 'the ultimate objective of validation in system dynamics' according to Forrester & Senge (1980, p. 8).

The SD validation process is prolonged and complicated, involving both formal, quantitative tests and informal, qualitative ones (Barlas, 1996; Forrester & Senge, 1980). In his much-quoted essay on model validation in system dynamics, Barlas (1996) distinguishes between three types of validity tests for SD models which are carried out sequentially: *i) direct structure tests, ii) structure-oriented behaviour tests*, and *iii) behaviour pattern tests*. Direct structure tests assess the validity of the model structure by evaluating each causal relationship in the model against existing knowledge about real system structure. (See Chapter 5 for a description of how my model's structure reflects existing knowledge about the real system.) Structure-oriented behaviour tests assess the validity of the structure indirectly by applying certain behaviour tests such as extreme condition or sensitivity tests. Once enough confidence has been built in the validity of the model structure, behaviour pattern tests are applied to measure how accurately the model can reproduce the major behaviour patterns exhibited by the real system (Barlas, 1996). It is essential to note that the emphasis in behaviour tests is on capturing the dynamic character of the behaviour—frequencies, trends, phase lags, and amplitudes—rather than point accuracy in matching historical data (Forrester, 2003). Combined use of behaviour tests and structural tests builds confidence in that the model not only generates the 'right behaviour' but does so for the 'right reasons' as well. Several important structure-oriented behaviour tests and behaviour pattern tests that I have carried out on the model are reported in Chapter 6.

In the next section, I will give a brief overview of the types and sources of data I have used in this thesis for the purposes of parametrising, calibrating, and validating my model.

4.4. Data and Data Sources

I have based the structure (links, equations, and feedback loops) of my SD model primarily on existing literature. However, the model building process was also a very iterative process, whereby I sought feedback on the model structure frequently and at various stages—either face-to-face, online or via email—from experts in housing and in modelling. These included senior academics in housing economics, government housing officials (from the GLA and the MHCLG, for example), a CEO of a large housing development firm, a senior researcher at a London-based urban economics think tank, and the chief technical officer of an SD modelling NGO. Table 4.1 lists the face-to-face interviews and feedback sessions I have had throughout this PhD (but excludes the numerous email correspondence with a much wider panel of experts). Disconfirmatory interview is a recognised method for assessing and building confidence in SD models (Andersen et al., 2012). Such qualitative feedback has led to adjustments and improvements in the model at every stage.

Table 4.1 – List of interviews

	Interviewee	Date(s)	Topics of discussion
1	Senior professor in the field of urban planning (PhD supervisor)	14/9/2017 9/5/2018	Disconfirmatory model reviews, the role of speculative demand, housing financialisation, trends in housebuilding, relevant literature, etc.
2	Senior professor in the field of housing economics (PhD supervisor)	Several dates since 2018	Disconfirmatory model reviews, the role of housing credit, housing-finance feedback, macroprudential policies, relevant literature, etc.
3	Senior housing expert at GLA	30/8/2019	Disconfirmatory model review, housing policies of interest to the GLA, collaboration on a small policy impact grant, support in data acquisition and interpretation
4	Senior housing expert at London-based urban economy think tank	5/3/2020	Disconfirmatory model review, drivers of housing crisis, housing policies, Brexit impact
5	Senior policy advisor at MHCLG	17/3/2020	Disconfirmatory model review, drivers of housing crisis, housing policies, Brexit impact
6	CEO of large housing development group	3/4/2020	Drivers of housing crisis, taxation policies, Brexit impact, trends in private construction
7	Senior system dynamics expert	28/5/2020	Disconfirmatory model review, model calibration

Furthermore, in line with earlier discussions on the importance of a transfer of confidence in the model to its target audience, I have presented the results of my policy analysis to a group of 17 housing analysts and policymakers at the GLA in May 2021, with a view towards ultimately having an impact on policy. The presentation was well-received and generated substantial enthusiasm and interest.[17] Further presentations for the MHCLG and the Bank of England are planned for the future.

With regards to quantitative data, this study is based on secondary data taken from existing sources (and has not involved collecting any primary data). Collecting data from existing sources has, however, not always been a straightforward task. In several cases, obtaining data involved extensive correspondence with civil service offices, academics, and private enterprises. In other cases, extending certain time series back to 1980, the starting year of the model, involved borrowing physical volumes of discontinued housing statistics references from the library of another institution and digitizing data that only existed on paper.

The model built for this study and introduced in the following chapter is accompanied by an Excel spreadsheet which contains time-series data on model variables. This file needs to be imported into the SD software *Vensim®* in order to run the model. The numerical data in the accompanying spreadsheet have been used in four ways in this research:

(a) In the case of 'exogenous' variables—driven by external data throughout the simulation period—the data is used as direct input to the model. These exogenous variables are either those that are believed to be not noticeably affected by the internal dynamics, and therefore outside the scope of the model (e.g., *number of households* in London) or variables determined/majorly affected by policy (e.g., *residential planning applications success rate* or *average mortgage*

[17] A video recording of this presentation can be found at the following link: https://www.youtube.com/watch?v=0-g_E7KT-kQ

interest rate) which are given by historical data in the past and are left as policy levers for the model user to manipulate in the future.

(b) In case of the stock (level) variables (see Section 5.1), data for the year 1980 has been used as an input to initialise the model.

(c) The third way times series data have been used is for calibrating model parameters to historical data. Calibration has been done both manually, by tweaking model parameters—either individually or in tandem with each other—and investigating the resulting effect on model behaviour, and automatically, via running *Vensim*'s Monte Carlo calibration algorithm which automates the calibration process through running thousands of simulations while varying the value of the selected parameter(s) within a user-specified range and with a user-specified probability distribution. Chapter 5 will include specific examples of this method of calibration.

(d) The final way in which time series data are used is for validating the behaviour of the model against existing historical data. This comparison is done both visually (as the overall modes of behaviour, amplitudes and frequencies tend to be evident on visual inspection), as well as more formally, via the use of Theil inequality statistics (Sterman, 1984) which break down the mean square error between simulation results and historical data in three components of *bias*, *unequal variation* and *unequal covariation*. More details and examples of use of this error decomposition method will follow in Chapter 6.

In the model-accompanying Excel spreadsheet, each variable is given a row and each column holds data observations for one year. The default range of historical data collected and used is 1980–2020. In many cases, however, data for all the years in the range were not available, especially for the earliest and the most recent years. Where possible, incomplete data sources were complemented using data from other sources. In other cases, where needed and appropriate, data was extrapolated or interpolated for missing years. Where multiple sources were available, I have leaned towards using the one which has been consistently provided over my time horizon of interest for longitudinal comparability. Additional columns for each variable in the data spreadsheet include one for units, one for data sources, and one for any additional notes and comments, including ones explaining any processing done on the data.

The spreadsheet is organised under various headings and subheadings. The main headings correspond to the model sectors (Chapter 5): 1) *House Prices,* 2) *Mortgages* (including *new mortgage advances*, *mortgage balances outstanding, average mortgage period*, *average loan-to-value ratio of new mortgages*, etc. 3) *Construction* (including *private*, *local authority* and *housing association construction starts*, *completions*, as well as *under construction*, and completed housing stocks), and 4) *Tenure and Rent* (including numbers of dwellings by tenure type and average private/affordable *rents*).

The main sources where I have obtained this data include statistical live tables of the Ministry of Housing, Communities and Local Government (MHCLG) (formerly Department of Communities and Local Government DCLG), Office for National Statistics (ONS), London Datastore (which collates London-specific data from other sources, including the two mentioned above), Bank of England (BoE), UK Finance, Building Societies Association (BSA), and the discontinued physical volumes of Housing and Construction Statistics (1980-1998 volumes) published by the former Department of the Environment, Transport and the Regions (DETR) (dissolved in 2001). Table 4.2 lists key variables in the SD model for which data has been collated, the sources whence the data has been obtained, and the purposes for which it has been used.

Table 4.2 – Time-series variables, data sources and usages in the SD model

Variable	Source	Used for/as...
1. House Prices Sector		
house prices	Table 505 (1980–2010) (MHCLG, 2016b); House price data quarterly tables (2010–2020) (ONS, 2020c)	Initialisation, calibration, and validation
gross household disposable income	Historic economic data for regions of the UK (1984-96) (ONS, 2016); Regional gross disposable household income (ONS, 2020h) (1997–2017)	Exogenous input
2. Mortgage Sector		
2.1. New Mortgages		
new mortgage advances	(UK Finance, 2017)	Calibration and validation
number of new mortgage advances per year	(UK Finance, 2017)	Initialisation, calibration, and validation
average loan to value ratio of new mortgages	House price data quarterly tables (ONS, 2020c)	Exogenous (policy) input
average mortgage period for new mortgages	Housing and Construction Statistics (1980–2000) (DETR, n.d.); Table 536 (MHCLG, 2016b)	Exogenous input
average mortgage interest rate	Housing and Construction Statistics (1980–2000) (DETR, n.d.); Building Societies Association (2000–2019) (BSA, 2020)	Exogenous (policy) input
2.2. Balances Outstanding		
mortgage balances outstanding	(UK Finance, 2017)	Validation
debt service ratio	Bank for International Settlements (BIS, 2021)	Validation
2.3. Help to Buy		
number of help to buy equity loans	Help to Buy Tables (MHCLG, 2021)	Exogenous input
3. Construction Sector		
3.1. Construction Starts		

Variable	Source	Used for/as…
private construction starts	Table 253 (MHCLG, 2020b)	Initialisation, calibration, and validation
housing association construction starts data	Table 253 (MHCLG, 2020b)	Exogenous (policy) input
local authority construction starts data	Table 253 (MHCLG, 2020b)	Exogenous (policy) input
3.2. Under Construction		
private housing under construction	Housing and Construction Statistics (DETR, n.d.)	Initialisation and validation
housing association housing under construction	Housing and Construction Statistics (DETR, n.d.)	Initialisation and validation
local authority housing under construction	Housing and Construction Statistics (DETR, n.d.)	Initialisation and validation
3.3. Construction Completion		
private construction completion	Table 253 (MHCLG, 2020b)	Validation
housing association construction completion	Table 253 (MHCLG, 2020b)	Validation
local authority construction completion	Table 253 (MHCLG, 2020b)	Validation
3.4. Demolitions		
housing association stock demolition	Derived from Tables 684 and 115 (MHCLG, 2012, 2020a)	Exogenous input
local authority stock demolition	Derived from Tables 684 and 115 (MHCLG, 2012, 2020a)	Exogenous input
3.5. Other Housing Flows		

Variable	Source	Used for/as…
net other additions	Table 253 (MHCLG, 2020b) and Table 118 (MHCLG, 2020c)	Exogenous input
large scale voluntary transfers	Derived from Tables 674 (1980–2010) and 648 (2010–2015) (MHCLG, 2012)	Exogenous input
housing association right-to-buy transfers	Table 675 (MHCLG, 2012)	Exogenous input
local authority right-to-buy transfers	Tables 670 (1980–1997) and 685 (1998–2015) (MHCLG, 2012)	Exogenous input
3.6. Dwelling Stocks		
private housing stock	Table 109 (MHCLG, 2020a)	Initialisation and validation
housing association housing stock	Table 109 (MHCLG, 2020a)	Initialisation and validation
local authority housing stock	Table 109 (MHCLG, 2020a)	Initialisation and validation
3.7. Planning Applications		
residential planning applications success rate	District Planning Application Statistics (MHCLG, 2020d)	Exogenous (policy) input
4. Tenure & Rent Sector		
4.1. Tenure		
owner occupied dwellings	Table 109 (MHCLG, 2020a)	Initialisation, calibration, and validation
privately rented dwellings	Table 109 (MHCLG, 2020a)	Initialisation, calibration, and validation
dwellings rented from housing associations	Table 109 (MHCLG, 2020a)	Initialisation and validation
dwellings rented from local authorities	Table 109 (MHCLG, 2020a)	Initialisation and validation
4.2. Rents		

Variable	Source	Used for/as…
private rents	Housing and Construction Statistics (1980–1994) (DETR, n.d.); Family Resources Survey[18] (1995–2014)	Initialisation, calibration, and validation
housing association rents	Housing and Construction Statistics (1981–1993) (DETR, n.d.); Table 703 (1994–2018) (MHCLG, 2020e)	Exogenous input
local authority rents	Housing and Construction Statistics (DETR, n.d.); MHCLG Table 702 (MHCLG, 2020e)	Exogenous input
4.3. Housing costs		
number of households	Table 406 (1991–1996) (MHCLG, 2016a); Labour Force Survey (1996–2019) (ONS, 2020b). Before 1991 and After 2019 extrapolated.	Exogenous input

4.5. Chapter Summary

Towards better understanding the underlying dynamics leading up to the current housing crisis in London, I have used the system dynamics methodology in this thesis. For several reasons listed in 4.2.1, such as its ability to capture elements of dynamic complexity and disequilibrium dynamics, its feedback perspective, its strength in building a compelling narrative, and its endogenous point of view, SD presents a powerful approach to tackling the problem of London's housing crisis. There is also a long tradition of applying SD to housing issues going back to Forrester's (1970) seminal *Urban Dynamics*.

The review of previous SD literature in the field of housing revealed that, with a few exceptions, the works in this stream of research have generally suffered from at least one of the following two principal weaknesses: a) not being grounded in the vast literature on urban dynamics and housing economics on the one hand and/or b) not

[18] Processed annual data obtained from the GLA.

being closely based on and validated against real historical data on the other hand. Eskinasi (2014) reaches a similar conclusion in his comprehensive review of this literature and, in attempting to explain the riddle of why SD has not been widely applied to housing research given its strengths and advantages, Eskinasi attributes this to an 'endemic isolation' of SD from other social sciences (Eskinasi, 2014, p. 40). He refers to Repenning (2003), who, in his acceptance speech of the Jay W. Forrester Award,[19] hypothesises a vicious circle that has continuously isolated SD practitioners from other disciplines: 'as SD was critically received outside the field, efforts to make it accessible to others were reduced, thereby insuring an even more critical reception in the future. [...] The result is a community that, today, is largely isolated from mainstream social sciences' (Repenning, 2003, p. 322). In order to break this cycle, Repenning (2003) advises SD practitioners to collaborate with academics from the fields they are trying to enter, and to ground their work in the literature of the field.

Through the extensive literature review reported on in the preceding chapters, as well as by seeking feedback on my model and analysis on several occasions from experts in the field of housing economics, it has been my aspiration throughout this PhD to follow Repenning's (2003) and Eskinasi's (2014, pp. 42–43) advice in grounding SD work in the language and literature of the respective field, rather than doing modelling in a methodological silo. Moreover, by calibrating and validating my model against historical data, I have tried to further strengthen the relevance and foundation of this study. The next chapter describes the quantitative SD model in detail, before validating it against existing data in Chapter 6.

[19] The Jay Wright Forrester Award is presented as often as once annually for the best written contribution to the field of System Dynamics during the preceding five years (from the System Dynamics Society webpage).

Chapter 5. Model Documentation

Chapter 5. Model Documentation

In this chapter, I will document the quantitative system dynamics model that I have built based on the literature and drawing upon the qualitative causal loop diagrams developed in Chapters 2 and 3. The model can be considered medium to large in size, with a total of 233 variables, including 44 stocks (see Section 5.1 for a definition of stock variable). The model itself and the list of all model equations (as well as the scenario runs shown later in Chapter 7) come as separate files in the supplementary material that accompanies this thesis. A high-level sector diagram of the model—which will be described in detail throughout this chapter—is shown below (Figure 5.1). As depicted in the diagram, the model is structured in four inter-connected sectors, shown as boxes. The four sectors make up a single simulating model and are not separate entities; indeed, each sector is linked with others at more than one node. They are, however, presented sector by sector for better understanding and clearer communication. The four sectors are: *(1) House Prices, (2) Mortgage, (3) Construction,* and *(4) Tenure and Rent.* In each box a few of the key variables in that sector are named. The variables listed in bold letters are policy levers foreseen in the model which are going to be used in Chapter 7 to run policy scenarios.

The model is built in one of the most commonly used SD software packages called *Vensim® Professional* (Version 6.3D). I will document it by showing the stock-flow diagrams sector by sector and going through key equations where needed. Any required SD notions used will be introduced when the need arises. The following table details the colour-coding and other information needed to interpret the diagrams. In documenting equations, units are indicated in square brackets. Where no units are indicated, the variable is dimensionless. It must be noted that the model documentation in this chapter is fully structure oriented. The simulated behaviour resulting from this structure will be discussed in the next chapter.

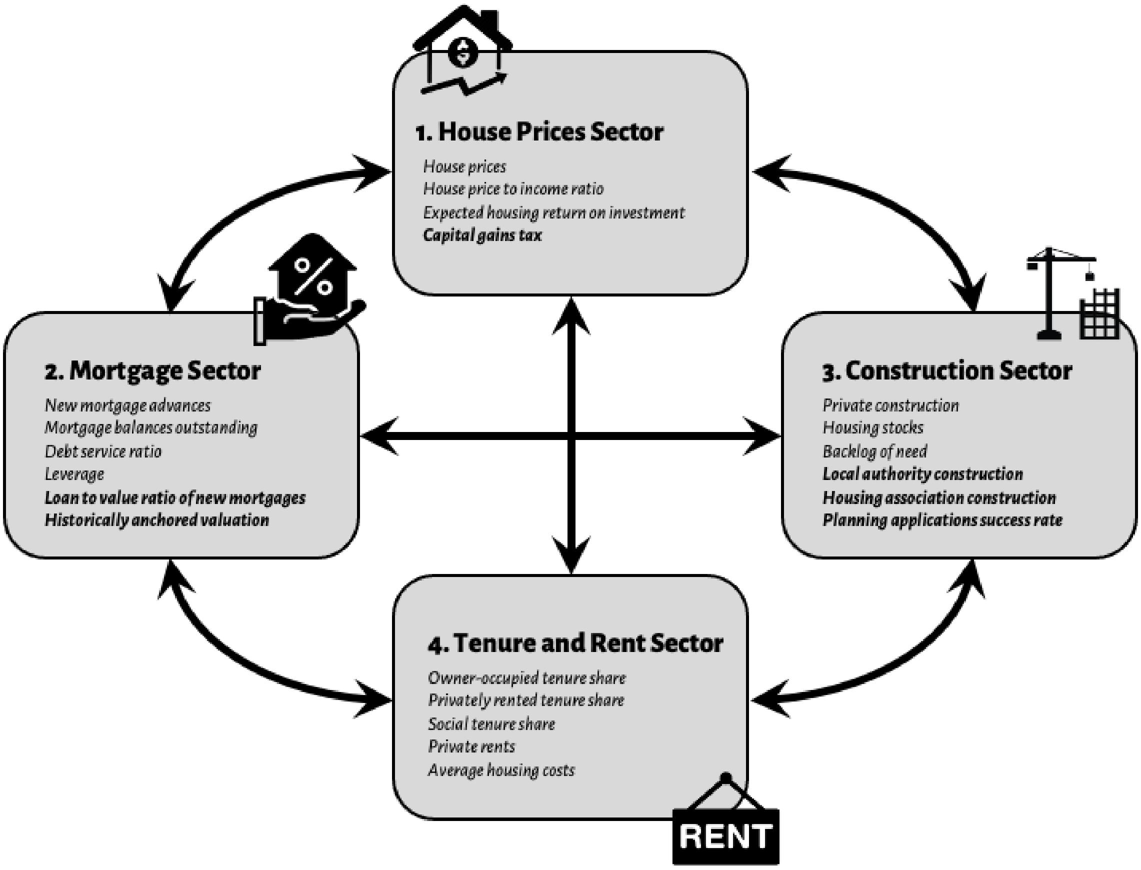

Figure 5.1 – Sector diagram of the SD model

Table 5.1 – SD model's visual codes explained.

Code	Meaning
Lower-case variable	Endogenous variable (formulated based on other variables within the model). The dynamic behaviour of such variables is given by simulation and is driven by model structure.
Upper-case variable	Constant. Such constants are either fixed parameters (black), or policy/scenario variables set by the user (green).
Variable with first word in upper case, rest in lower case	Exogenous (data) variable. Past behaviour of such variables is given by historical data. These variables are assumed to stay constant in the future, unless otherwise specified.
Capitalised variable in a box	Stock variable
Valve sign on double-lined arrow	Inflow to or outflow from a stock
Red variable	Key indicator
Green variable	Policy/scenario variable, set by the user
Blue variable, in angle brackets	'Shadow' variable, copied from another sector of the model, denoting interconnections between sectors

Code	Meaning
Blue arrow	Causal relationship, from cause to effect. Each (endogenous) variable is formulated based on variables connected to it via incoming arrows.
Grey arrow	Initial condition setting

In Sections 5.1 through to 5.4, the model is described sector by sector. Subsequently, a *model boundary diagram* is presented in Section 5.5, which summarises what is included in and what is excluded from the model. The chapter concludes with a simplified Causal Loop Diagram in Section 5.6, which elicits and highlights the model's key feedback loops. As will be evident from the CLD, while the SD model is founded on the whole-system CLD presented in Chapter 3 (Section 3.5.2), it does not include all its detail. This is mainly because the aim of this thesis is to present a *parsimonious* hypothesis of the mechanisms and structures underlying the characteristic exponential growth and periodic oscillations in house prices and housing finance, and therefore I have concentrated my efforts on including what I believe are the most crucial feedback loops in giving rise to the abovementioned patterns of behaviour, with an emphasis on the housing-finance nexus as elaborated in detail in Chapter 3 (Section 3.3). This means that, due to the considerable amount of time and research required for quantifying each of the qualitative links to include them in the formal model, I have had to exclude some of the notions so far introduced, as made explicit in Sections 5.5 and 5.6.

Let us now turn to the sector-by-sector presentation of the SD model.

5.1. House Prices Sector

Starting right away with our central variable of interest, Figure 5.2 shows a schematic view of how *real house prices* is captured in the model. Where a variable name is preceded by the prefix '*real*', it means that it is adjusted for inflation, and measured in constant 2018 Pounds Sterling (abbreviated as GBP18). In the SD language, *real house prices* is a *stock* variable and the rate of *change in real house prices* is a *flow* variable. Stocks are denoted inside a box and flows are shown with valves and thick hollow arrows flowing into or out of stocks. The small 'cloud' where the flow originates signifies that the source (but not the drivers) of this change is outside the model boundary or irrelevant for our purpose. A stock is a level that is, at any point in time, the result of the accumulation of its net flow (inflows minus outflows), plus any *initial* value assigned to it. Mathematically speaking, a stock is an *initial* value (connected to the stock with a grey arrow in Figure 5.2) plus the integral of its net flow over time. In terms of behaviour, stocks capture the processes of accumulation that give systems their dynamic disequilibrium behaviour (Mass, 1977).

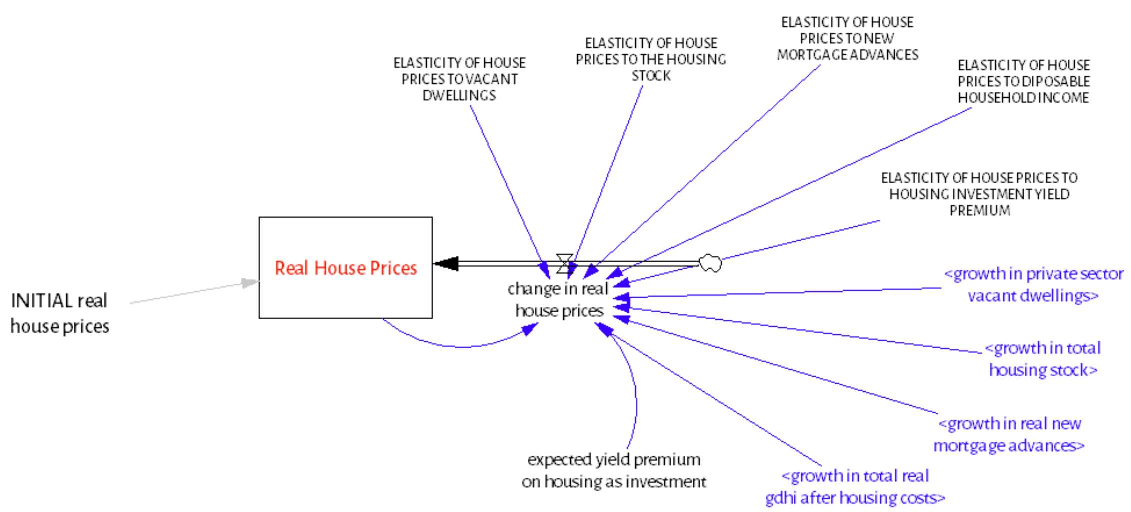

Figure 5.2 – Real house prices

Therefore, in this case *real house prices* is formulated as:[20]

real house prices = initial real house prices + INTEG (change in real house prices) [1]

[20] All integration is carried out over time. The *dt* at the end of integral arguments is not made explicit for simplicity.

All stock variables in the model are formulated in the same way: an *initial* value plus the integral of inflows minus outflows. Therefore, henceforth the equations for stocks are not repeated in the text for brevity.

Initial real house prices is the level of house prices at the start of the simulation period (1980) and is given by data. All stocks in the model need to be exogenously (i.e., externally) initialised in the same way, using either data from the real world, an informed estimate, or via calibrating the behaviour of the stock to existing data which might be available only for later years in the simulation period.

Therefore, as is usually the case in modelling stock-flow structures in SD models, the key variable to be formulated here is *change in real house prices*. In this model, *change in real house prices* is assumed to be driven by five factors (counterclockwise from the bottom of Figure 5.2): *expected yield premium on housing as investment, growth in total real GDHI*[21] *after housing costs, growth in real new mortgage advances*, *growth in total housing stock*, and *growth in private sector vacant dwellings*. In other words, *house prices* are driven by three demand-side and two supply-side factors. The demand-side factors are: (a) return on investment in housing as an asset, expressed as premium over the yield on government securities, (b) disposable household income after deducting housing costs, which is endogenously determined by developments in tenure and various housing costs (see Section 5.4), and (c) new mortgage advances. All three demand-side drivers have a same-direction relationship with *house prices*, meaning that as they rise, *house prices* rise as well and vice versa. The supply-side drivers are (a) *total housing stock* and (b) *private sector vacant dwellings*. These have opposite-direction relationships with *house prices*, meaning that as they rise, *house prices* fall and vice versa. Except for *expected yield*, which is formulated in

[21] Gross disposable household income

this sector based on developments in *house prices* itself, as we will shortly see, all other drivers are imported from other sectors in the model and establish interconnectivity among sectors, as denoted by their blue colour.

In each case, the effect from each driver is quantified using an *elasticity* parameter which relates changes in the 'cause' variable to changes in the 'effect' variable. Formally, the *elasticity* is the ratio of the percentage change in the effect variable (in this case, *real house prices*) as a result of the percentage change in the cause variable. The elasticities can be either positive or negative, based on the direction of the relationship between the cause and the effect variables. In this case, the elasticities associated with the three demand-side drivers are positive, reflecting the same direction relationships, and those related to supply-side factors are negative, reflecting the opposite-direction relationships. For instance, a value of 0.4 for the *elasticity of house prices to new mortgage advances* means that a 10% *growth in real new mortgage advances* would lead to a 4% change in *real house prices* in the same direction.

The values of the elasticities are estimated numerically to give the best possible fit to existing historical data for key indicators. This process of 'estimating the model parameters to match observed and simulated behaviour (Oliva, 2003, p. 552)' is referred to as 'calibration' and is considered part of the SD validation process (Barlas, 1996). Such calibration can be done manually for small models but for larger models with hundreds or thousands of feedback loops manual calibration becomes impossible. Thus, for a medium-size model such as the one of this study, calibration involves automated numerical optimisation techniques which are often included in SD software packages. The *Vensim* software, for instance, includes an optimisation and calibration feature based on Powell's algorithm (Dangerfield & Duggan, 2020; Dangerfield & Roberts, 1996; Powell, 1964; Ventana Systems, n.d.) which is 'a hill-climbing method that finds a function's minimum value by sequential one-dimensional searches' (Parra, Jaramillo, &

Arango-Aramburo, 2018, p. 191). A pay-off function is defined which reflects the error of simulated model behaviour versus actual historical data, and the algorithm sets out to minimise this pay-off function while varying the parameters set by the user within defined ranges and simulating the model with thousands of different parameter configurations and working its way towards the set of parameters which gives the lowest error between simulation and data.

Such estimated elasticity values can often be different from those found in econometric studies (if any). Besides the fact that other studies have different geographical and temporal scopes as well as different model boundaries than this one, another crucial reason for such differences is that econometric studies tend not to include the complex web of feedback relationships amongst variables, as included in this integrated model. Reinforcing feedbacks in a system dynamics model can make a nominally low elasticity equivalent to a higher effective value in a feedback-free model, while counteracting effects from balancing feedback loops can do the opposite.

Regarding this particular elasticity, for instance, a study by the International Monetary Fund (IMF), using data for 19 OECD countries for the period of 1980 to 2010, found that a 10% increase in household credit leads to a 6% increase in average house prices (IMF, 2011). Furthermore, Favilukis *et al.* (2012) find that, in the American context, credit supply alone explains 53 percent of the quarterly variation in house price growth over the period 1992–2010 and 66 percent of variations over the period since 2000. Barone *et al.* (2020), find a significant causal effect from mortgages to house prices in the Italian context, albeit with a much lower elasticity of 0.1. The value of 0.4 given by our calibration produces a growth rate in prices that is generally in line with what is observed in the data. Given a higher value, the reinforcing feedbacks between *house prices* and *new mortgage advances* would become too overpowering and lead to a faster exponential growth in both variables than what is witnessed in historical data.

As for the *elasticity of house prices to disposable household income*, Cheshire *et al.* (1999) find a strong and stable elasticity of housing demand to income using a microsimulation model for three regional housing markets in England. They argue that, although in traditional planning processes population growth is taken as the key determinant of how much land to be released for housing, in fact rising real incomes is a far more important driver of demand (Cheshire, Marlee and Sheppard, 1999 cited in Cheshire, 2009). Cheshire and Sheppard (1998) estimate that a 10% increase in incomes leads to about 17% more spending on housing space by households in the medium-sized English city of Reading, implying an income elasticity of 1.7. Meen (1998) estimates an income elasticity of up to about 2.4 for the UK, given the low responsiveness of supply to prices. Here, model calibration gives a value of 1.1 for the *elasticity of house prices to disposable household income* for London, lower than the above econometric estimates in other contexts and perhaps reflecting the relative importance of mortgage credit in driving house prices in London since 1980.

For the *elasticity of house prices to housing investment yield premium*, calibration gives a value of 0.45 for this constant, meaning that every 1% premium of investing on housing over and above the yield on safe government securities (bonds), leads to an annual 0.45% increase in *real house prices* over a year. This *elasticity* is a key determinant of the strength of the *Investment Loop*, as described previously in Section 3.5.1.

On the supply side, Mulheirn (2019) reports that 'multiple modelling exercises, for the UK and elsewhere, find that a 1% increase in the stock of houses tends to lead to a decline in [...] prices of between 1.5% and 2%, all else equal' (Mulheirn, 2019, p. 6). In line with that, our calibration gives a value of -1.5 for the *elasticity of house prices to the housing stock*. This is the effect of changes in the *total housing stock*, which includes the local authority and housing association stocks, on house prices. In addition, the model includes a separate effect from private vacant housing, which is more directly related to new units of private housing being completed. As we will see later in Section 5.4, newly built units flow into a stock of *private sector vacant dwellings* before being sold or let out. The assumption here is that an increase in this stock of vacant housing will lead to a decrease in house prices. The associated *elasticity of house prices to vacant dwellings* is estimated via calibration to be -0.5: An increase of 1% in vacant housing is expected to lead to a decrease of -0.5% in *real house prices*.

Having in mind the effects described above, the equation for *change in real house prices* is as follows:

```
change in real house prices =
        real house prices *
        (
   expected yield premium on housing as investment * elasticity of house prices to housing investment yield premium
 + growth in real disposable household income after housing costs * elasticity of house prices to disposable household income
 + growth in real new advances * elasticity of house prices to new mortgage advances
 + growth in total housing stock * elasticity of house prices to the housing stock
 + growth in private sector vacant dwellings * elasticity of house prices to vacant dwellings
        )                                                                        [2]
```

In other words, the indicated percentage change in house prices is obtained as the cumulative percentages of growth implied by the various drivers and subsequently multiplied by the value of the stock of *real house prices* to give the absolute value of the *change*. Each component of the indicated percentage change is given by multiplying the *growth* (percentage change) in the driving factor by its associated *elasticity* parameter.[22] The *growth* variables are measured over time (per year) and the elasticities are

[22] For more on this type of formulation using elasticities, see Box 5.1 on page 180.

dimensionless (dmnl). The result of multiplying the two gives a *dmnl/year* unit which, when multiplied by *real house prices*, gives the unit *GBP18/house/year* for *change in real house prices*, ensuring unit consistency.

An exception, in terms of formulation, among the four factors is the effect of *expected yield premium on housing as investment*, which is already measured over a year and is assumed directly proportional to *change in real house prices*, with a constant parameter determining the strength of the relationship. The *yield premium* is simply the difference between *expected housing ROI* (return on investment; see below) and a benchmark *average yield from British government securities* obtained from the Bank of England (2021a). The yield premium of housing investment over this benchmark is taken as a measure of the attractiveness of housing as an investment.

Expected housing ROI is given endogenously in the model based on the dynamics of *house prices* and *private rents* (Figure 5.3). The structure portrayed in Figure 5.3 captures the *Investment Loop* discussed in Chapter 3 (Section 3.5.1). Starting from *real house prices* and moving in a counterclockwise direction, *house prices* (in nominal terms) is obtained by multiplying the *real* value by the *GDP deflator*—a standard economic conversion. Subsequently, *expected house prices* is formulated using Vensim's FORECAST function,[23] which provides a trend extrapolation forecast of the future value of *house prices* based on past values. The equation is as follows:

---

[23] Syntax: FORECAST (input, average time, horizon). Returns a forecast of the value the input will take on at Time + Horizon.

expected house prices = FORECAST (house prices, forecasting average time, one year period) [3]

The *forecasting average time* is estimated via calibration to be equal to four years, which implies that investors, on average, consider the trends of price over the past four years when deciding whether to invest in housing. This is consistent with a number of economic studies that estimate the lagged 4 or 5 year rate of appreciation as a strong candidate for expectations as part of the user cost (Cameron, Muellbauer, & Murphy, 2006; Duca et al., 2011). Later in Chapter 6 (Section 6.1.3), I will run a sensitivity test to gauge the sensitivity of overall model behaviour to variations in this uncertain parameter.

Next, *expected price appreciation* is calculated by subtracting *house prices* from *expected house prices* and dividing it by a *one-year period* to obtain a unit-consistent expected change in price over a year. This expected gain, however, must be moderated by any potential tax on the windfall capital gains due to a rise in house prices. This is done by multiplying the difference by one minus any *capital gains tax as share of house price appreciation*, which is an exogenous policy variable to be determined by the user. This input is set to zero for past years but can be set to positive values for future years in order to simulate a potential *capital gains tax* policy on all residential property, aimed at dampening the reinforcing *Investment Loop*, as shown later in Chapter 7 (Section 7.3.1). Therefore, the equation for *expected price appreciation* is as follows:

expected price appreciation =
(expected house prices - house prices) * (1 - capital gains tax as share of house price appreciation) / one year period [4]

This *expected price appreciation* is only the capital gain component of return on housing investment. The other components include return from (imputed) rents[24] and associated costs. Major costs include interest payments and depreciation. Depreciation is excluded from the model for simplicity as it is not expected to majorly affect dynamic modes of behaviour. Therefore, average *housing investment costs* is obtained by dividing total *interest on mortgage debt* (imported from Sector 2. Mortgage Sector) by the *total housing stock* (imported from Sector 3. Construction Sector). For the first 20 years of simulation (1980–2000), This cost is moderated by the *mortgage interest tax relief multiplier*, representing this former policy. The effect from this tax relief is captured in a rough way, assuming that it provided a 10% reduction in *investment costs* initially, going up to 20% in 1983 and gradually reducing to zero from 1994 to 2000 when it was fully abolished (see Section 3.4.1.2).

Expected housing investment costs is an extrapolation of *housing investment costs* which is obtained in the same way as *expected house prices* (equation [3]). The equation for *expected housing ROI* is therefore as follows:

expected housing ROI =
(expected price appreciation + expected rents - expected housing investment costs) / expected house prices [5]

This formulation of rate of return on housing as an investment is in line with Muellbauer and Murphy (1997, p. 1703). They present a model which reveals that an extrapolation of recently experienced rates of return play an important part in driving demand in the housing market (Muellbauer & Murphy, 1997). Linking the resulting *expected housing ROI*

[24] This is either actual rent for private rented property, or 'imputed' rent in the case of owner-occupied property, in both cases proxied by *private rents* coming from the Tenure and Rent Sector.

to *expected yield premium on housing as investment* and subsequently to change in *real house prices* thus closes the reinforcing *Investment Loop*, considered to be a key driving force behind house price inflation (Gallent et al., 2017). Within the SD literature, this part of the model is broadly in line with Eskinasi (2014, p. 54) as well as Mukerji and Saeed (2011) who also model the 'self-fulfilling' characteristic of house price appreciation through the effect of 'expected price' on future changes in price. On the flip side, in the event of a fall in prices, this formulation can also capture a situation where the *expected yield premium* becoming negative and triggers a vicious cycle that simulates a 'fire-sale' situation (Shleifer & Vishny, 2011).

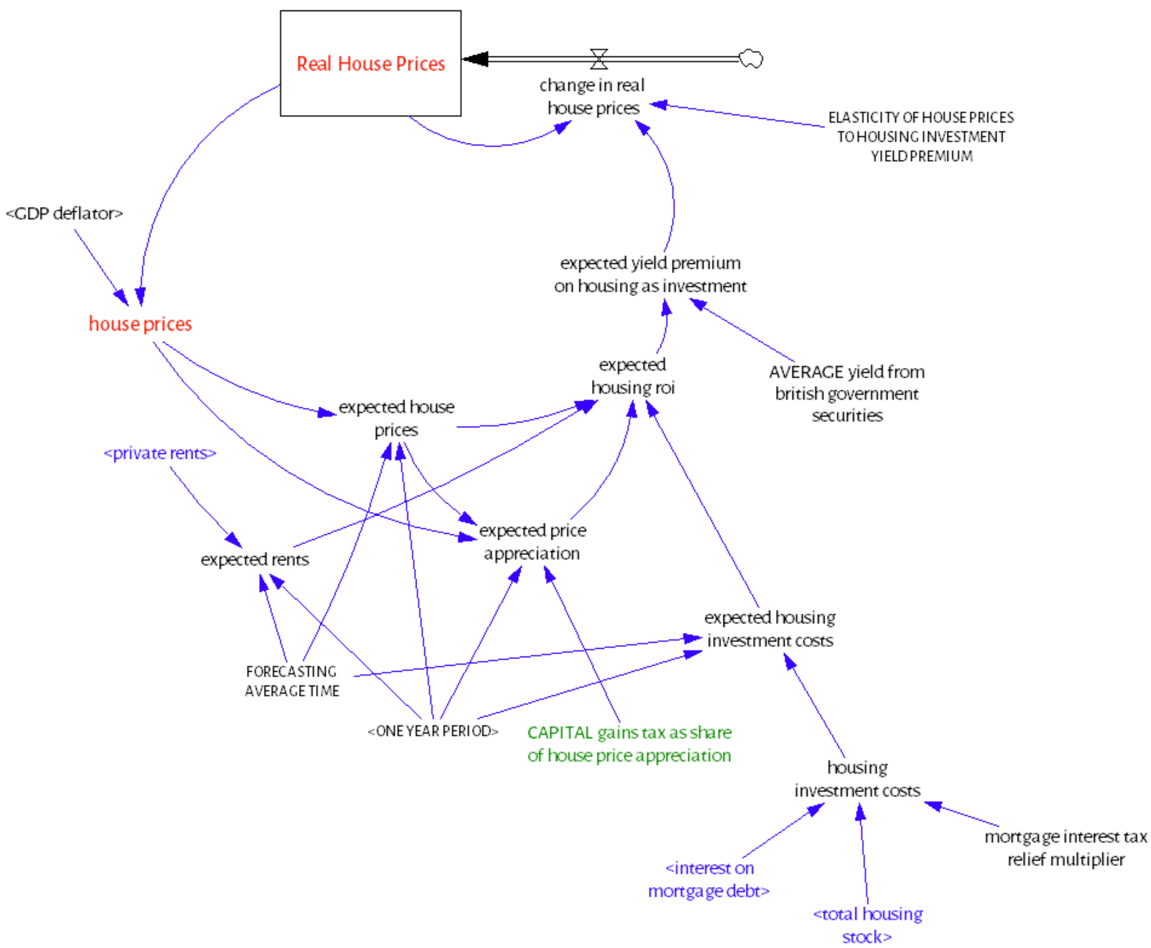

Figure 5.3 - Investment Loop

Finally, in this sector *average house price to income ratio* (not shown in the diagram) is also calculated as a key indicator by dividing *real house prices* by *real average disposable household* *income*. This latter variable, in turn, is obtained by dividing external data for *gross disposable household income* (GDHI) by *number of households*, both series obtained from the ONS (2020h, 2020b). *Average house price to income ratio* is used as an input to the Mortgage Sector, as we will see shortly.

5.2. Mortgage Sector

The Mortgage Sector captures the dynamics around the accumulation and depletion of private housing debt from an aggregate point of view. The model does not, for instance, distinguish among different types of lenders (e.g., commercial banks, building societies, etc.) or different types of borrowers (e.g., first-time buyers or home-movers). The aim is rather to capture, from a top-level whole-of-London point of view, past and likely future developments in mortgage lending and the burden of housing debt on households.

A key variable at the heart of this sector is the stock of *Mortgage Balances Outstanding* (Figure 5.4), which captures the accumulation of mortgage debt by London households. The dynamic behaviour of this stock is driven by an inflow of *new mortgage advances*,[25] another inflow of *interest on mortgage debt*, as well as an outflow of *mortgage repayments*.

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[25] It must be noted that what this model incorporates is only the inflow of *new mortgages*, and not *remortgages*. This is an important limitation for the model, as remortgages constitute an important chunk of total housing credit: in those years where data from UK Finance is available (2006–2016), remortgages amount up to on average about 40% of total mortgage lending (UK Finance, 2017). However, precisely because this data is only available since 2006, i.e., 26 years after my model's starting point, I was unable to include it in the model as a separate variable. Nonetheless, to a great extent, the same driving forces and consequences that apply to new mortgages apply to remortgages as well, which means that this

Starting with the inflows, *new mortgage advances* (in nominal terms) is given by *real new mortgage advances* multiplied by the *GDP deflator*. *Real new mortgage advances* is formulated as the product of the *number of new mortgage advances per year* multiplied by the *average real value of new mortgage advances*. This latter variable is obtained as the *effective average loan to value ratio for new lending* multiplied by *real house prices mortgage valuation*. This is normally just equal to *real house prices* (which is endogenously modelled in the House Prices Sector, as we saw previously), as property valuation for mortgage lending in the UK is based on the current market value of the property. However, an alternative to this method exists where property valuation for the purposes of mortgage lending is anchored to historical levels of prices—as is common in Germany and Switzerland for example—aiming to exert a countercyclical influence on the housing credit market (Tsatsaronis & Zhu, 2004). This alternative is built into the model here, so that in Chapter 7 (Section 7.3.3) we can investigate the consequences of implementing such a policy in the UK. Thus, after 2020, if the *historically anchored valuation switch* (policy variable in green) is set to 1, *real house prices mortgage valuation* will become a smoothed moving average of *real house prices*, with a *house price valuation smoothing time* of 5 years.[26] Otherwise *real house prices mortgage valuation* will remain equal to *real house prices*.

Effective average loan to value ratio for new lending is determined mainly by *average loan to value ratio for new lending* which is a data-driven variable in the past (ONS, 2020c) and a user-determined policy variable in the future. On this exogenous time-series, however, an adjustment is applied to reflect the effect of the Help to Buy scheme (see Section

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shortfall is not expected to drastically alter the model's dynamic modes of behaviour or our policy recommendations.

[26] Consequences of shortening or lengthening this time constant are looked at in Chapter 7.

3.4.1.3). This adjustment is implemented in the equation for *effective average loan to value ratio for new lending* in the following way, using an IF THEN ELSE function:[27]

effective average loan to value ratio for new lending = IF THEN ELSE (Time<2013, average loan to value ratio, proportion of total loans using HTB * (average loan to value ratio + help to buy upper loan limit) + (1-proportion of total loans using HTB) * average loan to value ratio) [6]

In other words, before 2013, when there was no Help to Buy (HTB) scheme, the equation simply returns the exogenous *average loan to value ratio*. Since 2013, when HTB starts, however, the equation calculates a weighted *average loan to value ratio*, using the exogenous *proportion of total loans using HTB* as the weight factor, and assuming a higher *average loan to value ratio* for the HTB loans. This average is assumed to be higher by the *help to buy upper loan limit*, which is 20% from 2013 until 2015 and raised up to 40% thereafter. This is to reflect the Equity Loan scheme, where the government lends a portion of the price of the new home to the lender (20% up to 2015, raised up to 40% after 2015 for London) (UK Government, 2021). The *proportion of total loans using HTB* is obtained by dividing the *number of help to buy equity loans* (MHCLG, 2021) by *number of new mortgage advances per year* in the model's accompanying Excel spreadsheet.

The formulation of the key variable *number of new mortgage advances per year* is somewhat more extensive and will be explained in a separate sub-section.

[27] Syntax: IF THEN ELSE (cond, tval, fval). Returns first value (tval) if condition (cond) is true; second value (fval) if condition is false.

The second inflow to the stock of *mortgage balances outstanding*, i.e., *interest on mortgage debt,* is the product of the outstanding debt multiplied by *average mortgage interest rate*, an exogenous data series from the Building Societies Association (BSA, 2020).

As for the stock's only outflow of *mortgage repayments*, at a micro level (the level of an individual loan), repayments might be calculated at the outset and stay constant over the whole term of the loan. At a macro level (all London loans aggregated), however, *mortgage repayments* must increase when the stock of *mortgage balances outstanding* is larger, and vice versa. Time-continuous *mortgage repayments* is given by the following formula (Beckwith, 1968):

$$M_a = P_0 \cdot \frac{r}{1 - e^{-rT}}$$

Where M_a is the amount of repayments over a year (equivalent to the *mortgage repayments* outflow), P_0 is the loan principal (equivalent to the *mortgage balances outstanding* stock), r is the annual interest rate (the *average mortgage interest rate* variable), and T is the total loan period in years (the *average mortgage period of outstanding mortgages* variable). The intermediate variable *monthly mortgage repayment coefficient* calculates the second component in the above equation which, when multiplied by the stock of *mortgage balances outstanding*, gives the outflow.

As this is an aggregate model which pools together all mortgages, the *average mortgage period of outstanding mortgages* is not the same as the current *average mortgage period for new mortgages* since the former depends on the specifications of all past loans since the beginning of the simulation. Therefore, in order to capture this dynamic, I have used a parallel 'coflow' structure (Sterman, 2000, pp. 497–503) to calculate the *average mortgage period of outstanding mortgages*, as illustrated in Figure 5.5. Coflow structures are used to keep track of dynamic attributes of stock variables over time.

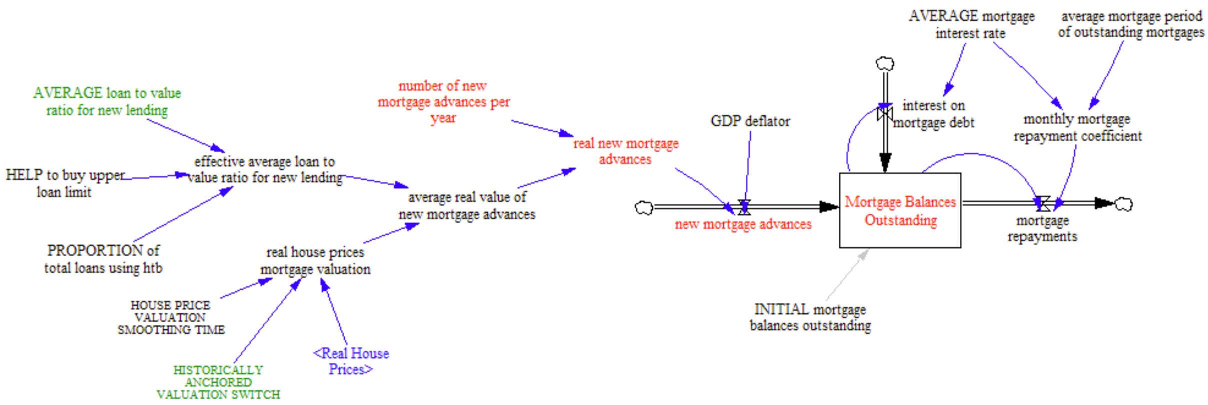

Figure 5.4 – New mortgage advances *and* mortgage balances outstanding

In the structure shown below, as *new mortgage advances* flow into the stock of *mortgage balances outstanding*, the *average mortgage period for new mortgages* is collected in a separate stock (*aggregate mortgage periods*). The inflow to this stock equals the inflow to the original stock, *new mortgage advances*, multiplied by the *average mortgage period for new mortgages*. Dividing this aggregate accumulated level by the value of the original stock of *mortgage balances outstanding* gives the ongoing *average mortgage period of outstanding mortgages*. Subsequently, under an assumption of perfect mixing[28] in the stock of *mortgage balances outstanding*, the outflow is formulated as the *average mortgage period of outstanding mortgages* multiplied by the outflow of the original stock, i.e., *mortgage repayments*. Thus, this piece of structure allows us to approximate the *average mortgage period of outstanding mortgages* that is needed for formulating *mortgage repayments* (as seen earlier).

[28] 'Perfect mixing means the order of entry is irrelevant to the order of exit. Put another way, perfect mixing destroys all information about the order of entry' (Sterman, 2000, p. 416).

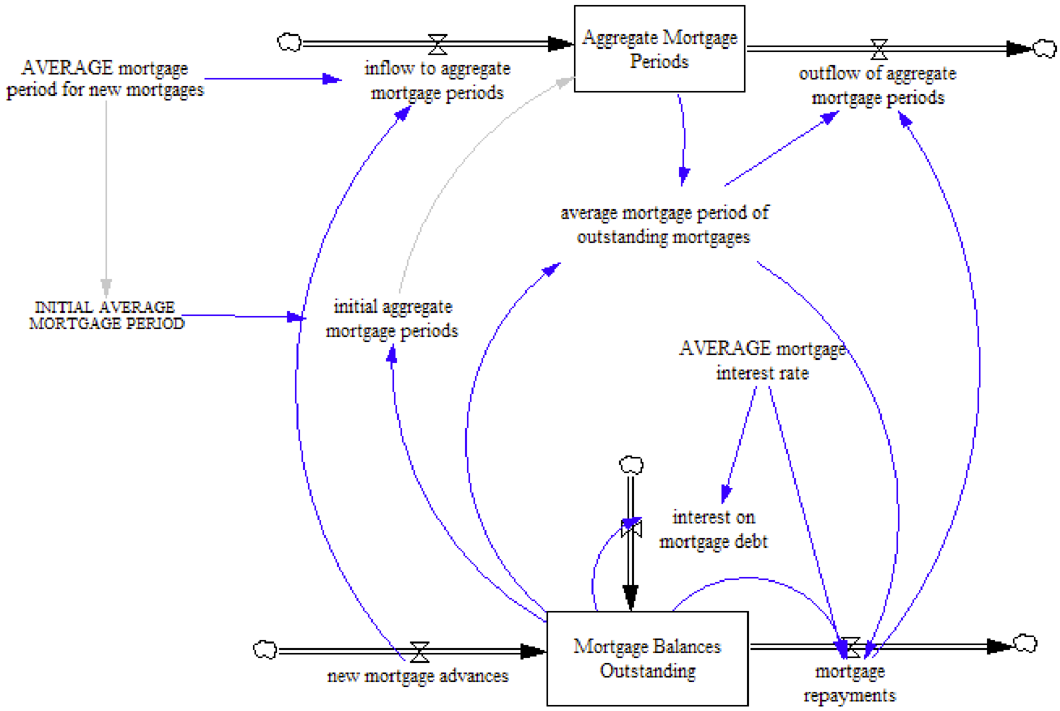

Figure 5.5 – Coflow structure: average mortgage period of outstanding mortgages

Number of New Mortgage Advances

A central variable in the Mortgage Sector, and one of the most challenging to model, is the *number of new mortgage advances per year*. This variable is assumed to be driven by the following factors:

- Average mortgage interest rate
- Average deposit to income ratio
- Total private housing wealth
- Leverage
- Debt service ratio

The relationship is captured using an elasticity formulation as follows:

number of new mortgage advances per year =
initial number of new mortgage advances per year
* relative average mortgage interest rate ^ elasticity of advances to interest rate
* relative average deposit to income ratio ^ elasticity of advances to deposit to income ratio
* relative total real private housing wealth ^ elasticity of advances to housing wealth
* lagged relative leverage ^ elasticity of advances to leverage
* lagged relative debt service ratio ^ elasticity of advances to DSR [7]

Each factor is incorporated after being normalised first (*relative* to its *initial* value at the beginning of simulation) and then raised to the power of its respective *elasticity* parameter, which is obtained via calibration. In the case of *debt service ratio* and *leverage*, as will be explained later, the normalised values are also *lagged* by significant time delays as their balancing (counter-acting) effects could take years to feed back and affect the issuance of new mortgages. Note that although the other effects are also likely to involve shorter delays, in order not to over-complicate and over-parametrise the model, and since the focus of this model is capturing the behaviour of the system over the very long run, these shorter delay effects are ignored.

Box 5.1. Using power functions for formulating non-linear causal relationships

The types of equation seen in equations [2] (*real house prices*) and [7] (*number of new mortgage advances per year*) are often used in this model. I have written this brief guide for those unfamiliar with these types of equations. These are two different forms of a *power function* whose generic mathematical expression is as follows:

$$y = f(x_1, x_2, \dots, x_n) = y_0 \cdot (\frac{x_1}{x_{1,0}})^{\varepsilon_1} \cdot (\frac{x_2}{x_{2,0}})^{\varepsilon_2} \cdot \dots \cdot (\frac{x_n}{x_{n,0}})^{\varepsilon_n} \quad [8]$$

In this generic form y is the dependent variable and $x_1, x_2, \dots, x_n$ are the independent variables. y_0 is the initial state of y and $x_{1,0}, x_{2,0}, \dots, x_{n,0}$ are the initial states of $x_1, x_2, \dots, x_n$. Furthermore, $\varepsilon_1, \varepsilon_2, \dots, \varepsilon_n$ are the elasticities of the dependent variable to each of the independent variables. *Elasticity* is defined as the relative change of the dependent variable divided by the relative change of the independent variable. Formally, the elasticity of $y = f(x_1, x_2, \dots, x_n)$ with regards to x_i $(i = 1, 2, \dots, n)$ is

$$\varepsilon_{y,x_i} = \varepsilon_i = \frac{\frac{dy}{y}}{\frac{dx_i}{x_i}} = \frac{dy}{dx_i} \cdot \frac{x_i}{y} \quad [9]$$

Note that, since we are operating in the realm of real numbers and the elasticities that we use are fractional numbers, the base arguments in the power function (i.e., the $(\frac{x_i}{x_{i,0}})$ components in equation [8]) cannot be negative. Therefore, in cases where some of the driving factors can indeed go negative (such as for instance *expected yield premium on housing as investment* which drives *real house prices* as we saw earlier), I have modelled the dependent variable as a stock whose net flow is driven by the independent variables $(x_1, x_2, \dots, x_n)$. In such cases, the derivative form of equation [8] is used instead to formulate the net flow (net change) in the stock. In equation [8], if we differentiate y with regards to time (t) and subsequently factorise y using equation [9], the equation for formulating the rate of change in the dependent variable is given as follows:

$$\frac{dy}{dt} = \frac{\partial y}{\partial x_1} \cdot \frac{\partial x_1}{\partial t} + \frac{\partial y}{\partial x_2} \cdot \frac{\partial x_2}{\partial t} + \cdots + \frac{\partial y}{\partial x_n} \cdot \frac{\partial x_n}{\partial t}$$

$$= y \cdot \left(\varepsilon_1 \cdot \frac{\frac{\partial x_1}{\partial t}}{x_1} + \varepsilon_2 \cdot \frac{\frac{\partial x_2}{\partial t}}{x_2} + \cdots + \varepsilon_n \cdot \frac{\frac{\partial x_n}{\partial t}}{x_n}\right) \qquad [10]$$

Once again, y is the dependent variable modelled as a stock (e.g., *real house prices*), and the equation above gives the formula for the net flow of the stock variable (e.g., *change in real house prices*). By differentiating, the multiplicative equation [8] is converted into the additive equation [9]. Each component of the additive phrase between parentheses ($\frac{\frac{\partial x_i}{\partial t}}{x_i}$) is the *fractional growth rate* of an independent variable over time (as obtained using the TREND function in Vensim), multiplied by the respective elasticity ε_i.

The reason the above types of formulation are thought to be good mathematical representations for many of the non-linear cause-and-effect relationships in the model is because we are interested in how—starting from a known initial state of the system—*changes* in each of the driving factors will lead to *changes* in the variable of interest. Such formulations will make percentage changes in the dependent variable constantly proportional to percentage changes in the driving factor(s), with the proportion being determined by the elasticities.

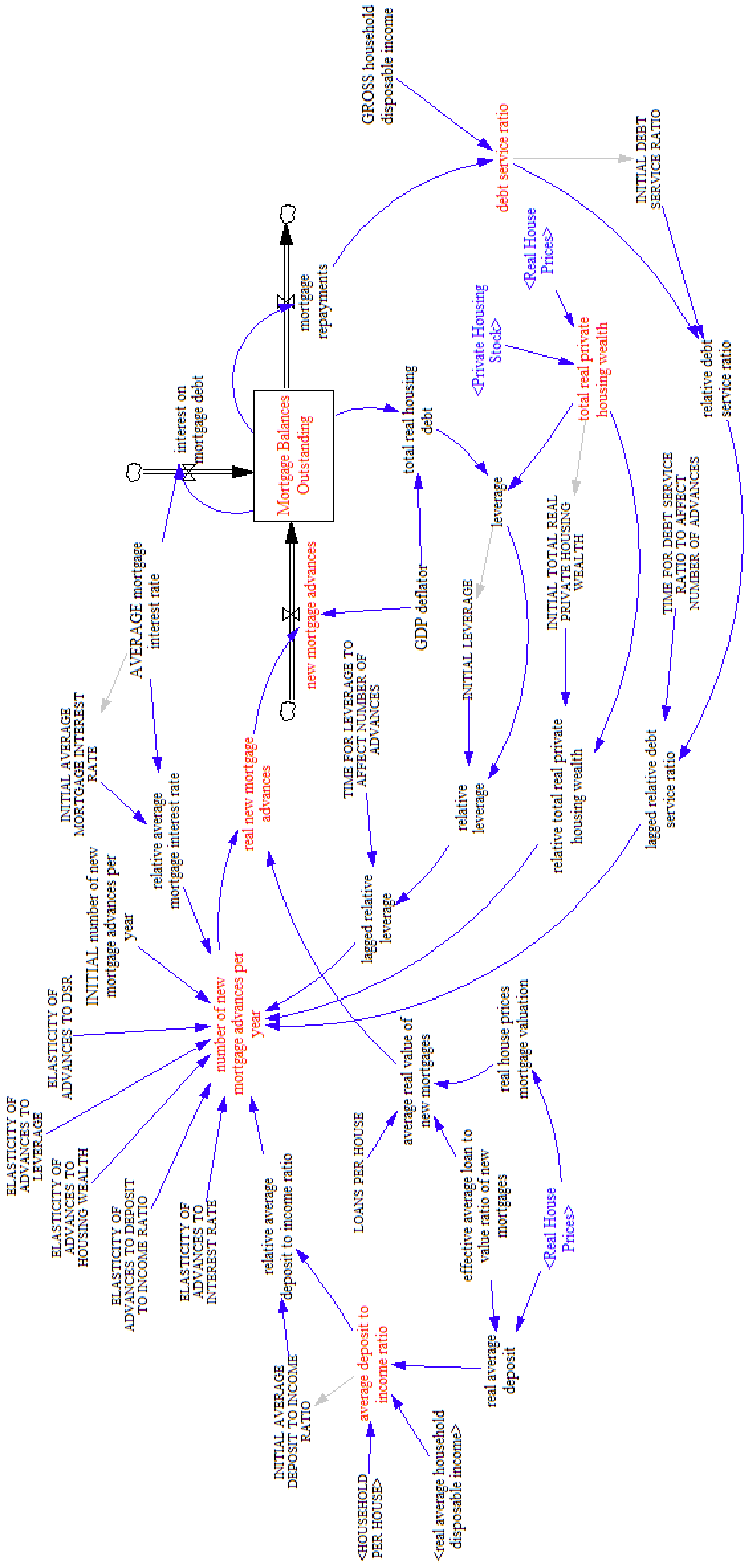

Figure 5.6 – Number of new mortgage advances per year

Starting with the first effect, that of *average mortgage interest rate*, the assumption is that the higher the interest rates asked for new mortgages, the lower the demand (Arestis & González, 2014; Meen, 1990). DeFusco and Paciorek (2017) estimate, based on data on over 2.7 million mortgages in the US market, that total new mortgage debt decreases between 1.5 and 2 percent per percentage point increase in the interest rate. A more recent study in the context of Mexico finds that credit demand is elastic with respect to changes in credit price and that the elasticity increases from -1.1 in Year one to -2.9 in Year three (Karlan & Zinman, 2019). In the case of our model, calibration gives a value of -0.85 for the *elasticity of advances to interest rate*, which is not far from the Year one effect found by Karlan and Zinman (2019). Once again, it must be stressed that while econometric studies do attempt to control for changes in other possible drivers when estimating the elasticity to a particular factor, they do not however capture the feedback loops, such as the *Housing-Finance* reinforcing loop (see Section 3.5.1) (which could be responsible for the impact of a change in interest rates growing over time, as found by Karlan and Zinman (2019)).

The second effect from *average deposit to income ratio* is another key factor affecting new housing credit, which lies at the intersection between credit supply and demand. It is related to supply as it depends on the *average loan to value ratio* offered in the market, and it is related to demand because it is in fact a measure of the affordability of the loan's down payment, particularly important for first-time buyers. This ratio, which was for the most part hovering around 1 from 1980 to 2000, has risen steeply to close to 3 in London since 2010.[29] The value of the respective *elasticity* obtained via calibration is -0.6,

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[29] Calculated based on loan to value ratio and house price data from the ONS (2020c).—Perhaps this would help explain the lower *elasticity of house prices to disposable household income* in London (see Section 5.1).

meaning that a 10% increase in *average deposit to income ratio* would, *ceteris paribus*, lead to a 6% decrease in the *number of new mortgage advances per year*.

The third effect involves *total real private housing wealth*, which is obtained as the product of multiplying the total *private housing stock* (imported from the Construction Sector) by *real house prices* (imported from the House Prices Sector). The assumption here is that as *housing wealth* increases, (either via new residential properties being completed or as a result of an increase in house prices), this can serve as additional collateral to raise more mortgage loans (e.g., for buying second homes or upsizing to a larger home) (Cloyne, Huber, Ilzetzki, & Kleven, 2019; Tsatsaronis & Zhu, 2004). This link establishes another way in which an increase in *house prices* leads to an increase in mortgage lending (with the other way operating directly from *real house prices* to *average real value of new mortgages*, as seen previously), and therefore another way in which the important reinforcing *Housing-Finance* feedback loop operates. The *elasticity of advances to housing wealth* is estimated at 0.2 via calibration, which is in line with the findings of Cloyne *et al.* (2019), although what they estimate is the elasticity of borrowing with respect to house prices (and not housing wealth), which according to their findings lies in the 0.2-0.3 range.

The fourth and fifth effect are effects from *leverage* and *debt service ratio*, two important lead indicators of stability in the financial sector and in the overall economy. Leverage has for many years been a central variable for economists in explaining macro-financial linkages (Juselius & Drehmann, 2020). This view goes back to Irving Fisher's (1933) debt-deflation theory following the Great Depression, which gives centre stage to the over-accumulation of debt and excessive leverage in bringing about financial and economic crises characterised by debt liquidation, distress selling of assets, bankruptcies and recession. Fisher, who criticised general equilibrium models in economics, maintaining for instance that '[i]t is as absurd to assume that, for any long period of time, the variables in the economic organization, or any part of them, will "stay put," in perfect equilibrium, as to assume that the Atlantic Ocean can ever be without a wave (Fisher, 1933, p. 339),' believed that developments in the financial sector, such as growing debt burdens, are not only consequences of a declining economy, but are themselves a major driver of economic downturn (Fisher, 1933; Iacoviello, 2005).

Decades later, the highly cited credit cycles theory of Kiyotaki and Moore (1997) explains how in a system where borrowers' credit limits are determined by collateral asset prices, and at the same time these prices are driven by the flow of new credit—as is the case in the housing system—the dynamic interaction between credit limits and asset prices becomes a powerful mechanism through which the effects of any external shock can persist, amplify, and spread out throughout the economy. Built on this theoretical work, Iacolviello (2005) develops a monetary business cycle (general equilibrium) model with loans and collateral constraints dependent on house prices and observes that the model is successful in replicating some key properties of the data reflecting real house price fluctuations in the US between 1974 and 2003. More recently, Mian and Sufi (2010) show, based on data from US counties between 2002 and 2009, that household leverage is an early and powerful predictor of economic recession and suggest that in order to better understand macroeconomic fluctuations, focus should be directed to household indebtedness and leverage.

Drehmann *et al.* (2012; 2017) and Juselius and Drehmann (2020), however, in a series of papers demonstrate that, in addition to leverage, *debt service ratio (DSR)* is an important indicator that mediates the relationship between housing debt and the real economy. The DSR is defined as the ratio of mortgage repayments (interest plus principal amortisations) to income. They suggest that this is a more useful measure than credit-to-income or interest payment-to-income ratios and gives a more comprehensive assessment (Drehmann & Juselius, 2012). Drehmann *et al.* (2017) argue that 'keeping track of debt service explains why credit-related expansions are systematically followed by downturns several years later' (Drehmann et al., 2017, p. 2). In their most recent work, Juselius and Drehmann (2020) show how the interaction between DSR and leverage can generate cyclical dynamics and explain macroeconomic developments during credit boom-bust cycles.

Based on this body of literature, two balancing feedback effects from *leverage* and *debt service* ratio are built into the model which feed back to drive *number of new mortgage advances per year*. As shown in Figure 5.6, *leverage* is formulated as *real housing debt* divided by *total real private housing wealth*. *Debt service ratio* is formulated by dividing the *mortgage repayments* outflow by *gross disposable household income*. Both are first normalised using initial (1980) values as with other driving factors. What sets these two effects apart from the other drivers of *number of mortgage advances*, is that they involve long time lags of several years in each case, as these effects travel through the real economy and via a number of macroeconomic variables such as consumption, consumer confidence, savings, investment and growth (Drehmann & Juselius, 2012). Thus, the two normalised variables are then *lagged* using a third-order SMOOTH function and time constants of 4.5 years for *leverage* and 7.5 years for *debt service ratio*, which are determined via calibrating the model to existing data on mortgage lending and house prices. Ideally, the intermediate effects engendering such long delays (via variables such as consumption, consumer confidence, savings, bank capital, and so forth) should have been made explicit, but including these wider macroeconomic aspects endogenously is beyond the scope of this thesis.

A couple of additional indicators (not shown in the diagrams) are calculated in this sector to be used later in the Tenure and Rent Sector for formulating average housing costs for households. These two indicators are *proportion of private housing owned outright* and *average real mortgage repayments*. The *proportion of private housing owned outright* is driven endogenously by changes to the ratio of *net real private housing wealth* (*total real* *private housing wealth* minus *real housing debt*) to *total real private housing wealth*, i.e., the proportion of housing wealth that is net of any outstanding debt. This ratio is normalised relative to its initial value and multiplied by the *initial proportion of private housing owned outright* to give a dynamic and endogenous *proportion of private housing owned outright*, which will be used to calculate *average real mortgage payments*. The *initial* value used to initialise this *proportion* is estimated based on data available from the GLA's Housing in London Tables (GLA, 2020a) on the annual trend in household tenure in London, according to which the share of households owning their dwelling outright was 19.23% in 1981. This is expressed as a percentage of all households while for our purpose we need to obtain it as a ratio of privately-owned houses. A couple of arithmetic operations using the estimated data available for total number of households and total private dwellings in 1980 gives an estimate of 27.8% for the *initial proportion of private housing owned outright*.

Once the *proportion of private housing owned outright* is obtained, one minus this proportion, i.e., the proportion of mortgaged housing, is then multiplied by the total *private housing stock* to give the *total number of mortgaged housing*. Dividing *total real mortgage payments* (the inflation-adjusted outflow of the stock of debt) by the *total number of mortgaged housing* gives *average real mortgage repayments* for every mortgaged household. This output is used later in the Tenure and Rent Sector to calculate *average housing costs* for all non-outright owner households based on their respective tenure shares and housing costs.

5.3. Construction Sector

This sector contains the basic physical stock and flow structure of housing provision. It consists mainly of three parallel and similar structures for private market housing, local authority housing and housing built by housing associations (Figure 5.7). The focus of this model is on the first stream that captures private housing provision. Nevertheless, since the construction of non-market housing can affect the market system, the local authority and housing association streams are included as exogenously driven inputs, with non-market housing construction foreseen as a key policy lever on the supply side of housing.

As shown in Figure 5.7, each parallel stream starts with a flow of *construction starts* going into an *under construction* stock. Over time, *under construction* units of housing flow out through *construction completion* to the *housing stock*. *Construction completion* is formulated using a first-order delay with a constant time lag, *time to completion*, which is estimated to be 1.5 years. Although conceptually construction constitutes a higher order delay where the order of entry into the stock matters in determining the order of exit (as opposed to a first-order delay which destroys all information about the order of entry (Sterman, 2000, p. 416)), this is nevertheless considered a workable simplification as our focus is on long-term dynamics in this model. As shown in Figure 5.8, this approximation captures real data closely (R^2= 0.71, root mean square percentage error (RMSPE)=18%) when you let *private construction starts* be driven by exogenous data, as a structure-oriented behaviour test (Barlas, 1996). The assumption is also in line with that which Barlas *et al.* (2007) use in their SD model, albeit in the different context of the Istanbul housing market.

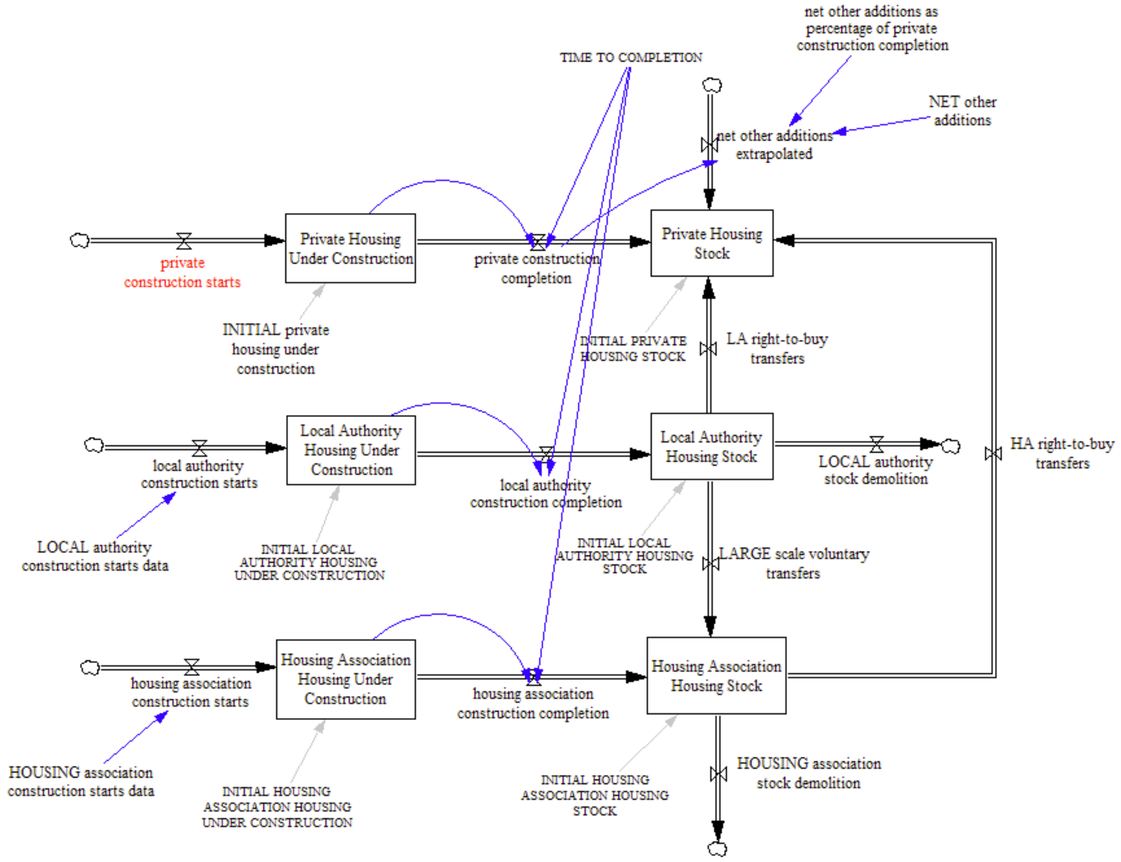

Figure 5.7 – Construction Sector: Physical Stocks and Flows

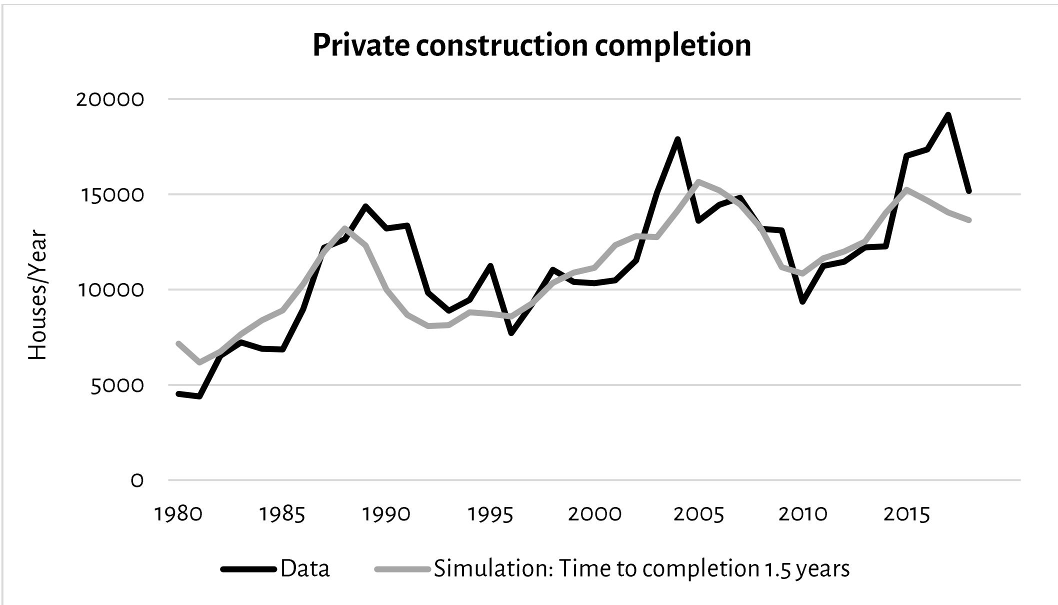

Figure 5.8 – Private construction completion *with exogenous* private construction starts *and* time to completion = *1.5 years*

Besides the endogenous *private construction completion*, there are three additional exogenous inflows to the private housing stock: two *Right to Buy transfer* flows from the local authority and housing association stocks, as well as *net other additions*. This latter flow is driven by external data for *net additional dwellings* from MHCLG's Table 118 (MHCLG, 2020c) minus *private dwellings completed* from Table 253 (MHCLG, 2020b), capturing the part of *net additional dwellings* which is not explained by the existing *private construction completion*, consisting of net conversions, net change of use, and net other gains minus demolitions (which is why we have not included a separate demolitions outflow for the private sector as we have for the other two types of housing, to avoid double counting). For years where data is available (2000–2018) *net other additions* is directly driven by data. For years before and after the 2000–2018 period, a linear trendline is fitted to calculated data for *net other additions as percentage of construction completions* and *net other additions extrapolated* is pegged to the endogenously generated *private construction completion*.[30]

Private construction starts should not, however, remain exogenous in the model, as it is a major determinant of housing supply and the key variable of interest in this sector of the

[30] It is worth noting that, based on the *Guide to MHCLG Housing Statistics* (MHCLG, n.d.), the Ministry's 'Housing Supply' series on net additional dwellings as presented in Table 118 is the primary and most comprehensive measure of housing supply provided by local authorities, and is the Ministry's recommended source for data on housing supply. However, this data only goes back to 2000, is not broken down by tenure, and does not include corresponding data for construction starts. Therefore, I have used data from Table 253 which only covers new build and is based on building control data (e.g., completion certificates). This has meant that I have had to separately include an estimate for *net other additions*, which is often quite significant compared to *completions*, pegging it to *completions* and using the rough linear extrapolation described above.

model. Hence, in the next step, I attempt to make this variable endogenous based on its drivers.

Private construction starts is determined primarily by the stock variable *indicated level of private construction starts*, as shown in Figure 5.9. Although *indicated level of private construction starts* can be conceptually considered a rate variable, it is modelled as a stock variable here because, as we will see, based on the literature, the sensitivity of changes in housebuilding to negative and positive changes in house prices is different, and the following stock formulation makes it possible to use different elasticities for positive and negative house price changes.

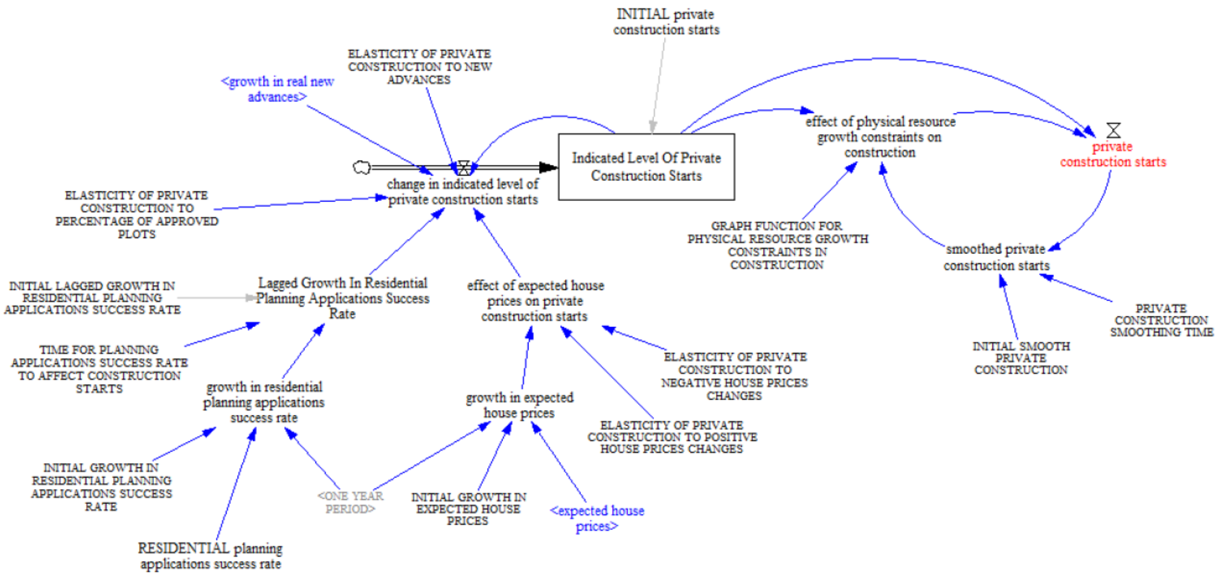

Figure 5.9 – Indicated level of private construction starts

As modelled here, changes in the *indicated level of private construction starts* are governed by changes in three factors: *new mortgage advances*, *expected house prices*, and *residential planning applications success rate*. I must add that in the course of building and calibrating this model, several other potential driving factors were tentatively included, tested, and eventually dismissed for not contributing, or contributing only marginally, to the explanation of the behaviour of *private construction starts* in London since 1980. Some of these factors which were excluded after extended periods of testing and contemplation include interest rates, land values and the number of construction firms. Before focusing on drivers included in the model, let us first take a brief look at these excluded factors.

Regarding a potential effect from *interest rates* for example, Figure 5.10 depicts historical data for *private construction starts* (MHCLG, 2020b) versus the Bank of England's *base rate* (Bank of England, 2021b) (secondary axis on the right-hand side). As can be seen, the two variables do not show a significant correlation,[31] which does not seem to justify the inclusion of *interest rate* as a key driver of *private construction starts*. If you argue for instance, that a fall in *interest rates* was an important factor in the boom in construction during the 1980s—although you might be correct within that particular timeframe— the same relationship does not hold in the 1990s and in the 2000s, where we have similar or steeper lowering of *interest rates* while *private construction starts* are falling as well. Numerous tests where I included *interest rates* together with other factors ruled out the possibility of other inhibiting factors strong enough to reverse such effect. Automated calibration of the model consistently returned values close to zero for the elasticity of *private construction* to Bank of England's *base rate*, and I therefore excluded it from the drivers of *private construction starts*. Theoretically, a central bank lowers interest rates when the economy is doing badly and, therefore, it may not be completely counter-intuitive to see *private construction starts* falling at the same time as *interest rates*. It is important to note that the significance of driving factors depends both on the context and the chosen timeframe. There might well be other geographic contexts or timeframes, even subsets of our timeframe, where interest rate would turn out to be a key driver of construction.

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[31] The coefficient of determination R^2 is equal to a modest 0.29.

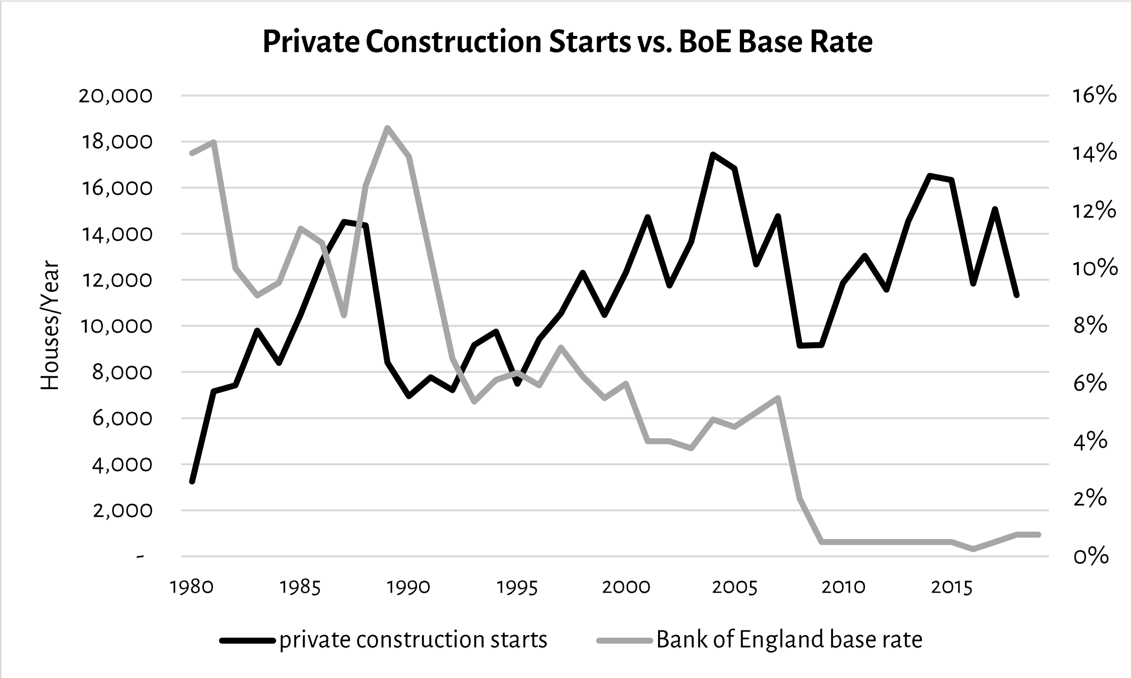

Figure 5.10 – Private construction starts *(left axis) versus Bank of England's base rate (right axis)*

Concerning the two other potential factors mentioned above, namely *number of construction firms* and *land values*, it is worth mentioning that for a long period during the model building phase, my model did include two separate sectors for these two notions as drivers of private construction. However, extensive testing and calibration revealed that the inclusion of these two factors was not very useful either, especially compared to the effort required for their endogenization (i.e., inclusion as endogenously driven variables), and therefore those two tentative sectors were eventually removed from the model. For *number of construction firms* for example, calibration revealed that its explanatory power for private construction does not appear to be significant enough to justify its inclusion, particularly because it would have needed to be made endogenous to be useful, with difficult questions regarding the direction of causality (from *number of firms* to *construction*, vice versa, or both ways). It is also worth noting that the recent Letwin review (Letwin, 2018) concludes that the diversity of housing units on offer is an important determinant of market absorption rate and therefore of build-out rate. This is linked to the notion of competition in the housebuilding market. These inter-linked notions are not part of the current model.

Box 5.2. The reasoning behind the decision to exclude land values from the model

Concerning land values, excluding this concept from the model was perhaps the most difficult decision among all excluded factors because land plays such a key role in the housing domain (see Ryan-Collins *et al.* 2017). There are a few reasons why one might assume that higher land prices would hinder residential construction. For example, more expensive land makes it less affordable for housebuilders, especially small and medium-sized (SME) builders, to acquire land for building, reducing competition and therefore residential construction (Aubrey, 2015). Also, *ceteris paribus*, assuming house prices stay constant, a rise in land prices as the main cost in housebuilding would reduce the profit and disincentivise housebuilding. Furthermore, rising land prices increase the incentive for further holding on to land as an asset, rather than building on it (Murray, 2020).

However, looking at the available data for the two variables does not seem to support such a relationship. If we plot year on year growth in available data for *private construction starts* and *real land prices* over time (Figure 5.11), we will see that in fact they seem to move in phase with each other in terms of long-run cyclicality and they show a positive, rather than a negative, correlation (with a correlation coefficient of 0.36). The data on land values consists mainly of a series compiled by the MHCLG in Table 563 (MHCLG, 2016b) based on the Property Market Report series (VOA, 2011) from the Valuation Office Agency (VOA) until 2010 (when the series was discontinued). Since 2010, due to the discontinuation of the VOA's regular land value series, a gap has emerged in data on residential land values (IPF, 2018). I have manually extended the VOA's discontinued series until 2019 using a residential land value index series available from Savills real estate company (Savills, 2019). The data for *private construction starts*, as mentioned before, comes from the government (MHCLG, 2020b).

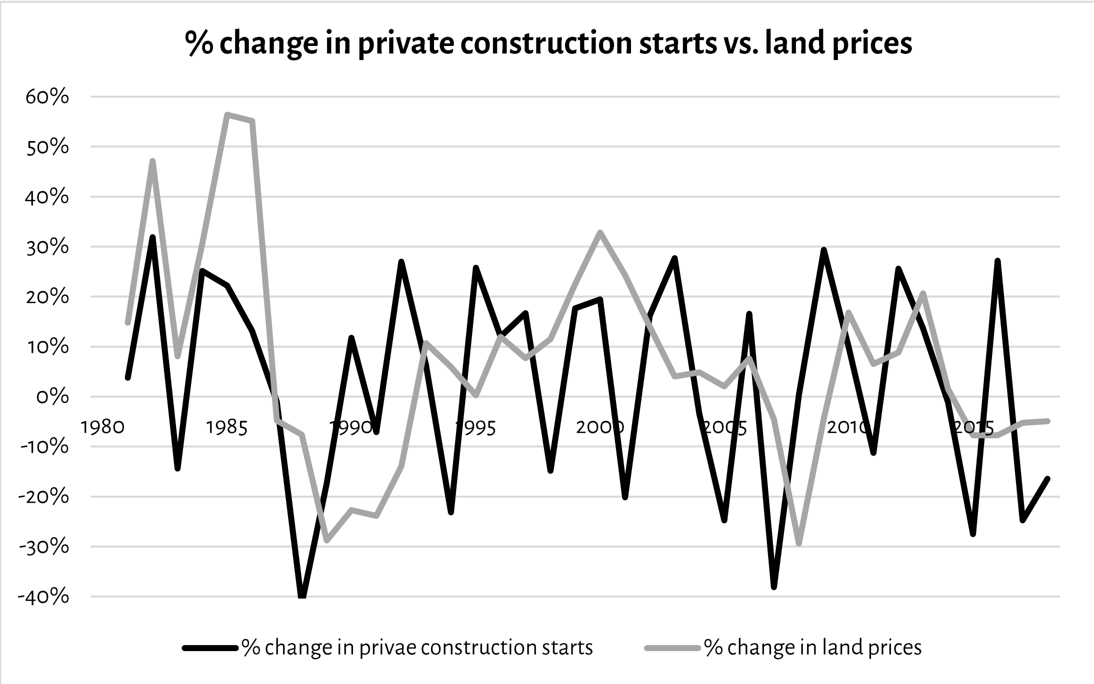

Figure 5.11 – Year on year change in private construction starts *and* real land prices

In light of the above reasoning, the same-direction relationship between the two variables pictured in Figure 5.11 is puzzling. It must, however, be noted that available data for land prices is not primary transaction-based data but derived values. Transaction-based land price data is rare for various reasons: the data is commercially sensitive information, transactions are not very many, and different sites are hardly comparable (IPF, 2018). Therefore, in existing data, land values are derived based on residual valuation (see Section 2.5.1). The residual method entails that minor changes in the estimated development value or costs can lead to large errors in the final residual value (Murphy, 2020). The substantial delays of several years involved in planning and construction adds an additional artefact to such derived data. These caveats have resulted in different valuation methods yielding significantly different results (IPF, 2018), which makes available data for land values difficult to rely on.

Having in mind the substantial uncertainty around existing data on land values and that its correlation with *private construction starts* appears to run against what I have learned through the literature, I decided against including it as a separate variable in my model. Although this does constitute a shortcoming for an integrated housing model, I do not believe it is major because, after all, development values, i.e., *house prices*—which is a central variable in my model—is expected to reflect major long-term trends in land values to a good extent, given that the other component of house prices, development costs, broadly follows the relatively stable trend in the retail price index (IPF, 2018; Meikle, 2001). Therefore, over the long term, developments in house prices can be considered a good proxy for those of land prices. Nevertheless, the long-term dynamics of land prices in London seem to be to a large extent unknown and under-researched and present a fruitful area for further research.

With excluded factors out of the way, we now turn to those drivers included in the final model. Let us start from the exogenous effect from the *residential planning applications success rate*. As discussed in Chapter 2 (Section 2.3), it is widely believed that inflexibility and restrictiveness of the planning system present a hindrance in the provision of new build housing. Although such hindrance may take various forms, such as introducing delays, complexity and uncertainty in the development process, as a quantitative proxy for planning restrictiveness, I have chosen the annual success rate of residential planning applications, a widely used metric for planning restrictiveness (Cheshire & Sheppard, 1997; Hilber & Vermeulen, 2016). Some commentators raise concerns over the use of this indicator due to a potential issue of endogeneity: in times of housing booms, we might observe a higher number of overly ambitious or non-conforming applications submitted, which lowers the success rate (Bramley & Watkins, 2014; Hilber & Vermeulen, 2016). Nevertheless, this is the most readily and consistently available quantitative measure of (non-)restrictiveness over the timeframe of our model, which makes it our preferred measure. Thus, it is assumed that *growth* (changes) *in residential planning applications success rate* drives *change in indicated level of private construction starts*. This effect involves a time lag, *time for planning applications success rate to affect construction starts*. Calibration gives a value of 2 years for this time constant, and a value of 3 for the *elasticity of private construction to planning applications success rate*, indicating a strong effect, and implying that relatively small changes in the *success rate* could lead to substantial changes in *private construction starts*.

The second effect goes from *new mortgage advances* to *private construction starts*. The effect of mortgage availability on residential investment and housebuilding appears to have been an important topic of interest in the past, although this interest seems to have later faded in the literature. Thom (1985) and McGarvey and Meador (1991) both present useful accounts of the debate around this topic. Several studies in the US context support a strong relationship between mortgage credit availability and construction starts (Dokko et al., 1990; Jaffee et al., 1979; Thom, 1985). This is not surprising given that mortgage availability provides indirect cash flow from lenders through borrowers to developers, often allowing the latter to sell proposed developments before completion, positively affecting the confidence of the housebuilding industry in being able to later sell the housing units that they start to build (Sprigings, 2008). The observed correlation (correlation coefficient=0.74) between the two variables in the context of London lends support to the likelihood of the existence of such relationship (Figure 5.12.) Although in the UK context, old studies find a weaker elasticity of construction starts to the flow of funds (Thom, 1984), with Whitehead (Whitehead, 1974, p. 137 cited in Thom, 1984) for example reporting an elasticity of 0.12, our calibration for London data (1980–2020) gives a high impact with an elasticity of 0.85. This is, however, not completely unexpected as the financialisation of housing in the UK, with London as its epicentre, had not taken place at the time (i.e., in 1974).

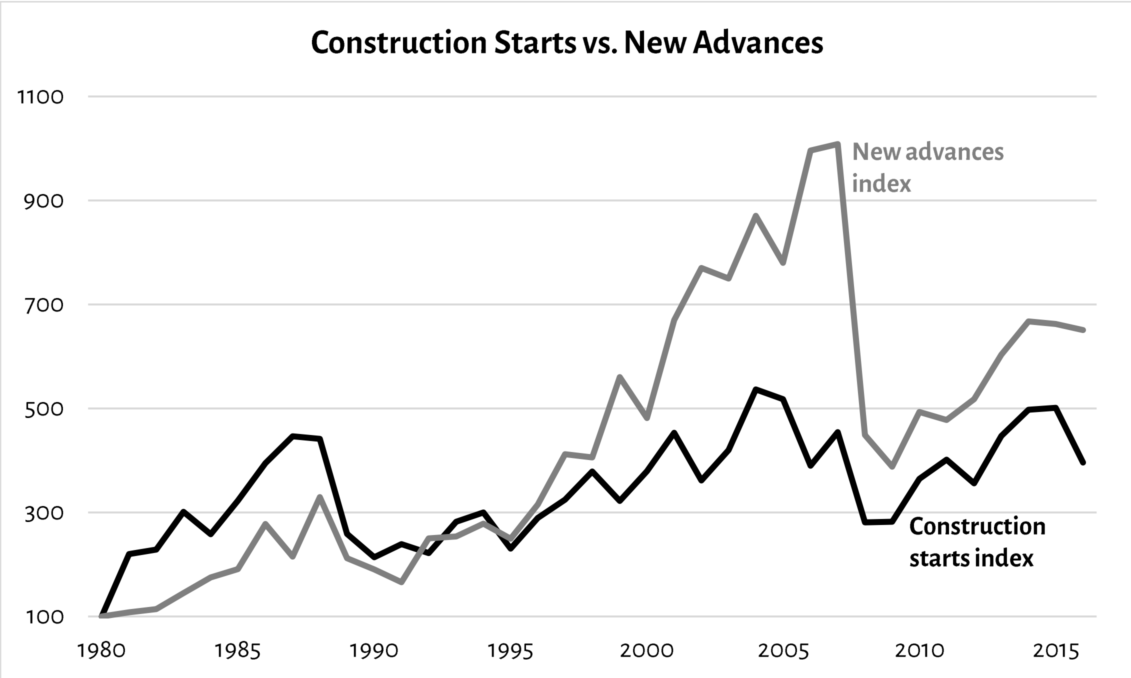

Figure 5.12 – Private construction starts *(black) and* new mortgage advances *(grey) indices: 1980 = 100*

A somewhat more complicated relationship is the effect of changes in house prices on residential investment. As discussed briefly in Chapter 2 (Section 2.1), contrary to conventional microeconomic theory, the steep increase in house prices throughout the past decades has not led to a comparable rise in new housing provision, indicating a famously low elasticity of new housing supply to house prices in the UK context (Meen, 2005). From a systemic perspective, this can be linked to the link from house prices to land prices—via residual land valuation—and therefore to overall development costs (in line with Eskinasi's (2014, p. 39) SD model), which entails that any rise in house prices, in a short time, will be reflected in a proportionate rise in land prices, increasing development costs and cancelling out any increase in developers' profit margins that otherwise could have accrued. Thus, an increase in house prices should not necessarily incentivise faster housebuilding. The following quote from *The Callcutt Review of*

Housebuilding Delivery describes a supply side that is relatively insensitive to rises in house prices:

> *It is almost an article of faith, universally held by housebuilders, that there is a limit of 35-50 homes which can be sold from one outlet in a single year; [...] Building out at a faster rate does not yield sufficiently larger early returns to offset the cost of discounts plus other marketing and management costs.*
> (Callcutt, 2007, p. 41)

If anything, growing prices may indeed tempt developers to be more patient in their build-out planning and wait for higher prices that make higher densities of building economically viable (Murray, 2019), or simply hold the buildout and release of new units in speculation (D. Adams et al., 2009; Murphy, 2020). Pryce (1999) in fact finds a smaller average price elasticity of supply during a boom period than in a slump. Corder and Roberts (2008) discuss 'asymmetric adjustment costs, which reduce the responsiveness of investment to *increases* in demand but have less impact when demand *falls*' (Corder & Roberts, 2008, p. 399). Having in mind the above evidence, as shown earlier in Figure 5.9, I have assumed different elasticities of new supply to positive and negative changes in house prices. Via calibration, the *elasticity of private construction to positive house prices changes* is in fact found to be zero, implying that, in the long run, increases in house prices have not tended to incentivise faster production of new housing. The *elasticity of private construction to negative house prices changes*, however, is found to be 0.5, i.e., a 10% decrease in *expected house prices, ceteris paribus,* would lead to a 5% decrease in the rate of new construction.

Therefore, following the generic form of equations introduced earlier in equation [10], the equation for the flow variable *change in indicated level of private construction starts* is written as follows:

change in indicated level of private construction starts =
indicated level of private construction starts *
(lagged growth in residential planning applications success rate * elasticity of private construction to planning applications success rate
+ growth in real new mortgage advances * elasticity of private construction to new advances
+ effect of expected house prices on private construction starts) [11]

Where:

effect of expected house prices on private construction starts =
IF THEN ELSE (growth in expected house prices >= 0,
growth in expected house prices * elasticity of private construction to positive house prices changes,
growth in expected house prices * elasticity of private construction to negative house prices changes) [12]

Once the *indicated level of private construction starts* is determined, it is used to drive the actual level of *private construction starts*. The only further adjustment made to the former variable before it becomes the latter is what I have called the *effect of physical resource growth constraints on construction*, which is multiplied by the *indicated level* to obtain actual *private construction starts*. This *effect,* which is modelled using a graphical function depicted in Figure 5.13, is aimed at preventing *private construction starts* to grow exceedingly fast in a short period of time and is meant to represent, in a highly approximate and aggregate way, all constraints in the growth of resources required for housebuilding, such as permissioned land, construction material, labour force as well as intangible resources, which cannot grow as rapidly as certain drivers of *construction starts*—mainly *new mortgage advances*—can grow. To capture this, I have added a *smoothed private construction starts* variable which is a moving average of *private constructions* during the previous five years (*private construction smoothing time*) at any point in time, using a third-order SMOOTH function in Vensim. The graph function below then operates on the ratio of *indicated level of private construction starts* over this moving average, which is the x-axis in the figure.

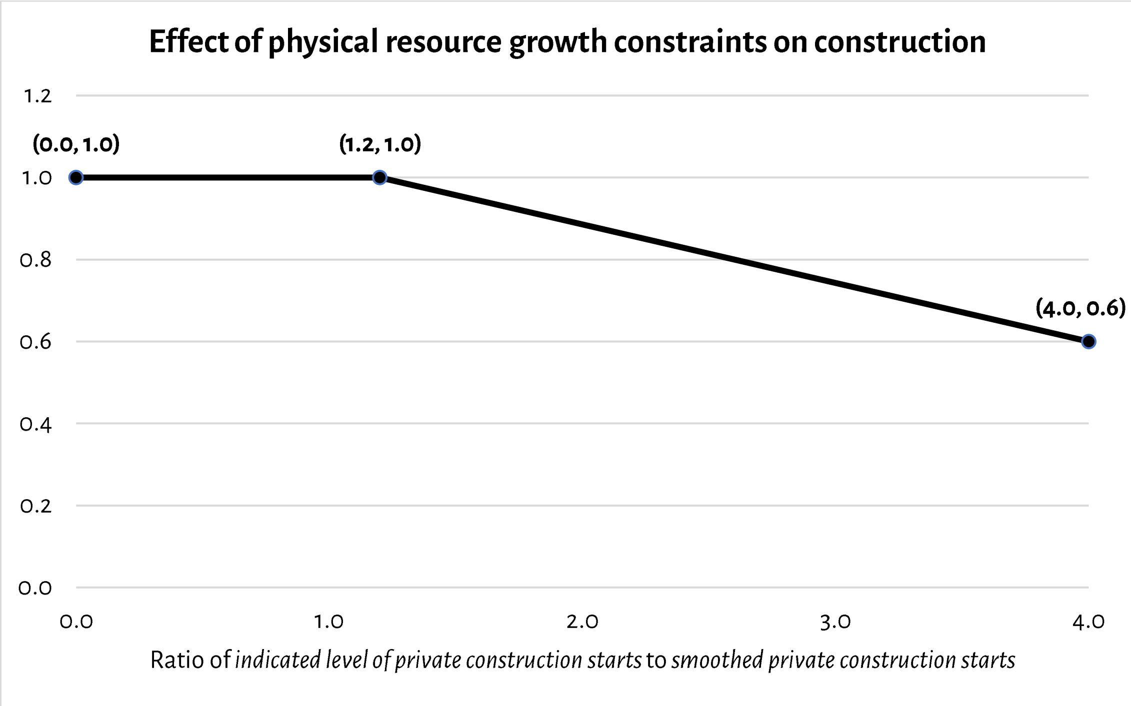

Figure 5.13 – Effect of physical resource growth constraints on construction

The graph function can be interpreted in the following way: as long as the *indicated level of private construction starts* is up to 120% of the moving average of the past five years (equivalent to 1.2 on the x-axis), this effect is neutral and actual *private construction starts* is equal to the *indicated level* (multiplied by the *effect* which is just 1). This represents an assumption that, if the *indicated level* is not higher than 1.2 times the average rate of construction starts during the past five years, this capacity constraint does not start to kick in. Then, as the ratio starts exceeding 120%, the *effect* starts to constrain the *indicated level* and apply a downwards adjustment on it, to reflect the fact that the resource constraints mentioned above cannot readily be adjusted to build more than 120% of the average build-out rate of the past five years. This constraint comes into effect at a ratio of 1.2 and linearly adjusts the *indicated level* down by up to 40% in the unlikely situation when the *indicated level* is four times as high as the moving average. This means that, for instance, when the *indicated level* is 50% above the move average (ratio of 1.5), this modelled constraint applies a downward adjust of about 4.3% on the *indicated level*, and if the ratio is as high as 2 (100% above moving average), then the downward adjustment is about 11.4%. The shape of the graph function, as well as the length of the smoothing time are based only on common sense and therefore present suitable candidates for sensitivity analysis, carried out in the next chapter (see Section 6.3.3).

Lastly, this sector also captures the flow of *large-scale voluntary transfers* from the *local authority housing stock* to *housing associations*, an initiative which was introduced in 1988 following the passing of the *Housing Act 1988* with the stated purpose of reducing the financial burden of affordable housing provision on the government. As with the Right to Buy, this was part of the broader neoliberal move towards privatisation (Lee, 2002). This, as well as the *stock demolition* outflows (for both local authority and housing association housing), are exogenous variables driven by data from the MHCLG (2020c).

5.4. Tenure and Rent Sector

The purpose of this final sector is to capture developments in the shares of different tenure types as well as in the level of private sector rents and average housing costs incurred by households of various tenure types. Thus, we will have numerous connection points to the previous three sectors. The aim is not to develop a detailed and sophisticated model of tenure choice, which would be beyond the level of aggregation of this integrated model. Nonetheless, as we will see in the next chapter, this simplified but consistent stock-flow representation of movements between different tenure types can reproduce broadly similar trends in the shares of the three main different tenure types as seen in existing historical data.

The *Tenure* part, as portrayed in Figure 5.14, consists mainly of three stocks representing *private sector vacant dwellings*, *privately rented dwellings,* and *owner-occupied dwellings*, as well as the flows of housing units in-between these stocks and the effects that govern these flows. Starting from the left-hand side of the diagram, *total inflow to private sector vacant dwellings* consists of *private construction completion* plus *net other additions extrapolated*, as described earlier in the Construction Sector. The assumption captured in this way is that as new units of housing are built (or converted) by the private sector they are initially vacant for a period until they are either sold into owner-occupation, in which case they flow into the stock of *owner-occupied dwellings*, or otherwise rented out into the stock of *privately rented dwellings*. The *share of new private housing becoming owner-occupied* is assumed to be dependent on *average deposit to income ratio*—with a higher deposit to income ratio, *ceteris paribus*, leading to a decrease in this *share*. This is captured using a negative *elasticity of owner-occupation to deposit to income ratio*, estimated via calibrating model behaviour to historical data on different tenure types from MHCLG's Table 109 (MHCLG, 2020a) to be -0.4, with the *initial share of new private housing becoming owner-occupied* estimated to be at 25% in 1980. Another potential factor that could have affected this *share* is the availability of buy-to-let (BTL) mortgages, which is believed to have helped drive the increase in the share of the privately rented sector in the total housing stock (Ryan-Collins et al., 2017, p. 7). However, I was not able to gain access to this data for London (see footnote 9 on page 68) and therefore had to exclude it.

The equations for *inflow to owner-occupied housing* and *inflow to privately rented housing* are as follows. These equations represent first-order delays (Sterman, 2000, pp. 415–416) with constant time lags. Average *time to sell* and *time to rent* are estimated via calibration to be ~7 and 3 months, respectively. Taking these two time lags as constants is a strong assumption, as the average speed at which vacant units can be sold or rented out depends very much on market conditions. However, such shorter-term dynamics are outside the scope of this model.

inflow to owner-occupied housing =
(private sector vacant dwellings * share of new private housing becoming owner-occupied) / time to sell [13]

inflow to privately rented housing =
private sector vacant dwellings * (1-share of new private housing becoming owner-occupied) / time to rent [14]

Housing does not only flow in one direction from *vacant dwellings* out to *rented* or *owner-occupied dwellings*. Rental contracts expire and owner-occupied housing can be remarketed for sale. These are captured via the two flows in the opposite direction: *termination of rental contracts* and *owner-occupied properties remarketed* which flow back into the stock of *vacant dwellings*. These flows are also formulated as first-order delays. In the case of *termination of rental contracts*, the *average private rental duration* time constant is set equal to ~22 months (Maxine Lester, 2017). The *fraction of owner-occupied housing remarketed per year* is obtained via calibration to be equal to 1% of dwellings per year. In reality, these two variables change over time depending on market conditions and the regulatory environment. Assuming them to be constants is a simplification and relaxing this assumption presents a potentially fruitful area for furthering this research.

Furthermore, units of housing can also flow directly in between the stocks of *owner-occupied* and *privately rented* dwellings. This is captured by the *net transfer from owner-occupied into private rental* flow, which is formulated as a *net fraction of private owner-occupied housing being rented out* which can be either positive (indicating a net transfer of homes from the *owner-occupied* stock to *privately rented* stock), or negative (indicating the opposite case). This *net fraction* is assumed to be driven by developments in the *house price to income ratio*, the conventional measure of affordability, with an elasticity obtained to be 0.15. An increase in the *ratio* which signifies a decline in affordability is a force towards a shift from owner-occupation to privately renting, as has been happening over the recent decades (see Section 1.1.3). This shift, however, does not take effect instantly in response to changes in affordability but occurs with a delay. It is, thus, modelled using a SMOOTH function, representing a first-order delay, with a constant time lag of two years. Finally, a separate inflow to the stock of *owner-occupied dwellings* consists of *right-to-buy transfers* (both from local authority (LA) and housing association (HA) stocks) which are data-driven variables from MHCLG's Table 675 (MHCLG, 2012).

Having obtained the stocks of *privately rented* and *owner-occupied dwellings* and importing the *local authority* and *housing association housing stocks* from the Construction Sector, we can now calculate the share of different tenure types in total housing, while making the simplifying assumption that each dwelling unit accommodates one household. In this way, *owner occupied tenure share* will for example be equal to the *owner-occupied dwellings* stock divided by the sum of *owner occupied*, *privately rented*, *housing association* and *local authority stocks*. The *social tenure share*[32] is defined as the sum of the *local authority* and *housing association housing stocks*, divided by the sum total of all tenures.

[32] In this thesis, the terms 'social' and 'affordable' housing are sometimes used interchangeably.

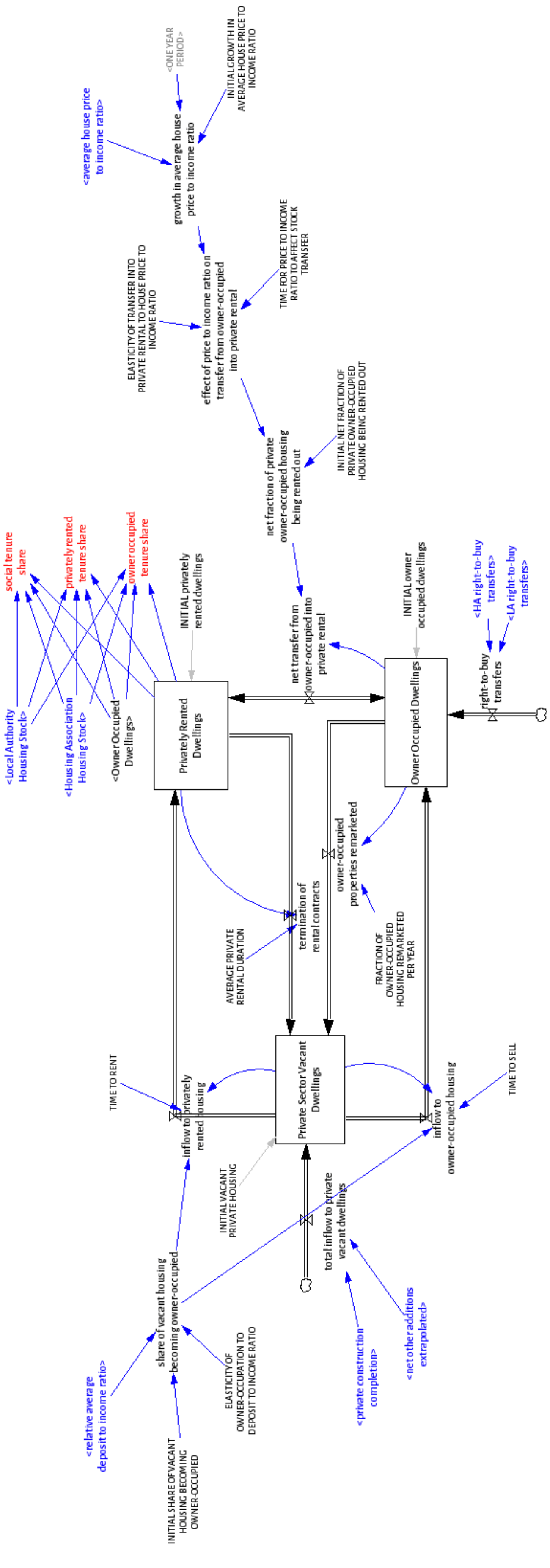

Figure 5.14 - Tenure

Next, still within this sector, *real private rents*, which was previously used in the House Prices Sector to formulate *expected housing ROI* (return on investment), is modelled (Figure 5.15) by linking it to the rate of *growth in privately rented tenure share* (as obtained above), *growth in private sector vacant dwellings* (also modelled above), and *growth in real house prices* (imported from the House Prices Sector). Most existing studies on rent prices focus on explaining static differences in rents for properties of varying physical characteristics or in different neighbourhoods. Few studies take a dynamic viewpoint and concentrate on explaining changes in average rents in a particular city over time. The assumptions made here are that, on the one hand, *growth in privately rented tenure share*, as an indicator of relative demand for private rental, will boost *private rents* (elasticity = 0.7), and on the other hand *growth in private sector vacant dwellings* indicates an over-supply of vacant homes and can therefore put a downward pressure on rents (elasticity = -0.05). In addition, *growth in real house prices* is assumed as another inflationary force on rents (elasticity = 0.25). The strengths of the effects—the *elasticities*—are determined using calibration to available data on private rents for the years 1995–2014, mainly from the Family Resources Survey (DWP, 2016) from the UK Department for Work and Pensions (DWP).[33] For the years before 1995, I have extrapolated this series based on the trend in data for *mean registered rent of private tenancies* from the discontinued Housing and Construction Statistics series.

[33] The Family Resources Survey provides raw data on a large number of variables. Through the GLA, I obtained a series for annual private rents gleaned from the raw data by the Institute for Fiscal Studies.

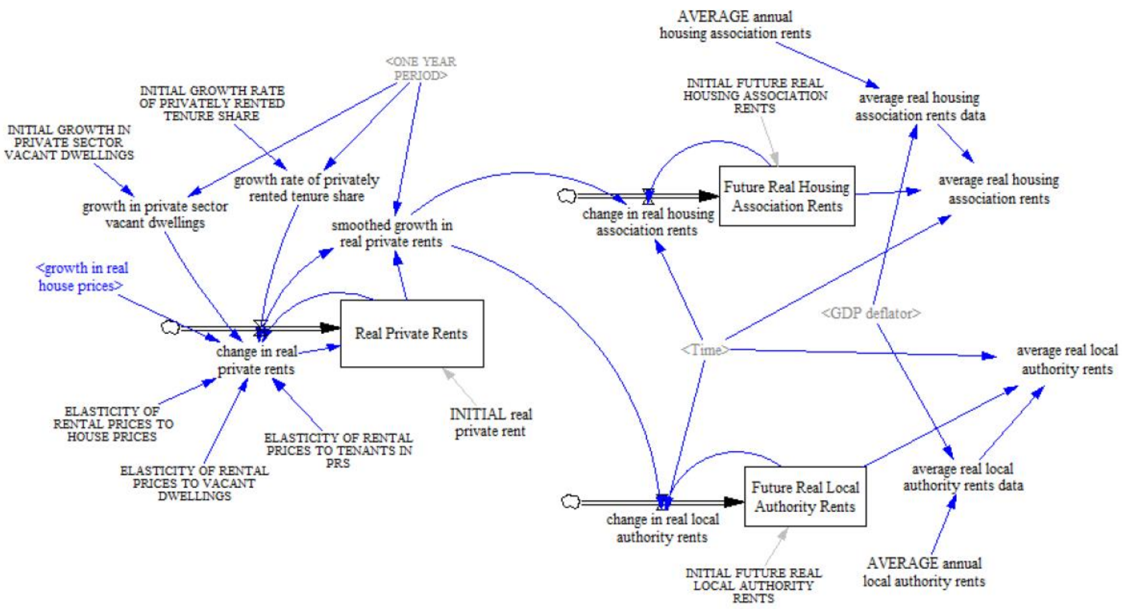

Figure 5.15 – Rents

In the model, *average annual local authority/housing association rents* are exogenous data-driven variables for past years, where data exists. Data for *housing association rents* comes from the MHCLG's series on *private registered provider weekly rents* in Table 703 (1997–2011 and 2013–2018) (MHCLG, 2020e), which is extrapolated for the years before 1997 based on the trend in data for *mean registered rent of RSL* (Registered Social Landlord) *tenancies* from the former Housing and Construction Statistics. Similarly, data for *local authority rents* comes from the Housing and Construction Statistics publication until 2001 and from MHCLG's Table 702 (MHCLG, 2020e) thereafter.

As we will shortly see, this information on average rents for various tenancies, together with the share of each tenancy type in total dwellings, will be used to calculate average housing costs for households both for the past as well as for projections into the future. For the future, *private rents* are modelled endogenously as already explained. Regarding the exogenous *housing association* and *local authority rents*, however, it would not be acceptable to assume that they would stay constant into the future, regardless of developments in the rest of the housing system. On the other hand, since the main focus of this model is on private housing, I needed to find a simple way of allowing social housing rents to change over time. As shown above on the right-hand side of Figure 5.15, I did this by allowing social rents to change with broadly the same rate of change as *private rents*. This is preferable to assuming social rents would stay constant or would grow with a fixed rate in the future. For this purpose, the *smoothed growth in real private rents*, a simple one-year moving average of *change in real private rents* divided by *real private rents*, is assumed to be equal to the growth rate of *future real housing association/local authority rents* stocks. Subsequently, *average real housing association/local authority rents* are driven by external data in the past and extrapolated according to the trend in simulated *real private rents* in the future.

The next and final piece of the model (Figure 5.16) focuses on obtaining *average housing costs* in an endogenous way based on previously modelled developments in tenure, in rents and in mortgage payments. *Average real housing costs* is calculated as the weighted average of housing costs for different tenure types, with the weights being their respective tenure shares in total. This indicator is used to obtain *total real housing costs* and *total real GDHI after housing costs* which, as seen previously in the House Prices Sector, is one of the drivers of *house prices*. In other words, this *average housing costs* is an intermediate variable in the way to capture the aggregate level of household income left after deducting housing costs, which can then generate further demand for house purchases. Based on this definition, as illustrated in Figure 5.17, what is accounted for in the equation for this variable are payments leaving the household sector, i.e., mortgage payments to banks and affordable housing rents to local governments and housing association. This conceptualisation, therefore, disregards private renting because private rents, as shown illustratively in Figure 5.17, are paid by certain households to others, with the payments and receipts on aggregate cancelling each other out within the household sector.[34] Thus, the equation for *average real housing costs* is as follows:

average real housing costs =
(share of mortgaged housing in total housing * average real mortgage repayments
+ share of housing associations in total housing stock * average real housing association rents
+ share of local authorities in total housing stock * average real local authority rents)
/household per house [15]

With outright ownership not included in the equation, a housing cost of zero for this type of tenure is automatically implied.[35] The function of the final argument in the equation (*household per house* with a value of 1) is only effectuating unit consistency without affecting the value of the outcome.

[34] Note that the squares in Figure 5.17 break down the total housing stock by ownership and by tenure. The circle of *landlords*, however, maps a group of people onto the housing stock. These people, who are all renting out property, might live in various tenure types themselves. Most of them are likely to be owner-occupiers, but some of them might live in rented properties as well.

[35] All households, including outright owners, still need to pay something towards housing, e.g., as council tax. These are not, however, part of the scope of our study.

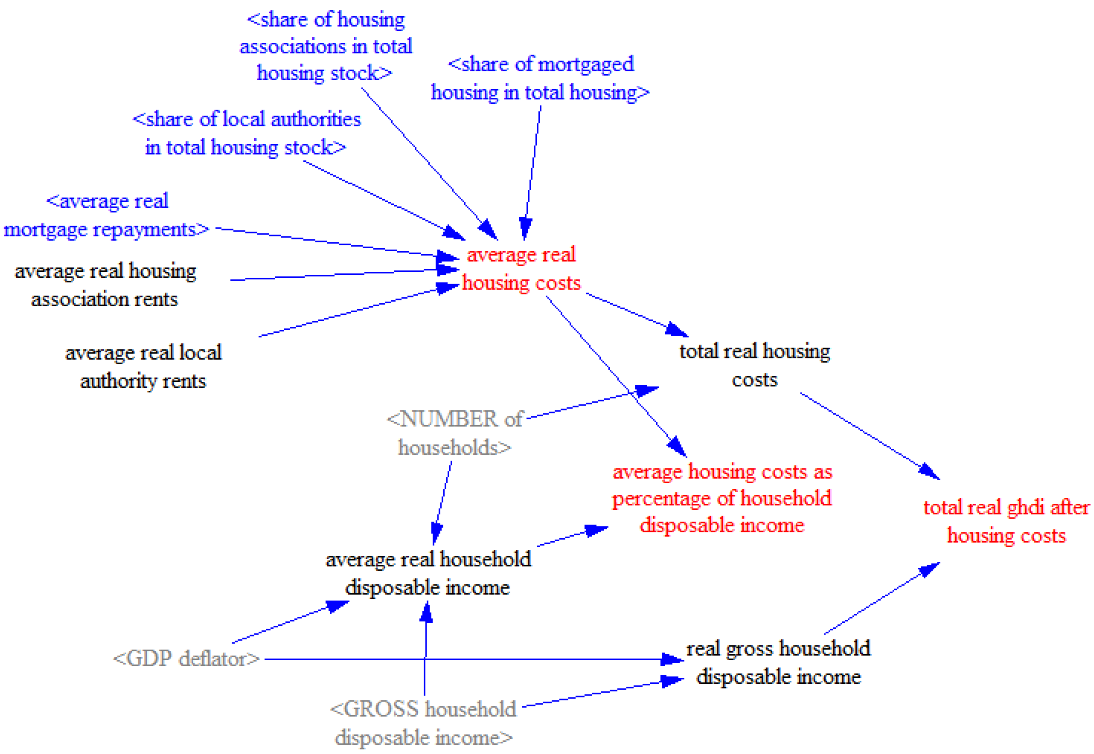

Figure 5.16 – Average housing costs

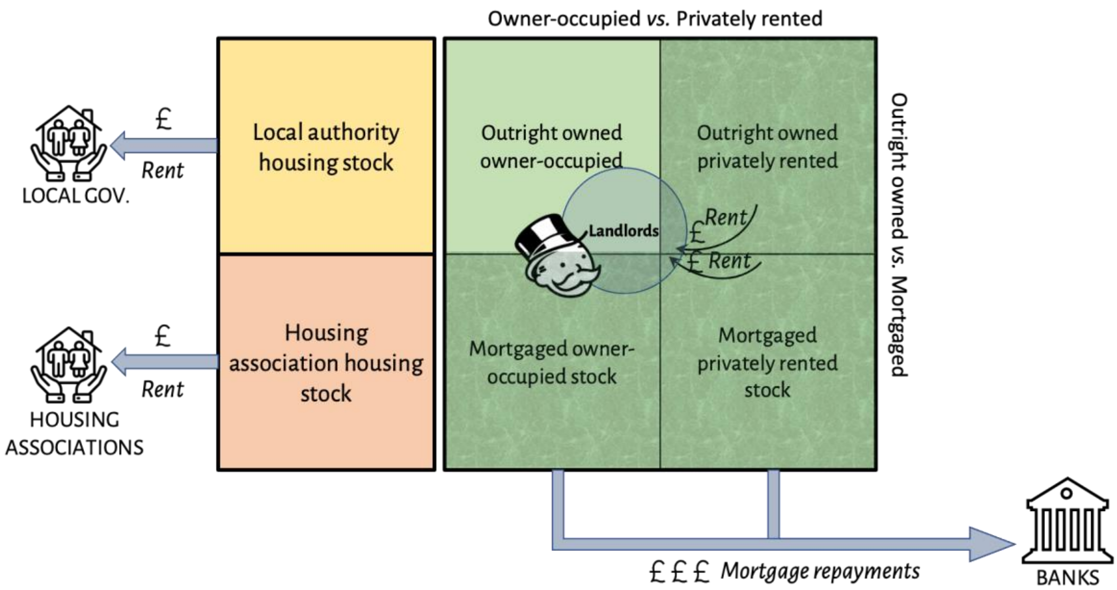

Figure 5.17 – The flows of housing costs by tenure. The light green square is the only tenure which entails no housing costs in the model.

The *average real housing costs* obtained above is useful for calculating disposable income after housing costs as a key driver of housing demand. However, since it also averages over outright owners that do not incur any significant housing costs, it hardly gives an accurate idea of developments in average housing costs for those households which really do incur housing costs. To find a good measure for this latter indicator, we need to remove outright owner-occupiers from the averaging population, or in other words calculate the average for all groups except the top-left quadrant in Figure 5.17. For this purpose, another similar piece of structure shown in Figure 5.18 captures *average real housing costs for all except outright owner-occupiers*.

There are two differences between this structure and the one for *average real housing costs* shown above: first, the four types of *tenure share* variables are calculated not as shares of the *total housing stock* but rather using *total housing stock except outright owner-occupied* in the denominator. The latter variable equals *total housing stock* minus *number of private houses owned outright*, which is in turn calculated by multiplying *private housing stock* (from the Construction Sector) by the *proportion of private housing owned outright* (from the Mortgage Sector). The second difference is that private renters are also included in this calculation. However, we need to find a way to only account for the private rents paid to outright owner-occupier landlords, as the part which is paid out to landlords who are mortgaged owner-occupiers themselves stays within the three-quadrant system (identified with darker texture in Figure 5.17) and is cancelled out between payers and payees.

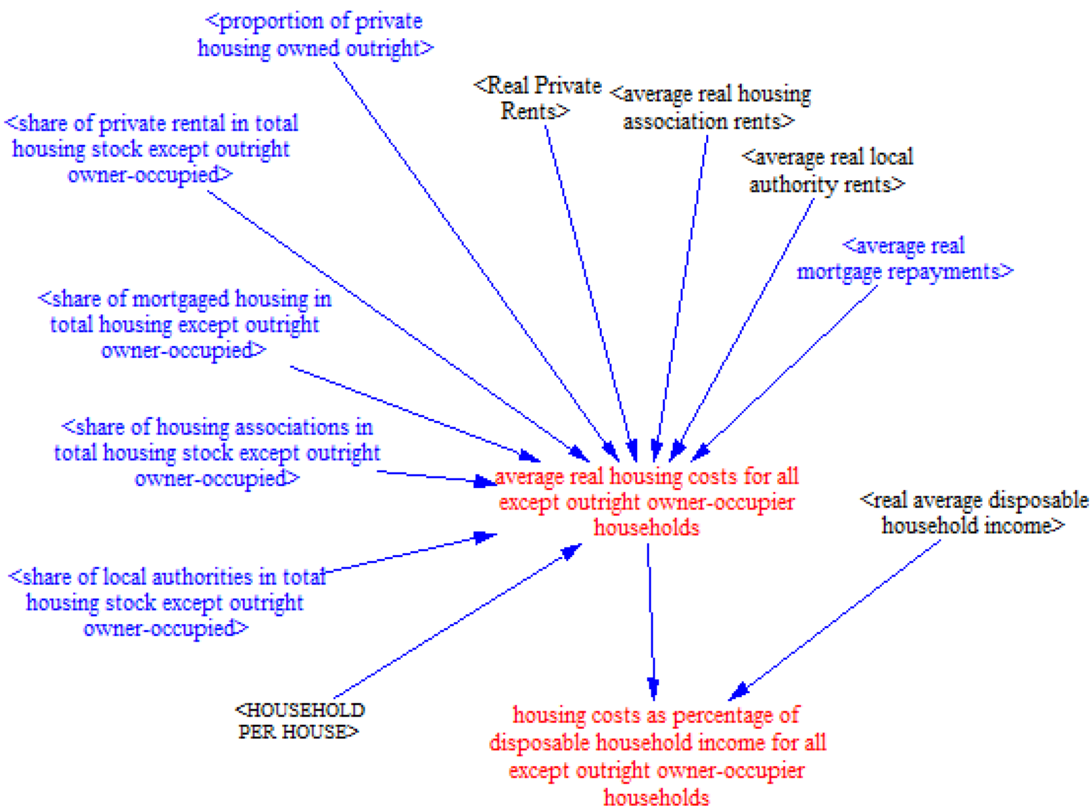

Figure 5.18 – Average real housing costs for all except outright owner-occupiers

In order to do this, in the last component of equation [16] below which deals with private renting, we further multiply the *share of private rental in total housing stock except outright owner-occupied* by the *proportion of private housing owned outright*, assuming that landlords are divided between outright owners and mortgagers according to this generic *proportion*. This assumption is not necessarily true, as there might be disproportionately more landlords among outright owner-occupiers than mortgaged owner-occupiers (as illustrated by the asymmetrically placed circle of *landlords* in Figure 5.17), which means that we could be underestimating average housing costs by assuming that too much of the rents is being paid to mortgaged owner-occupiers rather than outright owner-occupiers. But this sub-optimal assumption has to be made in order to estimate this division of rents in a dynamic and endogenous way within the scope of this model.

average real housing costs for all except outright owner-occupiers =
(share of housing associations in total housing stock except outright owner-occupied * average real housing association rents
+ share of local authorities in total housing stock except outright owner-occupied * average real local authority rents
+ share of mortgaged housing in total housing except outright owner-occupied * average real mortgage repayments
+ share of private rental in total housing stock except outright owner-occupied * proportion of private housing owned outright * real private rents)
/household per house

By dividing the resulting *average real housing costs for all except outright owner-occupier households* by *real average disposable household income* we obtain *housing costs as percentage of disposable household income for all except outright owner-occupier households*. Note that the income indicator is an average over all London households, without distinguishing amongst them by tenure type, as regional income data by distinction of tenure is difficult to come by. It is likely that if the group of outright owner-occupier households were to be taken out from the population this would bring the average down, as this particular group are likely to represent a swathe of households with higher incomes (Stockhammer & Wolf, 2019). For this reason, as well as the argument laid out in the paragraph above, the figures estimated for *housing costs as percentage of household income* are highly likely to be underestimates.

Therefore, in interpreting the results in later chapters, rather than relying on the absolute values given by this indicator, we will focus on its trend. The value of this indicator lies in its ability to project future trends in a highly endogenous way (i.e., with most key variables being driven by the internal dynamics of the model rather than external data) while accounting for key tenure types, which to the best of my knowledge, is a unique feature of this model. This will allow us to investigate the effect of various policies on this outcome in the future.

5.5. Model Boundaries

In this section, I present a diagram of the boundaries of the model introduced in this chapter. This model boundary diagram is shown in Figure 5.19. The choice of this model boundary was primarily and predominantly driven by the main purpose of the model, which is to capture in an endogenous manner the excessive growth and oscillations in house prices and housing debt, but also partly by the availability of reliable historical data and the methodological approach. This boundary, I believe, is close to being one that 'encompasses the smallest number of components, within which the dynamic behavior under study is generated (Forrester, 1968, pp. 4–2)' while also generating some of the most essential indicators in London's socio-economic housing system over the long term.

Figure 5.19 clusters variables and concepts into three distinct types:

i. The innermost circle encompasses the model's key *endogenous* variables and concepts. These are variables that are driven primarily by internal dynamics of the model, as opposed to external data. These constitute those concepts that are most central to this study's scope and focus including *house prices*, *housing return on investment*, *mortgage advances*, *mortgage balances outstanding*, *debt service ratio*, *private construction*, *total housing stock*, *housing wealth*, *tenure shares*, *private rents,* and *average housing costs* for households, as shown over the past sections of this chapter. This set of endogenous variables as core boundary of the model is broadly in line with (but more comprehensive than) what Ryan-Collins (2018) recommends, while pointing out that economic models that did incorporate flows of credit, stock of debt and house prices often succeeded in predicting the global financial crisis, whereas 'standard neoclassical models that ignored such attributes did not' (Ryan-Collins, 2018, p. 72). Endogeneity of key concepts, a foundational concept of the SD methodology (Richardson, 2011), is crucial because if these are allowed to be driven by external data, as often seen in econometric models, future projections tend to become simply extrapolations of past behaviour that inherently miss any reversal of trends, acceleration or deceleration of growth, or other non-trivial dynamic modes of behaviour. The endogeneity of well-formulated SD models, on the other hand, makes them capable of anticipating such shifts in behaviour modes in the system thanks to the inclusion of feedback loops—a direct consequence of the 'closed-boundary system' worldview (Richardson, 2011).

ii. The middle doughnut shape in Figure 5.19 encircles *exogenous* variables. These consist of variables which are driven by external historical data, and sometimes left as policy levers for the future to be decided or experimented upon for the purpose of policy or scenario analyses. These variables often play a crucial role in determining the behaviour of the model, but the assumption behind including them as exogenous variables is that their development is not majorly affected by internal dynamics of the model, or that they represent policy decisions even if those policies are influenced by other variables. This set of variables includes *average mortgage interest rates*, *mortgage periods*, and *loan-to-value ratio* for new loans, *Help to Buy loans*, *capital gains tax, planning applications success rate, local authority* and *housing association construction start, number of households* and *household disposable income*. Having in mind that the housing system is such a consequential sector of the overall economy, considering some of the above variables, such as the latter two, as exogenous might be considered strong assumptions. Nonetheless, these have been conscious decisions in order to be able to draw a boundary around the model and to limit the scale of the model to one that is manageable and conducive to better understanding and new insights. In Chapter 7, as will be seen, we will use several of these exogenous variables in defining our set of future-looking scenarios.

iii. The outermost circle includes several key concepts that are fully *excluded* from the model. Examples of such notions include *regional variances within London*, *distinction between high-end and low-end housing, housing implications for inequality* and other *macroeconomic implications of housing*, *homelessness and overcrowding*, *structure of the housebuilding industry, construction costs,* and *land prices*. This list is by no means exhaustive. Clearly, as with any other model, the list of excluded concepts and variables is infinitely longer than those which are included. The exclusion of some of these (e.g., *land prices* in Box 5.2) was discussed at more length in this chapter. Some have been excluded partly due to lack of data, others due to methodological challenges, and others simply to narrow down the scope and the focus of the model.

In terms of spatial boundaries, the model focuses on London as a whole, without any further disaggregation, e.g., among boroughs. While this entails some loss of spatial granularity, this aggregation is arguably more conducive to understanding the overarching dynamics rather than becoming bogged down in spatial peculiarities. At the same time, while many of the mechanisms discussed apply not just to London but to the UK as a whole, as argued by McKee *et al.* (2016), when speaking of the housing crisis there is no such thing as a uniform 'UK experience' since the nature of the crisis in London is very different from that of other regions in England or the UK. Therefore, the focus on Greater London seems a justified choice.

The model is a continuous-time model, with years as the base time unit: it is intended to capture dynamics that happen at the yearly scale or longer, and not shorter-term fluctuations. With regards to the temporal boundaries, the simulations in this study start 40 years ago in 1980, and—in the case of policy simulations (Chapter 7)—future simulations are extended 40 years ahead, until 2060. In order to understand the long-term dynamics in the housing system having led to the present situation it is necessary to go back a few decades. The choice of how far back to initiate the model was majorly affected by data availability for some of the key variables for which London-level data only becomes available since 1980 (such as those on dwelling stocks by tenure type (MHCLG, 2020a)). This time frame allows us to look at developments in the housing system since Thatcher's administration took office and implemented trend-setting neoliberal policies such as privatisation and financial deregulation (see Section 3.4). On the downside, this choice of time frame does not allow a comparison between the pre- and post-Thatcherite eras. The chosen period does, however, cover at least two clear high-amplitude cycles in house prices, construction and housing-related finance occurring in the late 1980s and the late 2000s (Figure 1.2 in Chapter 1).

In short, the emphasis in this modelling study has been on developments within the housing system of London as a whole entity. The focus is on high-level, whole-system, long-run dynamics (mainly the exponential growth and oscillations in prices and in housing debt), rather than having geared the model towards short-term fluctuations or market forecast. The modelling scope is summarised in Table 5.2.

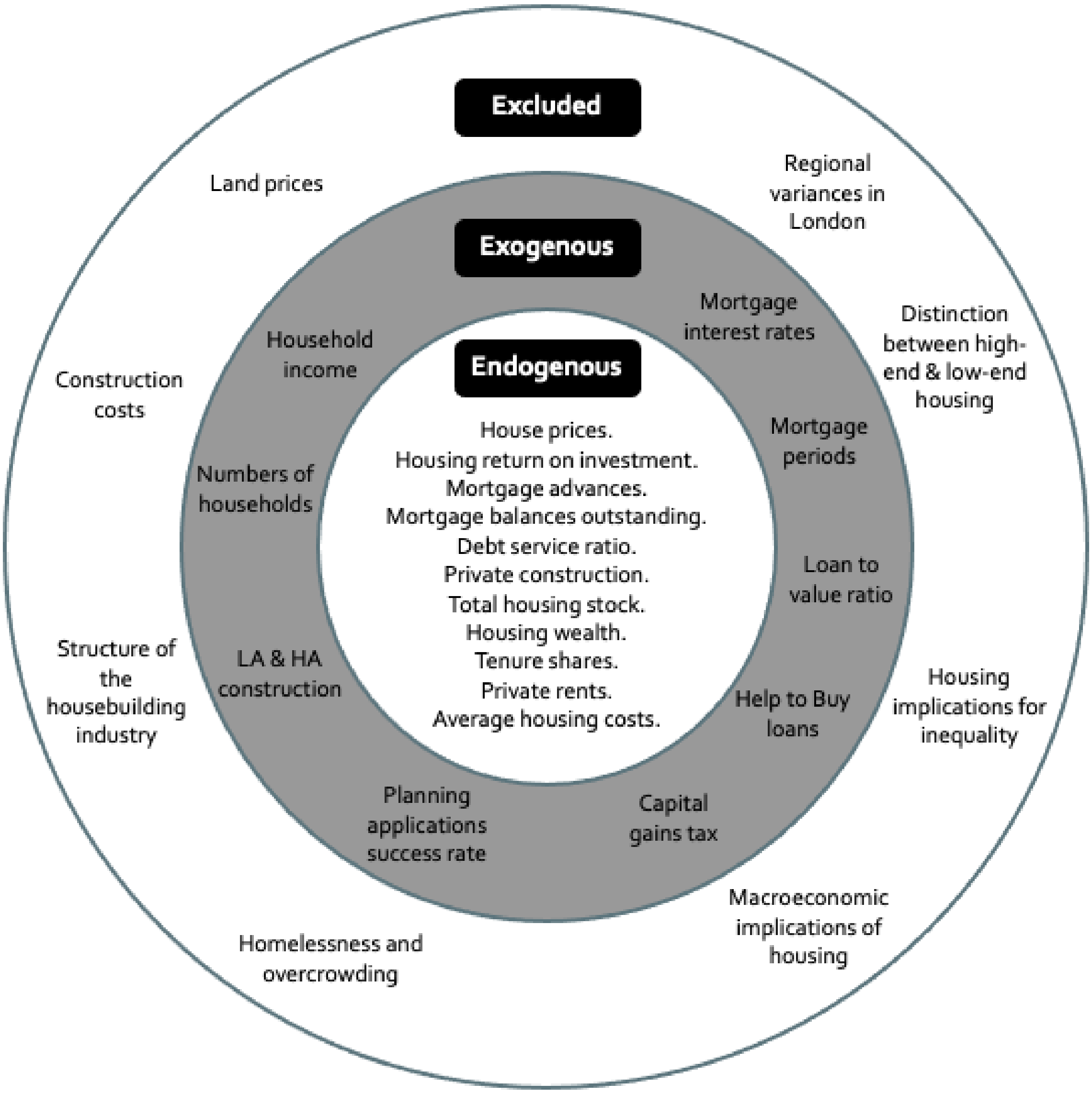

Figure 5.19 – Model boundary diagram

Table 5.2 – Modelling scope

Level of aggregation	Whole of London (not UK/England, not borough-level)
Level of detail	Long-term strategic rather than detailed operational Emphasis on whole system dynamics
Time unit	Year
Time frame	1980 – 2060

5.6. Causal Loop Diagram

As mentioned at the outset of this chapter, the quantitative SD model does not cover all the detail of the qualitative CLD shown towards the end of Chapter 3. To wrap up this chapter, in this final section, a simplified causal loop diagram of the quantitative model is introduced (Figure 5.20). This relatively simple CLD helps visualise the key interacting feedback loops in the model in one holistic picture. In its full detail, the SD model contains thousands of feedback loops. The central variable *real house* prices, for example, is involved in over 2,000 feedback loops. The diagram below has been greatly simplified to highlight some of the most important loops. Even in this simplified diagram the variable *house prices* is involved in 25 feedback loops. Out of these, only a handful have been highlighted, chosen based on their perceived importance in determining the behaviour of the model. The loops are numbered so as to match those in the whole-system CLD presented in Chapter 3 (Section 3.5.2, Figure 3.12), and therefore the loop numbers do not necessarily start at 1. The narratives implied by the identified feedback loops have already been outlined in Chapter 3, Section 3.5 and will not be repeated here.

Figure 5.21 compares this simplified CLD against the whole-system CLD of Figure 3.12 by showing parts that are *excluded* from the SD model in faded grey. Excluded parts largely overlap with the concepts shown in the outer circle of the model boundary diagram in Figure 5.19. A closer look at Figure 5.21 reveals that the balancing loops (B1-B5) of Figure 3.12 are all covered by the SD model, but out of the reinforcing loops R1-R10 only loops R4-R7 are included (see Table 3.1 for loop names). The excluded variables, links and loops mainly have to with the notions of land values, housebuilding industry structure, and the macroeconomy.

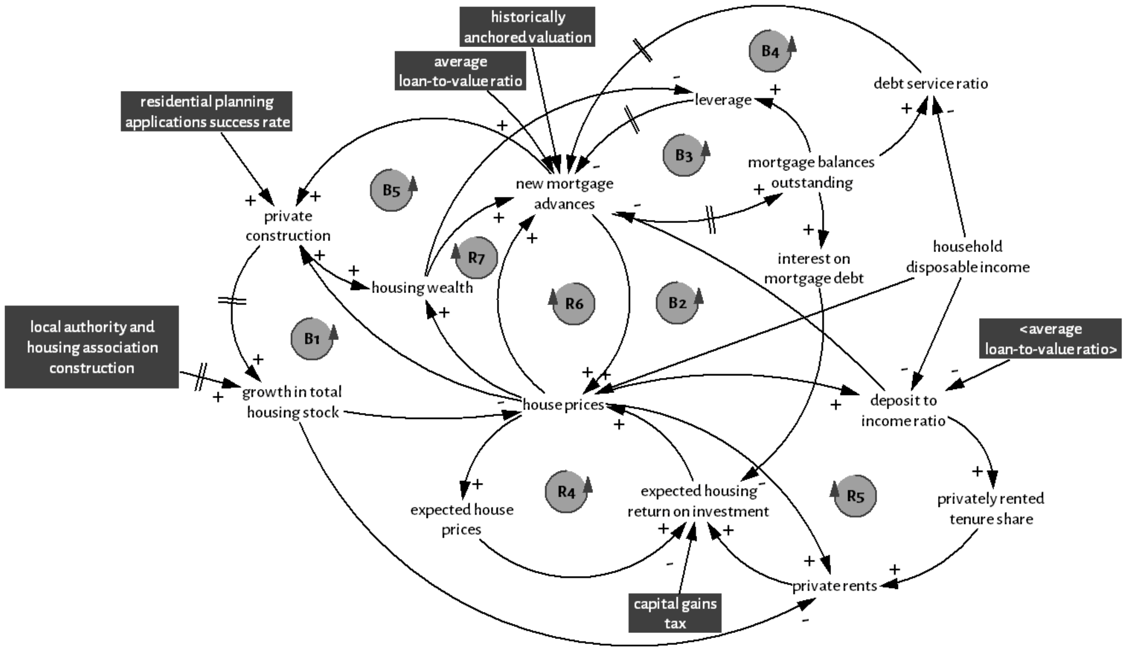

Figure 5.20 – Simplified causal loop diagram of the full model

In the next chapter, via simulation, we will put to test the *dynamic hypothesis* put forth in this chapter and summarised in Figure 5.20 and investigate whether the structure of our quantitative model can indeed replicate the characteristic exponential-like growth and boom-bust patterns seen in London's housing market. Whilst investigating model behaviour, frequent references will be made to the feedback loops so far identified in order to understand the behaviour of the model in light of its structure.

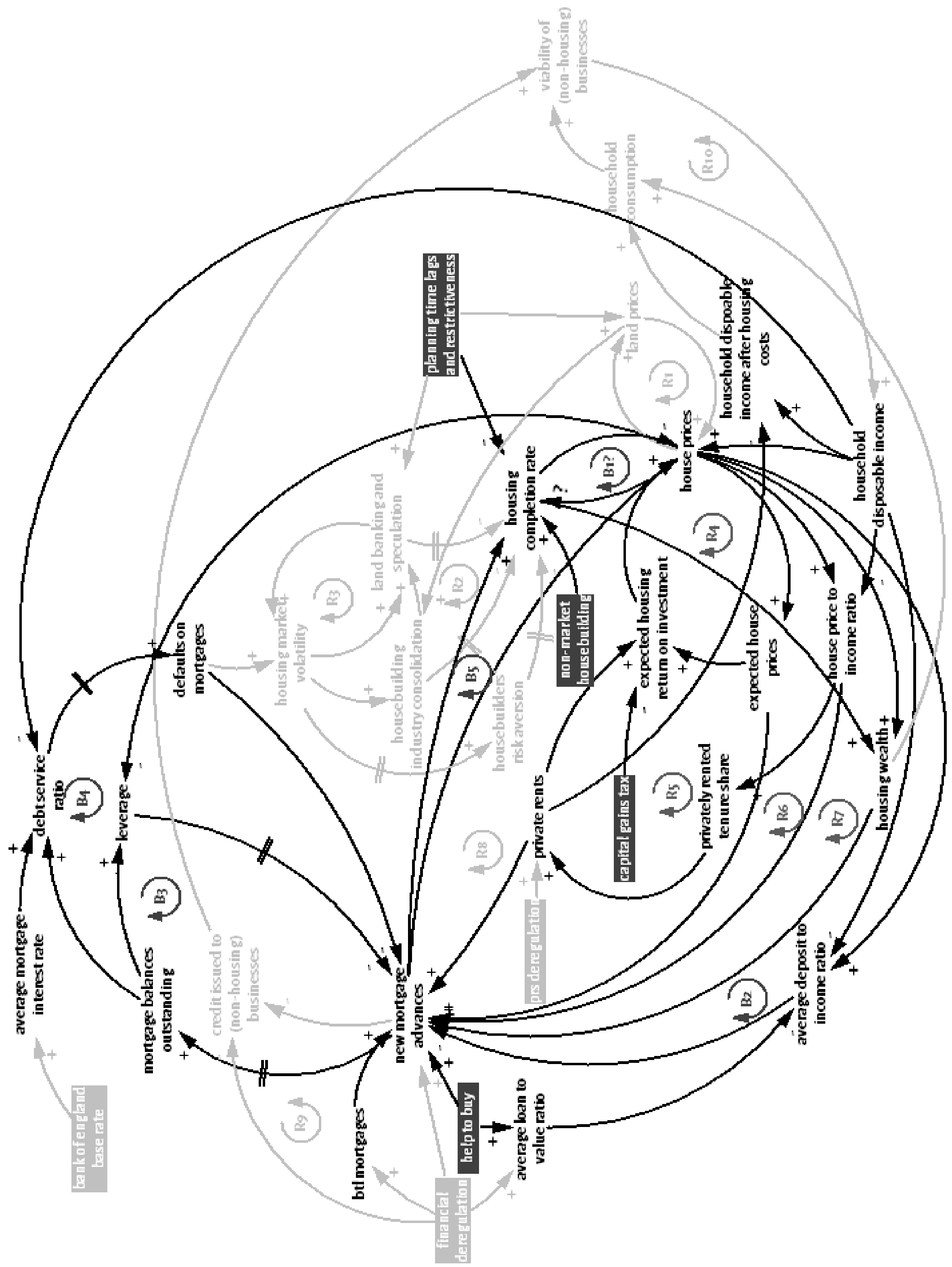

Figure 5.21 – Parts of the whole-system CLD (Figure 3.12) captured in the quantitative SD model, highlighted in bold

Chapter 6. Model Validation

Chapter 6. Model Validation

In this chapter, we are going to look at results from simulating the model over the time period of the past four decades up to present (1980–2020) and compare the behaviour of the calibrated model to existing historical data for some of the key indicators in the model in order to verify whether the model is capable of adequately replicating key patterns in the data. Where appropriate and possible, we will discuss the results and the discrepancies between simulation and data in light of existing literature. Notwithstanding the word 'validation' in the title of this chapter, in SD it is impossible to single out 'validation' as a separate and stand-alone phase in a linear modelling process. Rather, validation is considered an iterative process.[36] As discussed in more detail in Chapter 4, model validity in SD is closely related to confidence in its representativeness and usefulness, and this confidence is built gradually over the process of constructing, parametrising, calibrating and testing the model (Barlas, 1996), with many revisions along the way. In the case of this thesis, as mentioned in Chapter 4 (Section 4.4), the modelling process included countless revisions and numerous rounds of seeking feedback from housing experts.

Also note that, although this chapter focuses on behaviour validation tests, as mentioned earlier in the Methodology chapter, such tests are not the only aspect of validation in SD. Useful models should be able to not only replicate the right patterns of behaviour but do so *for the right reasons* (Oliva, 2003). In other words, before testing for

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[36] In this sense validation does not stop even once we reach the policy analysis stage. Later in the policy and scenario analysis phase (Chapter 7), the future behaviour of the model under various assumptions is compared against expected outcomes. Thus, any anomalies and major deviations from expectation, as will be seen, will either be satisfactorily explained as potential new insights or rectified if they turn out to point to flaws in the model.

behaviour, we need to ascertain that the structure of the model is valid and correctly reflects existing knowledge about the system. Concerning structural validation, as seen in previous chapters, every effort was made to build the structure of the model on the foundation of existing literature and knowledge about links between variables. Where possible, parameters were obtained from the existing information about the system. This reliance on evidence lends structural validity to the model. Furthermore, dimensional consistency has been ensured using Vensim software's automatic unit checking feature based on the units assigned to variables by the modeller.

It must also be noted that in the process of building the present model, calibration—matching simulation to observed historical behaviour—has been carried out at multiple levels of model endogeneity, i.e., at first focusing separately on each model sector while allowing key variables in other sectors to be driven by known historical data. This is closely related to the idea of *partial model testing* (Homer, 2012) and is in line with one of the heuristics recommended by Oliva (2003) in overcoming the caveats of automatic calibration. In this way, by cutting intersectoral feedback loops and without the risk of multiple feedback relationships amongst sectors confounding our results, I gained confidence in that my assumptions with regards to the drivers of key variables are reliable. Subsequently, more rounds of calibration were carried out as additional sectors were plugged in one by one, making the model more 'endogenous' with each step and finally reaching the fully integrated final model with its complete web of many interconnections and feedback loops amongst sectors.

The process of calibration itself is arguably the most stringent test of model validity, as it is a combined test of structure and behaviour at the same time (Oliva, 2003). However, an important critique of using automated calibration as part of the validation process of SD models is that it constitutes a confirmation test rather than a falsification test.

Therefore, it is important to complement this with other validation tests, as well as ensuring that the structure is built on sound evidence.[37]

Having founded the structure of the model on best available evidence and having subsequently calibrated model parameters to reproduce historical data, in this chapter we focus on behavioural validation using reference mode tests, endogeneity tests, and sensitivity tests. In terms of structure, I will follow the same order as in the previous chapter, presenting results sector by sector. Each section will include mainly a 'reference mode (replication) test', i.e., a comparison of model behaviour against available historical data, or in other words the *reference modes* of behaviour which characterise the problem under study. Some of these reference modes were used in Chapter 1 to describe and characterise London's housing crisis in dynamic terms and as relevant to our scope. These historical patterns of behaviour are called 'reference modes' in SD language because we continue to refer back to them in our modelling and analysis (Sterman, 2000, p. 90). The ability of a model to reproduce key patterns of behaviour observed in the reference modes is a key behaviour validation test in SD (Barlas, 1996).

For each sector, where appropriate, we will also conduct an 'endogeneity test', where we attempt to determine—in a qualitative way—the extent to which the model's behaviour results endogenously, i.e., as a result of the model's internal workings, as opposed to driven exogenously by external data inputs. As mentioned in Chapter 4, endogeneity is key in determining the capacity of a model to 'foresee' future developments in the system given the unknown nature of external drivers in the future. Finally, each section also includes a 'sensitivity test' to gauge the sensitivity of the model's behaviour to random

[37] For a full review of automatic calibration as a tool for validating SD models with all its strengths and caveats see Oliva (2003).

variations in relevant parameters and to verify whether this level of sensitivity is representative of what one would expect in the real world.

6.1. House Prices Sector Results

6.1.1. Reference Mode Replication Test

Reference mode (replication) tests involve reporting the results of calibrated model simulations and investigating the extent to which the model reproduces patterns observed in historical data and why it does or does not. For this purpose, we are going to rely on both visual inspection and statistical measures. It is essential to note that the emphasis is on reproducing *patterns* (including periods, frequencies, trends, phase lags and amplitudes) rather than point accuracy. This is a consequence of the long-term orientation of the present model of London's housing system, as is common in SD models in general (Barlas, 1996).

Figure 6.1 shows the result of model simulation for *real house prices* (in grey) compared against historical data (in black). Upon visual inspection, the model appears to broadly capture developments in historical data, both in terms of inflationary growth and in terms of periodic oscillations. More formally, the root mean square percentage error (RMSPE) between simulation and data is calculated to be 16.5%. This is obtained using the following equation, where n is the number of observations (in this case number of years between 1980 and 2020 which is 40), S_i is simulated value for each year, and D_i is historical data for each year.

$$RMSPE = \sqrt{\frac{\sum_{i=1}^{n}(\frac{S_i - D_i}{D_i})^2}{n}}$$

This single value, however, does not reveal much about the nature of the error. Theil (1971 cited in Sterman, 1984) suggests an elegant way of decomposing total mean squared error (MSE) into three separate components which allows for analysing the composition of the error with the aim of finding to what degree the error is systematic or random. The three components, expressed in proportions of total error, are *bias* (denoted as U^M), *unequal variance* (U^S), and *unequal covariance* (U^C), the sum of which equals 1 (total MSE). A large bias (indicated by *both* a large MSE and a large U^M) signifies a systematic difference (gap) between model simulation and data and can be a cause for concern. A large unequal variance can reveal systematic differences in terms of trend or amplitude of oscillations. A large unequal covariance (along with a small RMSPE) is, however, what a modeller would ideally wish to see upon calculating the Theil inequality statistics, as U^C indicates unsystematic point-by-point differences between data and simulation. Such a result implies that the model captures key behaviour modes, i.e., average values, trends, and magnitudes of oscillations (Sterman, 1984). [38]

[38] The interested reader is referred to John Sterman's 1984 paper *Appropriate Summary Statistics for Evaluating the Historical fit of System Dynamics Models* for details on how the three error components are calculated.

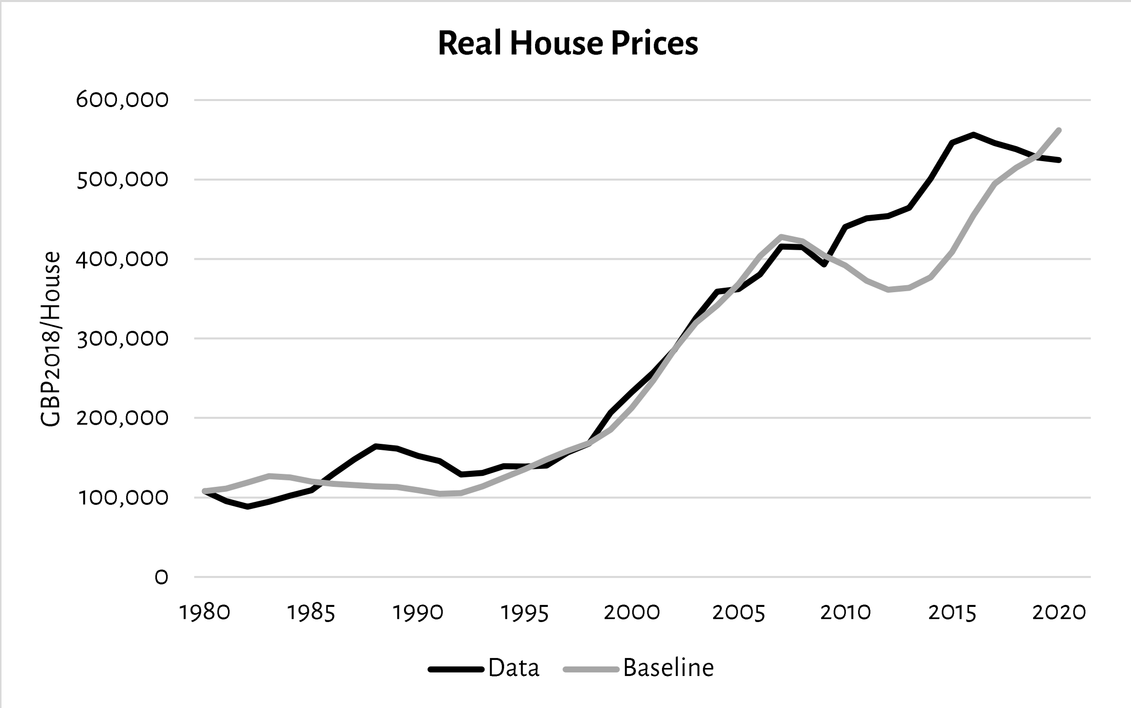

Figure 6.1 – Real house prices: Baseline *(grey) vs.* Data *(black) from ONS* (2020c)

Table 6.1 – Real house prices *summary statistics:* Baseline *vs.* Data

Real house prices (GBP2018)	**Min**	**Max**	**Mean**	**St. Dev.**
Data	88,410	556,400	285,000	162,700
Baseline	104,000	576,200	264,400	147,600
Goodness of fit statistics				
RMSPE	U^M	U^S	U^C	R^2
16.5%	0.212	0.097	0.691	0.937

Calculating Theil inequality statistics for the simulated versus data series for *real house prices* gives $U^M = 0.212$, $U^S = 0.097$, and $U^C = 0.691$. Therefore, most of the error (~70%) lies in unsystematic unequal covariance, with *bias* and *unequal variance* together representing a (0.212+0.097) * 16.5% = 5% RMSPE, which indicates a good fit of simulation to historical data. Table 6.1 summarises the above goodness of fit statistics, as well as general summary statistics for the two series.[39] Note also that values for minimum, maximum, mean, and standard deviation are close too for the two series.

A noticeable discrepancy between data and simulation, however, has to do with the deeper trough in the simulated curve following the 2008 bust in the market. This could be due to certain factors not captured in the model which may have prevented a deeper trough. For example, Hamnett and Reades (2019) point to the importance of international investment and global financial inflows to London housing in the rapid recovery of house prices following the Global Financial Crisis (GFC). Another important external influence absent in this model is the impact of large-scale government interventions following the GFC which helped keep the country's economy and financial sector afloat. These measures included 'an extraordinary level of public support' (Rose & Wieladek, 2012, p. 2038) for the banking sector via government funding or central bank liquidity insurance schemes, public capital injections, and nationalisations. With regards to the property market, measures such as a 'stamp duty holiday' on properties sold under £175,000 were introduced to support first-time and middle-income buyers (Kickert, 2012). Pugh *et al.* (2018) estimate that without the Bank of England's unconventional monetary policy intervention in response to the financial crisis, UK real house prices in 2014 would have been 22% lower than they actually were. Such external influences (trans-national flows of money or one-off government interventions) are not included in this model, which could explain why the recovery takes longer in the simulation, as it only happens 'organically', i.e., due to internal model dynamics having to do with the gradual lifting of the burden of debt on households.

[39] Unlike statistical significance tests, here there are no thresholds for accepting/rejecting the model. Rather, confidence in the model is built gradually based on the results of an array of tests.

Another visible difference between the two curves is towards the end of the curve, where data shows that *real house prices* in London have started to decline since 2016/2017, while the simulated curve keeps rising. The recent decline in prices could be explained as a result of two distinct external impacts, neither of which have been included in this version of the model. The first has to do with recent macroprudential policies put in place by the Bank of England since 2014 which impose certain restrictions on mortgage lending. These measures are discussed in further detail later in the Mortgage Sector Results. The second external shock is of course the Brexit referendum, which is thought to have led to a correction in house prices since 2016 (Peydro, Rodriguez Tous, Tripathy, & Uluc, 2020). These effects have not been included in the model, partly because the focus of this model is more on internal dynamics and endogenous mechanisms and less on external impacts, and partly because both these changes have been so recent that there are few studies quantifying their impacts and those which do exist are very recent and only appeared after the end of the model development phase of my study. However, the inclusion of both these major external shocks are important in making future projections and constitute high priority areas of improvement for future revisions of the model beyond this thesis.

6.1.2. Endogeneity Tests

Next, it is important to ask how the model generates this behaviour that traces historical developments fairly closely. In particular, is this behaviour driven predominantly by external data variables or does it emerge mainly from internal dynamics of the model? If the latter is true, which feedback loops in the model are responsible for the defining features of this behaviour (i.e., exponential growth superimposed by periodic oscillations)? In order to answer these questions, we use feedback loop cutting tests, where in each test we investigate the impact of disabling individual feedback loops (through cutting one of the links in the loop) on model behaviour. If disabling a feedback loop turns out to eliminate or weaken a particular mode of behaviour, it can be inferred that that specific loop is instrumental in generating the weakened mode of behaviour.

Figure 6.2 depicts the result of two such tests against the *Baseline* and *Data* curves shown earlier. The first test, titled *T101 Cutting the Housing-Finance Loops* involves setting the *elasticity of house prices to new mortgage advances* to zero, thus cancelling any effect from changes in *new mortgage advances* on changes in *house prices*. Cutting this link disables the key reinforcing loops R6 and R7 identified in the Chapter 5 (Figure 5.20), together referred to as the *Housing-Finance Loops* (see also Section 3.5.1). As is clear from Figure 6.2, this modification drastically changes the behaviour of the model. It significantly slows down growth in *real house prices*, and as a result considerably dampens oscillations as well. House prices are still growing to some extent, with the *Investment Loop* still active, but this non-financialised speculative demand on its own does not appear to be capable of generating an exponential growth in market prices.

If, in addition to the *Housing-Finance Loops*, we also break *R4: Investment Loop*—the reinforcing loop at the centre of the House Prices Sector (see also Section 3.5.1)—via setting the *elasticity of house prices to housing investment yield premium* to zero, we will see that a state of near-equilibrium is reached, as portrayed by the nearly flat dotted curve (*T102)* in Figure 6.2. This near-equilibrium is not a static equilibrium, of course. Rather, it implies a situation where, absent any propelling impact on prices from speculative investment demand or from the flow of mortgage credit, any remaining push created by slowly increasing household incomes is countered by the gradual increase in housing supply. This could perhaps be interpreted as representing a simplified canonical economics textbook model of housing where, in the absence of game-changing feedback loops, the relatively tame forces of supply and demand keep things in a state of equilibrium. A model that is, of course, far removed from reality.

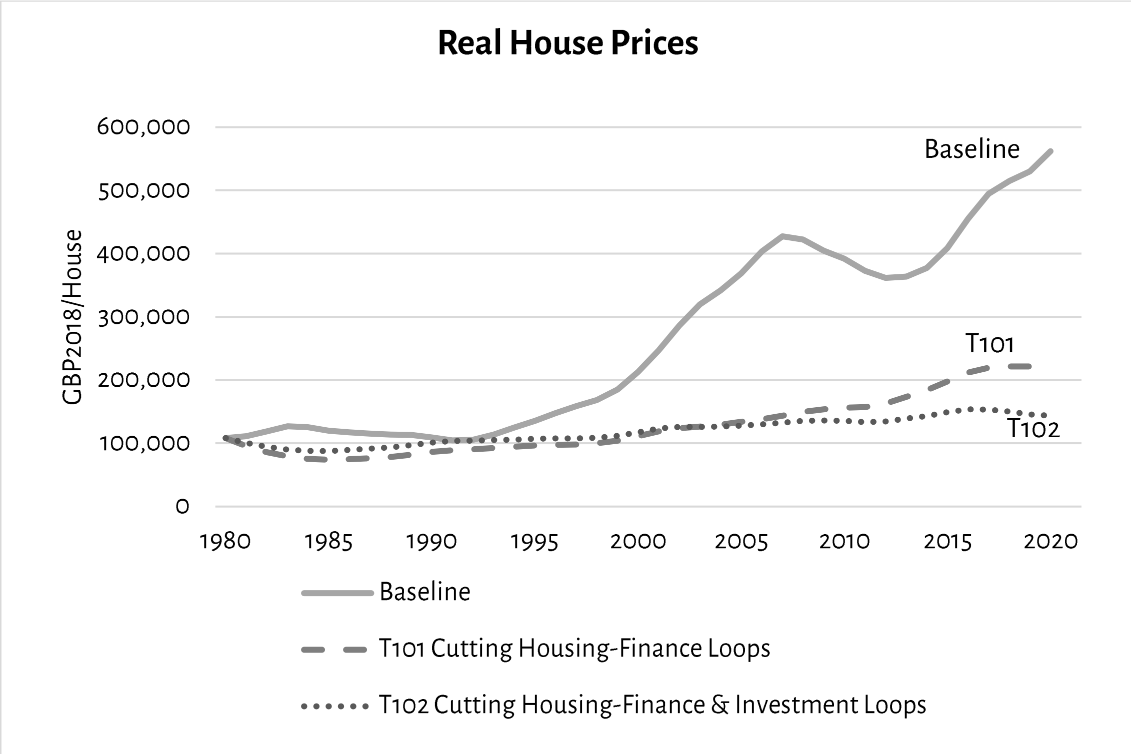

Figure 6.2 – Feedback loop cutting tests for real house prices.

What these experiments establish, therefore, is that, firstly, the model's behaviour is very much endogenous, as cutting three of the feedback loops (*R4: Investment Loop and R6 & R7 Housing-Finance Loops*) hypothesised to be crucial in our dynamic hypothesis—as outlined in the previous chapters—does indeed eliminate in large part the growth, oscillations, or in fact any notable patterns from simulated developments in house prices. Secondly, these experiments also serve to corroborate the importance attributed to these particular feedback loops in our dynamic hypothesis. This insight is key in designing our demand-side policies, as will be reported on in the next chapter.

6.1.3. Sensitivity Tests

Next, we are going to perform a sensitivity analysis, where we will test the sensitivity of the behaviour of simulated *real house prices* to slight changes in the five *elasticity* parameters which govern the strengths of each of its five driving factors: disposable household income after housing costs, new mortgage advances, the housing stock, the vacant dwellings stock, and housing investment yield premium. For this analysis, Vensim's Monte-Carlo simulation feature (Ventana Systems, n.d.) is used where the user specifies ranges and distributions for randomisation of each of the chosen uncertain parameters and the software automatically runs a specified number (hundreds or thousands) of simulations while randomly varying the uncertain parameters within the specified ranges. The results can then be visualised either as individual traces or as confidence bounds, which is easier to interpret and is the method chosen for visualisation of results below. Thus, for example, for a confidence bound at 50, 1/4 of the runs will have a value bigger than the top of the confidence bound and 1/4 will have a value lower than the bottom. The widest bounds shown are the 95% confidence bounds, which leaves out a negligible 2.5% of simulations on each side of the outermost visualised bounds (Figure 6.3).

These results are obtained while allowing the five *elasticity* parameters to vary under a uniform random distribution within a ±20% range of their values[40] in the *Baseline*. Within Vensim's sensitivity analysis feature, the Latin Hypercube Sampling method is used, which is a multivariate sampling procedure that assumes parameter independence and is appropriate for simulation models (Hekimoğlu & Barlas, 2010; McKay, Beckman, & Conover, 2000). One thousand simulations are performed to generate the confidence bounds depicted in Figure 6.3. Summary statistics for the sensitivity simulations for the year 2020 are given in Table 6.2, including the minimum, maximum, mean, median, standard deviation and relative standard deviation (coefficient of variation). The first line reports summary statistics relating to all 1,000 simulations. The second and third lines are intended to compare the median reported in the first line against the actual values in the *Data* and *Baseline* series for the same year.

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[40] A common choice for sensitivity analysis. See Hekimoğlu and Barlas (2010)

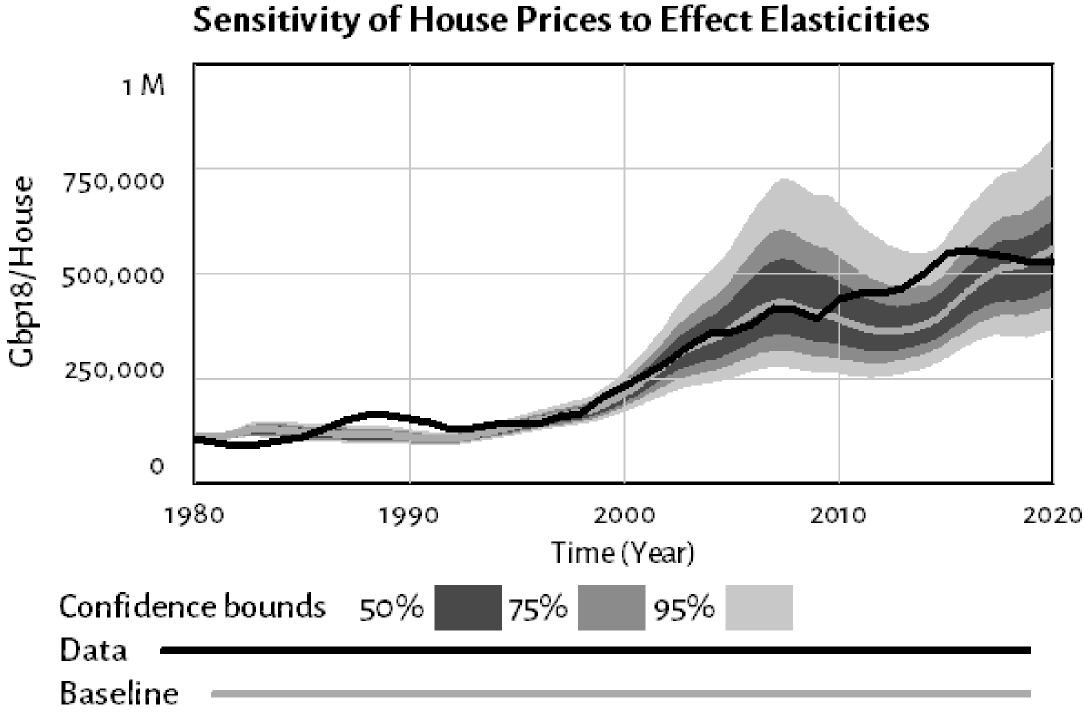

Figure 6.3 – Sensitivity of real house prices *to all its driver elasticities*

Table 6.2 – Real house prices *sensitivity to elasticities: summary statistics at year 2020*

Real House Prices sensitivity results @ 2020

Min	Max	Mean	Median	St. Dev.	Relative St. Dev.
291,147	1,021,790	553,300	535,055	118,636	0.21
Baseline			562,000		
Data			524,400		
Difference between *Median* and *Data*			2%		

Upon inspecting the range of potential behaviours given the uncertainty surrounding the *elasticity* parameters obtained via calibration, it is evident that while possible responses of the model to simultaneous variations in these parameters can cover a wide range, the pattern of behaviour, i.e., the growth, the oscillations, and the period of oscillations, remains the same. What is sensitive to the assumed random variation in the parameters is the rate of growth and the amplitude of oscillations. This provides further evidence that the observed pattern of behaviour is a result of the feedback structure of the model (rather than specific parameter assumptions) and is robust to slight variations in parameters.

Furthermore, the range of uncertainty, as captured by the width of the confidence bounds, does not stay the same over the simulation period. It tends to grow over time, widening during the boom phases when reinforcing feedback loops are dominant and shrinking over the bust periods when balancing mechanisms gain dominance. The fact that it grows over time has to do with the cumulative nature of stock variables, not only *real house prices* itself but also other key variables in the model such as *mortgage balances outstanding*, which creates a 'memory' in the system and results in the accumulation of errors once simulation veers away from the baseline. In those simulations which lie above the *Baseline*, *real house prices* grows faster, indicating a higher gain of dominating reinforcing loops (e.g., as a result of higher *elasticity of house prices to new mortgage advances*). Where reinforcing loops become dominant, small discrepancies with the *Baseline* become amplified over time. In these cases, we see not only the highest peaks in prices but also the deepest troughs, which suggests that the severity of the bust periods is related to the steepness of the boom.

It can be argued that this growth in uncertainty of results over time also highlights a caveat involved in attempting to model developments in the housing system over a long period of 40 years, during which an abundance of relevant external forces and events that are not included in the model have no doubt affected the course of the system. Such long-term time horizons, however, are not uncommon in applications of system dynamics. The key argument in dealing with the concerns around having a fixed structure to capture long-term behaviour, given the many excluded external influences and the growing uncertainty resulting from unknown parameters, is that, as mentioned earlier, the purpose of such modelling practices is to reproduce and explain *patterns* of behaviour rather than achieving point accuracy (Barlas, 1996).

Next, recall from Chapter 5 (Section 5.1) that a sensitivity test was promised for the *forecasting average time* parameter, which determines the averaging time of the trend function used in extrapolating *house prices*, *rents* and *housing investment costs* to obtain their future *expected* values, which are then used in calculating the *expected housing return on investment*. This represents the length of the period of past values that investors, on average, take into consideration when extrapolating expected returns. Note that, *forecasting average time* is different from the forecast horizon that is set to one year. Lacking empirical evidence, we assumed a value of 4 years for this parameter, which gave the best fit to data in our model calibration. Here, we will conduct a sensitivity test to gauge the importance of this specific parameter, and the consequences of a possible error in our assumption. For this test, we allow the parameter to vary in a ±25% range around its current value (i.e., between 3 to 5 years) based on a uniform distribution, and we simulate 200 runs. As shown in Figure 6.4, the confidence bounds are very narrow, meaning that *real house prices*—and model behaviour in general—shows little sensitivity to variations in this assumption, which is reassuring. Note, however, that an important difference between this test and the previous one is that here we are only allowing one parameter to randomly vary, while in the previous test multiple parameters were allowed to vary simultaneously, naturally resulting in a much wider range of uncertainty.

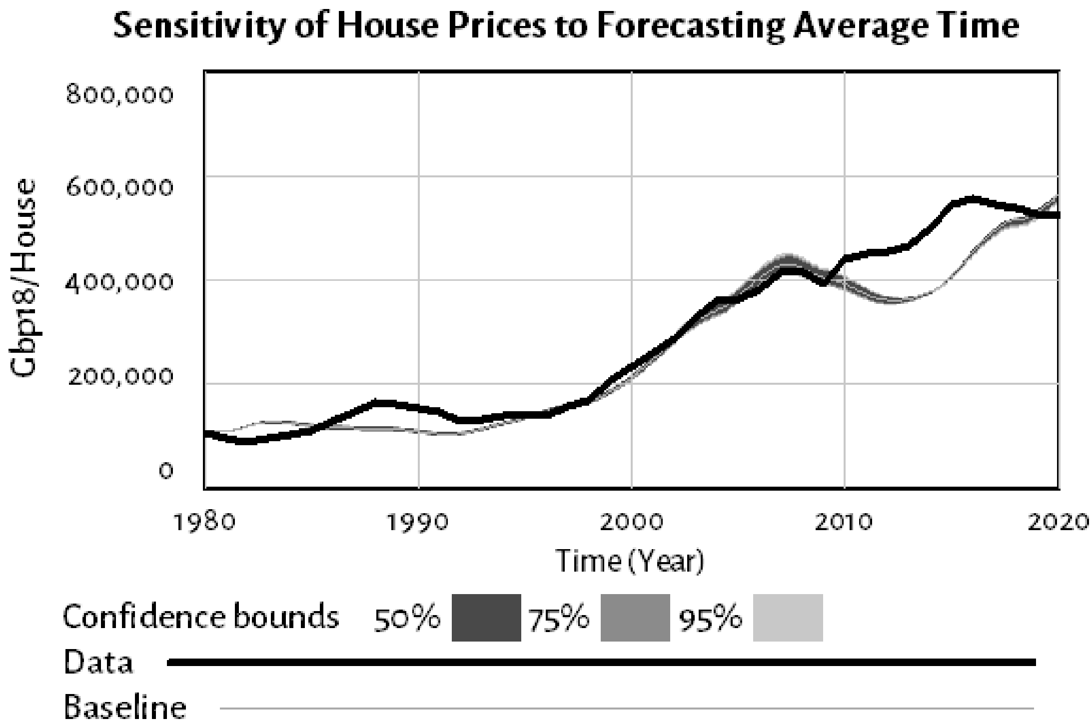

Figure 6.4 – Sensitivity of real house prices *to* forecasting average time

6.2. Mortgage Sector Results

6.2.1. Reference Mode Replication Tests

Figure 6.5 shows the result of our reference mode replication test for *real new mortgage advances* issued every year. *Baseline* (in grey) is compared against historical Data (in black) from UK Finance (2017). Summary statistics comparing the two series, as well as those reporting on the goodness of fit between simulation and data are given in Table 6.3.

As can be seen, the general trend of exponential growth in *new mortgage advances*, and the drastic fall in 2007–2008 as well as the subsequent rise back up is broadly captured. The coefficient of determination (R2) is equal to 0.79 which indicates a good level of co-movement between simulation and data. The root mean square percentage error is higher than the earlier figure for *real house prices*, and looking at its breakdown, one can see that although by far the largest share (U^C =%71) is attributed to unequal co-variance (which is what we would like to see), there is still a notable share (U^M=28%) having to do with a bias-type error, which originates because simulation continually undershoots data during an extended initial period (1985–2008).

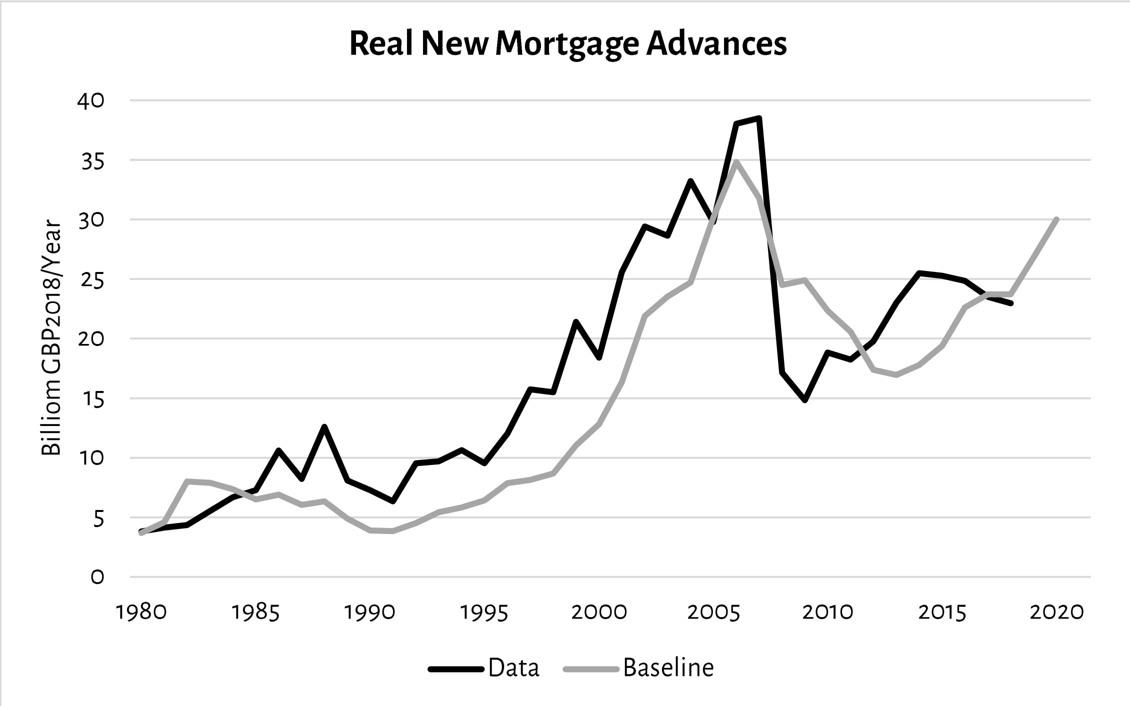

Figure 6.5 – Real new mortgage advances: Baseline *(grey) vs.* Data *(black) from UK Finance*

Table 6.3 – Real new mortgage advances summary statistics: Baseline vs. Data

Real new mortgage advances (Billion GBP2018/Year)	**Min**	**Max**	**Mean**	**St. Dev.**
Data	3.82	38.50	17.04	9.53
Baseline	3.69	34.82	15.06	9.25
Goodness of fit statistics				
RMSPE	U^M	U^S	U^C	R^2
35.1%	0.277	0.009	0.714	0.788

The reason behind this mismatch has to do with the extent of the ability of the model to reproduce the steep downfall of lending in 2008 in an endogenous manner (or as endogenously as possible). One can see that, while the model does generate a bust around the same time, it occurs over a longer period and is not as precipitous as what happened in reality. Apart from the exogenous fall in *average loan to value ratio of new* *mortgages*, I have not included any exogenous shocks to the system that would contribute to a bust and considering that the 2008 GFC was an event of global impact with significant forces external to London's housing system affecting mortgage lending in important ways, it would be unreasonable to expect the model to reproduce the bust with the same steepness and severity observed in reality. Therefore, the problem of calibration in this case became a trade-off between getting a close match with data up to 2008, and then significantly overshooting the data afterwards (due to the less severe downfall), or else somewhat undershooting data in the past so that the smaller collapse in 2008 does bring us close enough to the more recent data. Giving more weight to better match in more recent years, I opted for the latter option. Since in SD any measure of validity is dependent on the purpose of the modelling exercise, and since the purpose of this modelling exercise is to explain and broadly reproduce the exponential rise in house prices and mortgage lending and the cyclical boom-and-bust patterns rather than point-accuracy, the current extent of match between simulation and data can be considered satisfactory in this case.

Another noticeable mismatch between simulation and data has to do with the slight downturn in lending in data for the most recent years, since 2015. This could be attributed to a policy intervention which is not included in the model, i.e., the Bank of England's macroprudential measures recommended by its Financial Policy Committee (FPC) and in place since 2014. These measures include 'a loan to income (LTI) flow limit to restrain the proportion of new mortgages extended at or above 4.5 times a borrower's income (Bank of England, 2019, p. 49),' plus a requirement towards lenders to apply more stringent interest rate stress tests on prospective loans (Bank of England, 2019). In a recent Financial Stability Report by the Bank of England (2019), the FPC has reported that although they believe that these 'measures have not constrained a material number of prospective homebuyers from purchasing a home, [...] some borrowers may have taken out smaller mortgages as a result of the Recommendations, as intended' (Bank of

England, 2019, p. 50). This intervention being relatively recent, and especially given that the micro-level data are not publicly available, there were not many studies published on its material impact on lending volumes during the model development stage of my work. Currently, there are a couple of very recent studies by the Bank of England and the Financial Conduct Authority (FCA) on the impacts of recent macroprudential policy in the UK (Belgibayeva, 2020; Peydro et al., 2020). Peydro *et al.* (2020), for instance, find 'overall credit contraction to low-income borrowers in local-areas more exposed to constrained-lenders, lowering house price growth,' and that this macroprudential policy has led to fewer defaults than expected following the post-Brexit house price correction.

Another recent influential event was the Brexit referendum, which, as mentioned earlier, led to a 'correction' in house prices. Not having included the impact of Brexit means that the model is unable to replicate the associated correction which, as a result of the reinforcing *Housing-Finance Loops*, would have led to lower levels of lending as well. Since both the Bank of England's macroprudential measures and Brexit were quite recent, and reliable studies on the impacts of these in the housing market are only just coming out, their impacts have not been modelled in this work.

As described in the previous chapter (Section 5.2), *real new mortgage advances* is modelled as the *number of new mortgage advances per year* multiplied by *average real value of new mortgage advances*. The latter is driven primarily by *real house prices* (the results for which was presented in the previous section) and *average loan to value ratio of new mortgages*, which is an external input. The other key argument, the *number of new mortgage advances* is driven by five different factors, as you will recall from the previous chapter—one external (*average mortgage interest rate*) and four endogenous factors, namely *average deposit to income ratio*, *real private housing wealth*, *debt service ratio* and *leverage*. Figure 6.6 below shows the result of our reference mode replication test for *number of new mortgage* *advances*. Table 6.4 presents summary statistics for the two series as well as for the goodness of fit between simulation and data.

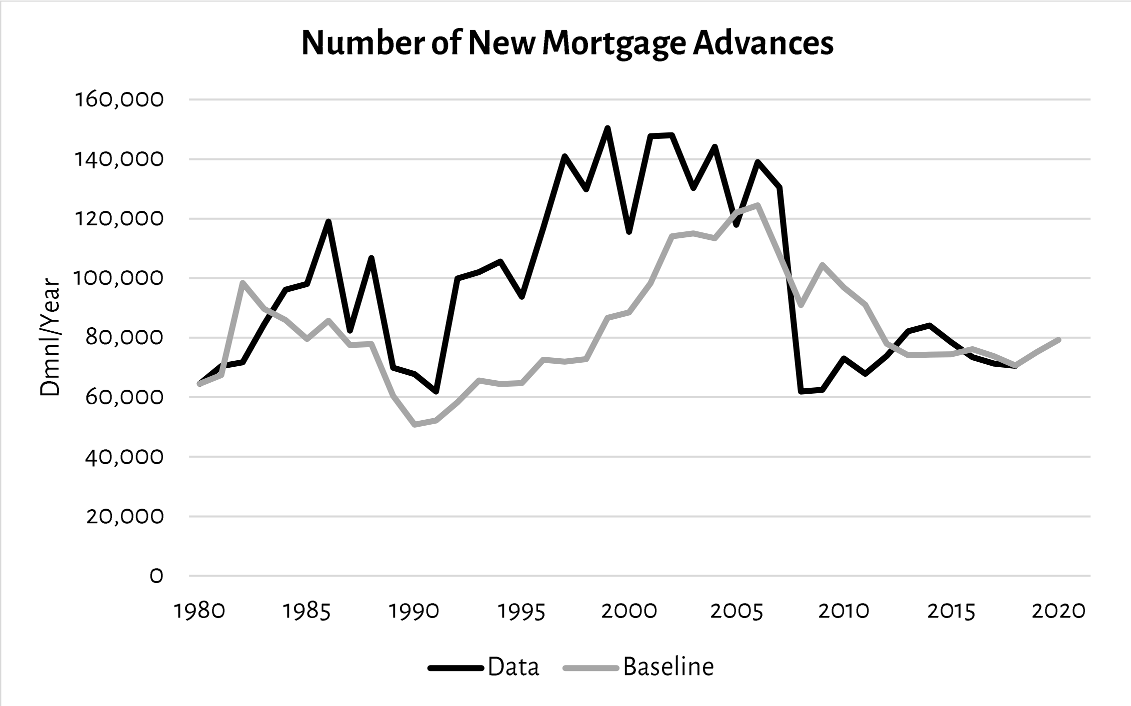

Figure 6.6 – Number of new mortgage advances: Baseline *(grey) vs.* Data *(black)* (UK Finance, 2017).

Table 6.4 – Number of new mortgage advances *summary statistics:* Baseline *vs.* Data

Number of New Mortgage Advances per Year	**Min**	**Max**	**Mean**	**St. Dev.**
Data	61,900	150,400	97,560	28,520
Baseline	51,050	111,500	80,440	14,560
Goodness of fit statistics				
RMSPE	U^M	U^S	U^C	R^2
27.7%	0.249	0.111	0.640	0.238

As seen in Figure 6.6, the two graphs compare somewhat similarly to the graph for *real new mortgage advances* shown earlier, in the sense that the model captures to some extent the boom-and-bust cycles of 1980–1990 and 1991–2008 in numbers of new advances, albeit not with great accuracy in terms of steepness of the rises and falls. The limited correspondence of simulation with data that is visually apparent is reflected in an RMSPE of 27.7% which is about one-fourth bias (U^M), about one-tenth unequal variance (U^S), and 64% unequal co-variance. In other words, a mean-squared error of about

27.7%*(0.249+0.111) = 10% is attributable to bias and unequal variance. This is not ideal and is evidence that the model is lacking one or more important driver(s) of the *number of new mortgage advances per year*, which could be either endogenous or exogenous to the scope of our study. Nevertheless, this imperfect match can be considered adequate for our purpose because, together with the good match we previously obtained for *house prices*, it generates an acceptable match for the value of *new mortgage advances*, as seen previously in Figure 6.5. This latter variable, which shows a close enough match between simulation and data, is what affects other parts of the model and is therefore more important.

Two other central variables in this sector are *mortgage balances outstanding* and the resulting *debt service ratio*. These are shown below in Figure 6.7 and Figure 6.8. For *mortgage balances outstanding*, data at a London level is only available for some recent years (2013–2018) from UK Finance. The stock is initialised in a way that simulation gives a figure to roughly match the most recent data point available in 2018, at about £270B. Since the stock's main inflow of *new mortgage advances* matches historical data sufficiently closely, and since the other inflow of *interest on mortgage debt* and the outflow of *mortgage repayments* are accounting entities which are straightforward in formulation, I have confidence that the simulated behaviour of the stock must be broadly representative of actual historical developments. Note the tremendous exponential rise in the stock of outstanding housing debt for London households, from an estimated ~£10B in 1980 to over £300B in 2020; a rise by a factor of 30 in nominal terms in the space of four decades. Also noticeable is the visible acceleration in the 2000s and the subsequent deceleration following the GFC in 2008. Nevertheless, it must be emphasised that, despite the drastic fall in lending in 2008, the stock of accumulated debt is still growing, albeit more slowly. This important distinction between the behaviour of the flow of new debt and that of the stock of outstanding debt is highlighted by Drehmann, Juselius and Korinek (2017).

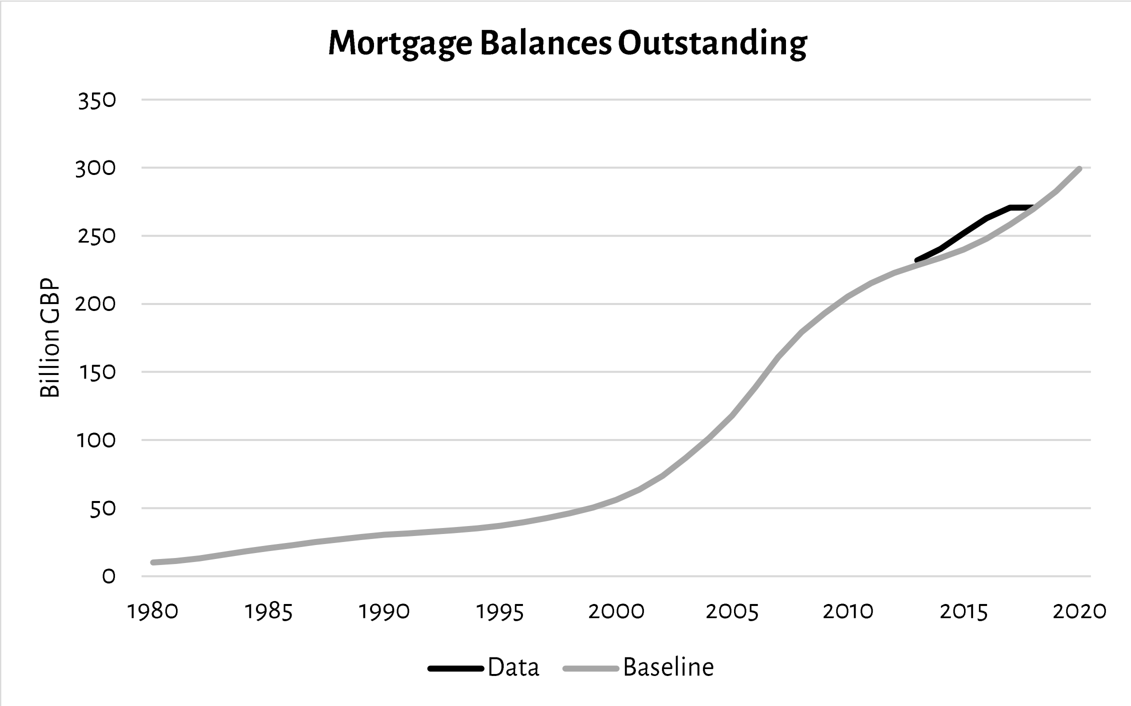

Figure 6.7 - Mortgage balances outstanding: Baseline *(grey) vs.* Data *(black) from UK Finance* (2017).

Results for *debt service ratio* (DSR) are shown below. Recall that DSR is formulated simply as *mortgage repayments* divided by *gross disposable household income* and captures the proportion of income which must be allocated to servicing housing debt at an aggregate level. Note that the only data available in this case, which covers the period between 1999 and 2017, is UK-level data. Regional data is not available for this variable. Therefore, the bias-type difference between simulation and data is not surprising. The gap could likely be explained with reference to higher average earnings in London as compared to the UK average. Nonetheless, it is evident that the two series follow a similar rise-and-fall trend during the first 15 years of the 20th century, which is a result of accelerating mortgage lending up to 2008 along with slowly increasing *average mortgage interest rate*, followed by a drastic fall in lending and much slower growth in the stock of debt, coupled with a fall in *average mortgage interest rate*. Note that, as conceptualised in this model, the fall in DSR which started in 2008 can, with a delay of several years, contribute to a re-rise in lending and a perpetuation of boom-bust cycles.

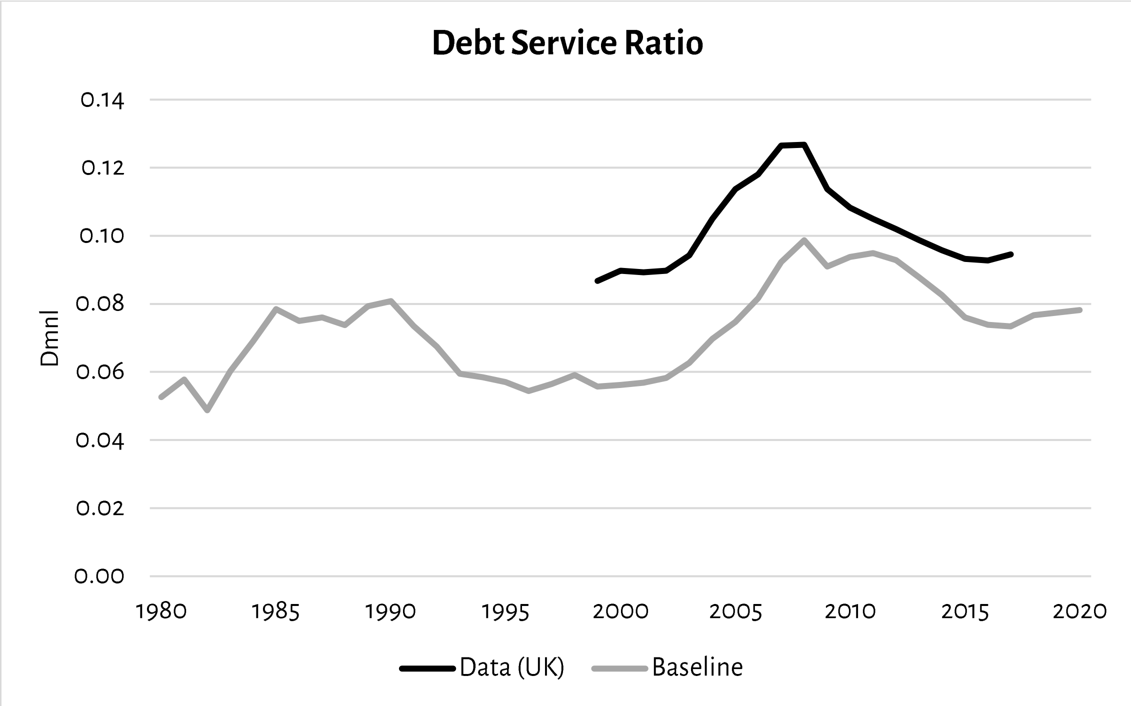

Figure 6.8 – Debt service ratio: Baseline *(grey) vs. UK-level* Data *(black) from Bank for International Settlements* (BIS, 2021)

6.2.2. Endogeneity Test

For this sector, we are going to conduct the endogeneity test in a different way than the previous sector. With regards to mortgage lending, the only strictly exogenous driver is *average mortgage interest rate*.[41] Therefore, in this case it is more straightforward to disconnect this one effect and investigate the impact of this change on new mortgage lending. If the pattern of behaviour changes drastically, this would mean that the model's behaviour is predominantly driven by this exogenous input, which is undesirable in an SD model. The opposite result would lend further support to the

[41] There is also the partially exogenous variable of *average real value of new mortgage advances* which is partially driven by the exogenous *average loan to value ratio for new loans*. This variable cannot be disconnected as it is essential for calculating the value of new loans.

endogeneity of key behaviour patterns in the model. The result of this test is shown in Figure 6.9.

These results show that disconnecting the external effect from *average mortgage interest rate* does not fundamentally change the pattern of behaviour in simulated mortgage lending, i.e., the exponential rise up to 2008 and the subsequent bust. The difference is that, absent the effect from falling interest rates, the cycle is lagged by a few years. This is what we would like to see in a model that claims its behaviour is primarily driven by internal interactions among endogenous variables rather than by externally fed data series. With reference to our dynamic hypothesis described in the previous chapter, the exponential rise observed in lending prior to the 2008 crisis can be attributed primarily to *R6 & R7: Housing-Finance Loops*, while the balancing feedback loops involving long time lags, *B3: Leverage Loop* & *B4: Debt Burden Loop*, are responsible for the subsequent bust. The time lags of several years from increases in leverage or debt burden to a suppressing impact on further lending result in the overshooting of new lending. These results do not support Miles and Monro's (2021) thesis which attributes the rise in house prices relative to incomes between 1985 and 2018 in the UK to the decline in interest rates.

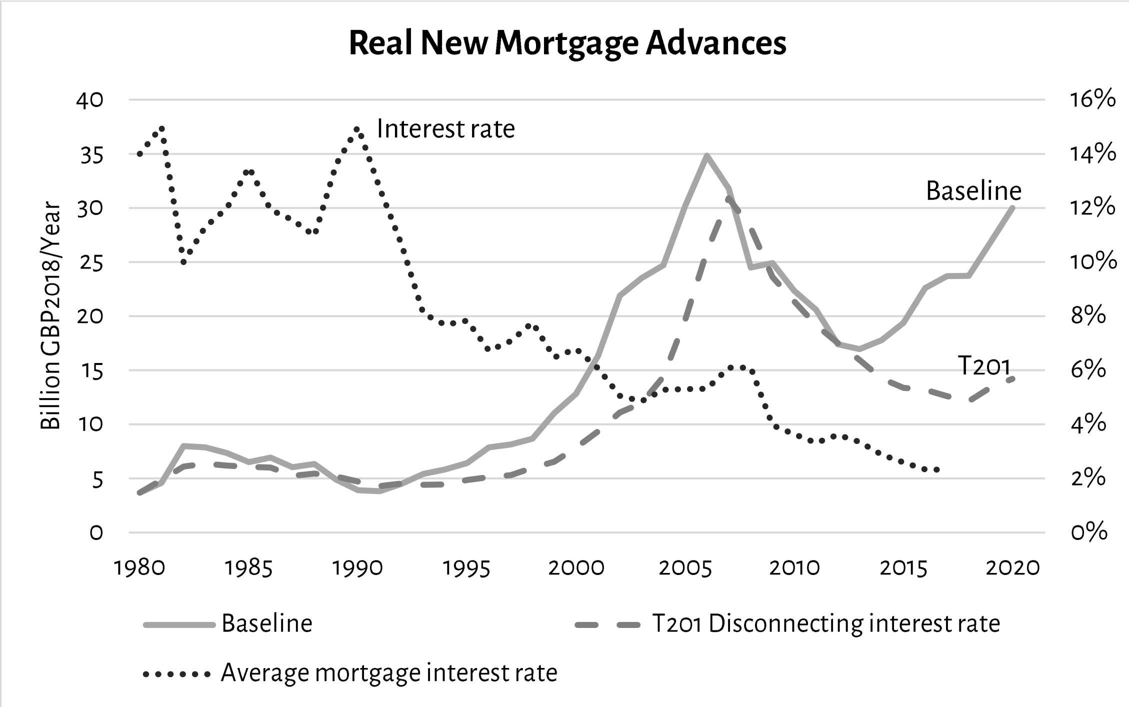

Figure 6.9 – New mortgage lending endogeneity test. Real new mortgage advances *(left-hand axis)*, average mortgage interest rate *(right-hand axis)*

Nevertheless, this change in structure, i.e., cutting the effect of mortgage interest rates on new lending, does change the curve in two important ways. First, the growth in lending is less steep in our test run as compared to *Baseline*, which shows the extent of the contribution of the steady decline in *average mortgage interest rate* since 1990 in the growth in mortgage lending. Secondly, it also shows that without the new wave of reductions in interest rates following the 2008 crisis, new lending would not have started to grow again as it does around 2013 in the *Baseline* (and much earlier in data).

6.2.3. Sensitivity Test

As with the previous sector, here again we are going to conduct a Monte Carlo sensitivity test on the elasticity of the five different driving factors of *number of new mortgage advances per year*, namely *average mortgage interest rate*, *average deposit to income ratio, private housing wealth, debt service ratio,* and *leverage*. We are going to allow the five respective *elasticity* parameters to vary with a uniform random distribution within a ±20% range of their base values previously obtained using calibration. The sensitivity of *real new* *mortgage advances* to random simultaneous variations in these parameters in 1,000 simulations is visualised in the confidence bounds of Figure 6.10.

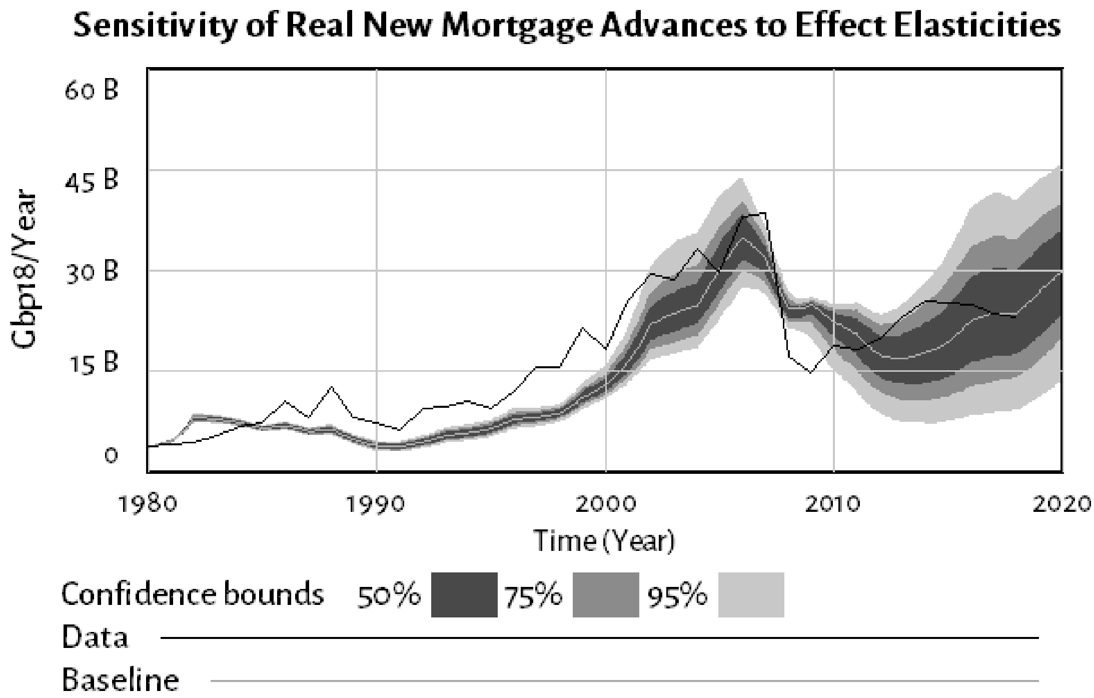

Figure 6.10 – Sensitivity of real new mortgage advances *to factor elasticities*

As with the sensitivity analysis carried out earlier for *house prices*, a salient feature of the graph presented above is the growing range of uncertainty during periods of market expansion where reinforcing loops are dominant and shrinking of the bounds during downturns (e.g., around 2008). The bounds show particular divergence towards the end of the simulation period, indicating a strong dominance of reinforcing mechanisms in that period (2012–2020) in the model. This strong dominance of growth forces is not observed in the most recent available data. In data, lending does start to grow in 2009 but peaks in 2014 and starts declining thereafter. This is an important mismatch between simulated model behaviour and data, which might be attributed to stricter financial regulations in the UK following the 2008 GFC which, as discussed in the previous section, are not included in the current model. Their inclusion in the future could bring the most recent behaviour of the model closer to actual data, not only with respect to lending but also, as a result of that, with respect to *house prices* and therefore the whole model. It would also be expected to have a dampening effect on the wide range of uncertainty towards the end of our simulation period.

6.3. Construction Sector Results

Recall from the previous chapter that this sector keeps track of flows of new construction and the stocks of housing in the private, housing association and local authority sectors. In this section, we are going to attempt to validate the structure and behaviour of this sector against available data.

6.3.1. Reference Mode Replication Tests

As mentioned in the previous chapter, the key variable in this sector is *private construction starts*, which directly determines the supply of new private housing in the market. Results of the reference mode replication test for this variable is shown in Figure 6.11. Goodness of fit statistics are reported in Table 6.5.

Table 6.5 – Private construction starts: *Goodness of fit statistics*

Private construction starts (houses/year)	**Min**	**Max**	**Mean**	**St. Dev.**
Data	3,250	17,440	11,296	3,195
Baseline	3,250	16,466	9,975	3,395
Goodness of fit statistics				
RMSPE	U^M	U^S	U^C	R^2
26.4%	0.265	0.003	0.732	0.487

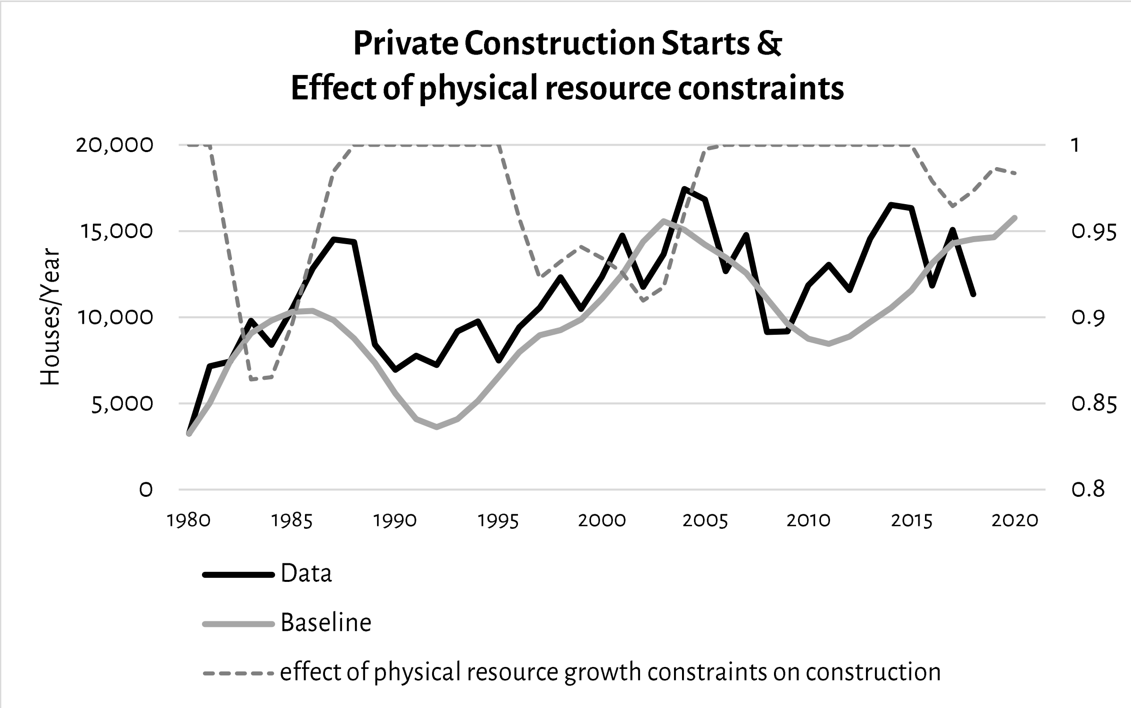

Figure 6.11 – Private construction starts *(left axis):* Baseline *(grey) vs.* Data *(black) from MHCLG* (2020b). Effect of physical resource growth constraints on construction *(right axis, dashed curve)*

As seen above, based on the three main driving factors included in the model, namely *new mortgage advances, expected house prices* and *residential planning applications success rate,* past developments in private construction activity are fairly well captured. The RMSPE is 26.4% and most of this error (73.2%) is due to unequal co-variance. The model roughly captures two of the major boom-bust cycles in data, i.e., the one in the 1980s and the one that stretches broadly between 1995 and 2008. The third and most recent cycle (2010–2018) is not well captured, with simulation rising with a delay behind data and not showing signs of regressing. This reflects a pattern that we have seen in comparing simulation against historical data for the key variables of all three sectors inspected so far, namely *house prices, new mortgage advances,* and *private construction starts.* For all these interconnected variables, we observe a slight downturn since 2015 in available data, which is not captured by the model. As previously mentioned, this failure of the model to follow real-world data for most recent years could be attributed to the exclusion of the effects of Brexit and of the FPC's recent macroprudential regulations which are believed to have led to lower-than-otherwise levels of lending (Peydro et al., 2020). Such effects, if included, would have propagated through all sectors of the model, also resulting in a downturn in residential construction for most recent years.

The breakdown of the root mean square error does show a non-negligible bias component of 26.5% (of a total 26.4% error, which equals an error of around 7%). Visually comparing the graphs, it can be seen that an important part of this error is mainly due to the gap between simulation and data during the late 1980s, where simulation does not quite capture the spectacular rise in construction. In an interview with a long-time director of one of the leading development firms in London, he indicated that the fall in interest rates during that decade was probably the key driver behind this growth. However, as mentioned in the previous chapter, an impact from interest rates did not appear to hold over our long-term time horizon because a similarly steep or steeper fall in interest rates during the 1990s or 2000s did not lead to a rapid growth in construction; in fact, looking at historical data, a rapid fall in interest rates (usually in reaction to worsening economic conditions) often coincides with a fall in construction as well (see Section 5.3). In short, the model somewhat undershoots historical data between 1985 and 1995 in *private construction starts*, and this remains a question for further probing in future research.

Figure 6.11 also shows developments in the auxiliary variable *effect of physical resource growth constraints on construction* with the axis on the right-hand side. As described in the previous chapter (Section 5.3), this multiplicative *effect*, which is a conceptual proxy for all construction resource constraints (e.g., labour, material, land) that cannot expand instantaneously to accommodate a potentially steep construction indicated by other driving factors, constrains *construction starts* where it is lower than 1. As shown, this effect kicks in during periods between 1981–1985, 1995–2005, and post 2015, preventing simulation from overshooting historical data during these periods. As the strength of this effect is chosen arbitrarily (judgment-based) rather than based on the literature, later in Section 6.3.3 I will test the sensitivity of model results to this assumed strength.

Figure 6.12 shows developments in dwelling stocks by distinction of tenure type, along with *total housing stock*, comparing the *Baseline* simulation (dashed lines) against *Data* obtained from MHCLG's Table 109 (solid lines). Note that the *local authorities* and *housing association stocks* are predominantly data-driven (as the respective *construction starts* variables are externally fed to the model for the past years and left as policy variables for the future, as used in the next chapter). The *private housing stock*, however, which is the largest, fastest growing, and perhaps most important, is endogenously determined, as just seen in the graphs for *private construction starts*. As can be seen, the model closely captures developments for all tenure types, and therefore for the *total housing stock*.

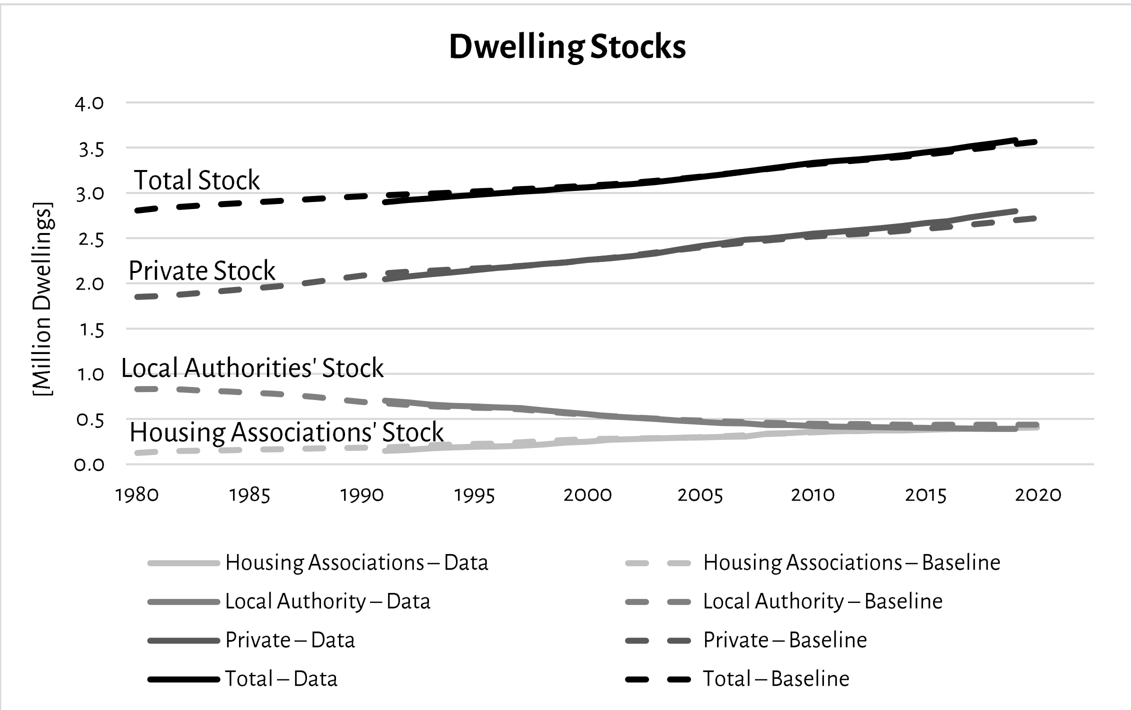

Figure 6.12 – Dwelling stocks by tenure: Baseline *(dashed) vs.* Data *(solid) from MHCLG* (2020a)

Two features in Figure 6.12 are perhaps worthy of closer attention. First, the graph clearly shows the large-scale move towards privatisation started by the Thatcher administration since the early 1980s, with the steady decline in the *local authorities' stock* since the beginning of the graph, and the rise in the *housing associations* and *private* stocks. These are the result of the Right to Buy (RTB) and Large-Scale Voluntary Transfer (LSVT) initiatives (see Sections 3.4.1.1 and 5.3), which are included in the model as external data inputs.

Secondly, and perhaps more interestingly, it is worth highlighting the slow growth in the various stocks of housing,[42] and comparing it with the remarkable exponential growth in the stock of housing debt (*mortgage balances outstanding,* see Figure 6.7). Taking the former variable as a generic proxy for housing supply and the latter as a key determinant of housing demand, it is therefore not at all surprising to observe that house prices have been soaring since the 1980s. Ryan-Collins (2018) points to this imbalance as an important driver of increasing housing unaffordability, not only in London or the UK but across many metropolitan areas in advanced economies.

6.3.2. Endogeneity Test

To reiterate, the key drivers of construction in this sector are the *residential planning application success rate, new advances,* and *expected house prices.* The latter two are endogenously generated within the model while the former is an exogenous data-driven input for 1980–2020, and a policy choice for the future, as exploited in the following chapter. Like with the previous sector, here again in order to gauge the level of the endogeneity of the behaviour of our central variable of interest, i.e., *private construction starts,* we disconnect the effect from the exogenous *residential planning applications success rate* to see how much of an impact it has. The result of this test is shown in Figure 6.13

[42] Such inertia is a common characteristics of physical stock variables (such as population, inventory, or greenhouse gas concentrations in the atmosphere) in systems (Sterman, 2000, p. 195), unlike non-physical levels (such as debt or stock prices) which can change much more rapidly.

(dashed grey curve) along with the previously shown *Baseline* and *Data* curves, as well as the available data for the *residential planning applications success rate* (dotted black curve). This data comes from the MHCLG's District Planning Application Statistics which provides data for total residential planning application decisions, total granted, and total refused by distinction of major/minor developments. For our purposes, the two types are aggregated, and the aggregate success rate is used.

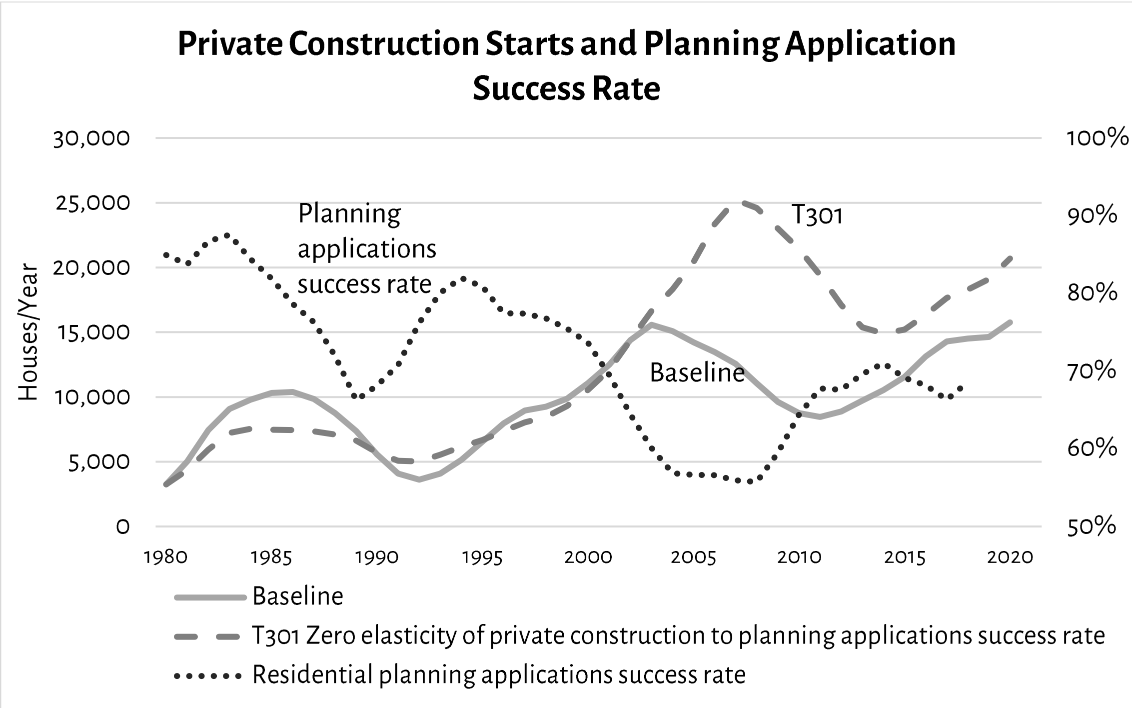

Figure 6.13 – Endogeneity test: private construction starts *(left axis) and* planning applications success rate *(right axis)*

Data sources: MHCLG's Table 253 (2020b) *and District Planning Application Statistics* (2020d).

It becomes clear from the graph above that cutting the effect from the *planning applications success rate* makes a significant impact on the behaviour of *private construction starts*. The rate of construction during the first decades goes below *Baseline* in comparison, while it stands considerably above *Baseline* after early 2000s. Moreover, the peak that occurs around 2003 in the *Baseline* is postponed by about five years in the test run. This means that without the rapid decline in planning application success rates starting around the 2000s, construction starts could have kept rising to much higher levels up to 2008, given abundantly available mortgage loans in the run up to the GFC. This restriction, whether a deliberate counter-cyclical measure by the planning authorities or simply a product of too many 'ambitious' applications submitted by developers in a time of housing boom in an effort to secure market share (Hilber & Vermeulen, 2016), was perhaps a good thing given the unforeseen and painful bust in housing following the GFC in 2008. Laxer planning regulation could possibly have led to a much more severe housing bubble such as the one that led to the phenomenon of 'empty urbanism' in post-financial crisis Spain characterised by 'a huge urban land stock in different phases of development […], along with [a] large amount of unsold new housing stock' (Burriel, 2016, p. 159).

In any case, the above test reveals that, while the characteristic cycles in construction persist even without the external input from *planning applications success rate*, this factor does have a strong impact on construction starts. This, however, is not unexpected given the high *elasticity of private construction to planning applications success rate* (with a value of 3 as obtained via calibration), which is in line with the plethora of studies (especially by scholars at the London School of Economics) suggesting a strong impact from planning restrictiveness on housebuilding, as reviewed in Chapter 2 (see Section 2.3). This test also suggests likely promising results in expanding the supply of new build housing from policies targeted at relaxing planning restrictiveness, as will be investigated in the next chapter.

Note, however, that this test also shows that the occurrence of cycles in construction is unrelated to planning restrictions and rather has to do with its link to changes in house prices and new mortgage lending (see *B1: Supply Loop* and *B5: Mortgages Support Housebuilding* Loop in Figure 3.12). *New mortgages* has a strong impact in our formulation of *private construction starts* and shows strong correlation with it, as shown in the previous chapter (Figure 5.12). Via its impact on the future cash flow of residential property developers, instability with roots in the housing finance market propagates through the physical sector of housebuilding.

6.3.3. Sensitivity Tests

For the Construction Sector, we will skip reporting on the elasticity sensitivity analysis, which shows broadly similar features as those run for the previous two sectors, i.e., confidence bounds which grow wider over time, especially during boom periods, and shrink during bust periods. Instead, as promised in the previous chapter, we will run a sensitivity test around the *effect of physical resource growth constraints on construction* variable, and the shape of its associated graphical function.

As you might recall from the previous chapter (Section 5.3), this feature of the model is foreseen to represent, in an aggregate way, the various physical constraints against any rapid expansion of *private construction starts* beyond the current capacity of the industry. The endogenous proxy used for giving an idea of the existing capacity in the industry is a 5-year moving average (3^{rd}-order SMOOTH function) of the past rate of *private construction starts*. In this section, we will first run an automatic Monte Carlo sensitivity test on the length of this moving average, which was arbitrarily assumed equal to 5 years. In a way, this could be roughly interpreted as the time it takes the industry on average to expand its capacity in response to a higher demand for housebuilding. We will thus let this parameter to vary within a relatively wide range of ±50%, i.e., between 2.5 and 7.5 years, and inspect the extent to which such random variation would impact the resulting rate of *private construction starts*. The result of this test is visualised in Figure 6.14. The quite narrow confidence bounds reassuringly demonstrate that the behaviour of the model is not very sensitive to our assumption regarding the length of the moving average, within a reasonable range.

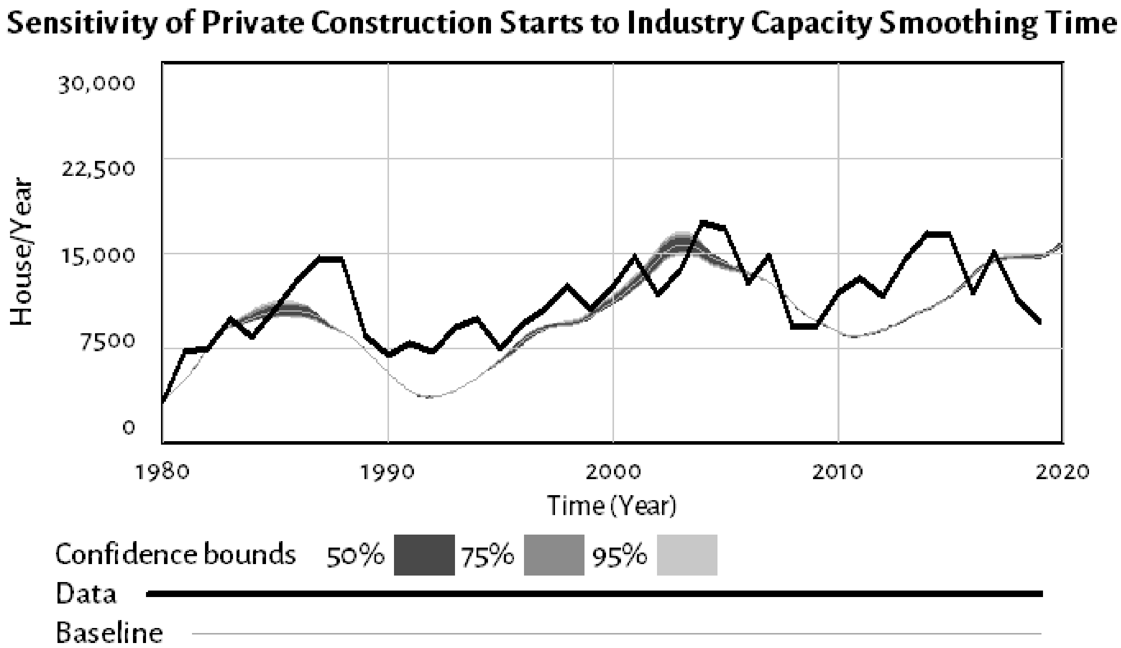

Figure 6.14 – Sensitivity of private construction starts *to* industry capacity smoothing time.

The next test is intended to give an idea of the sensitivity of *private construction starts* to the steepness of the *graph function for physical resource growth constraints in construction* as shown in Figure 5.13 of the previous chapter. The slope of this graph function, as previously described in Section 5.3, represents the degree to which such physical growth constraints are likely to inhibit a potential expansion in housebuilding instigated by a rapid growth in demand. Since in this case we are not dealing with a single uncertain parameter, but rather the shape of a graphical function, the sensitivity test cannot be conducted using the software's automatic Monte Carlo analysis feature and needs to be done manually. For this purpose, we envisage two alternative strengths for this effect, represented by two different slopes for the respective graph function, as depicted in Figure 6.15. In one simulation, we are going to increase the (absolute) slope by 50% using the 'steeper' graph function (dotted line) and in another simulation we will decrease the steepness of the graph by 50% (dashed line), representing a smaller impact from physical resource constraints. The simulated effect of this variation in the rate of *construction starts* is shown in Figure 6.16.

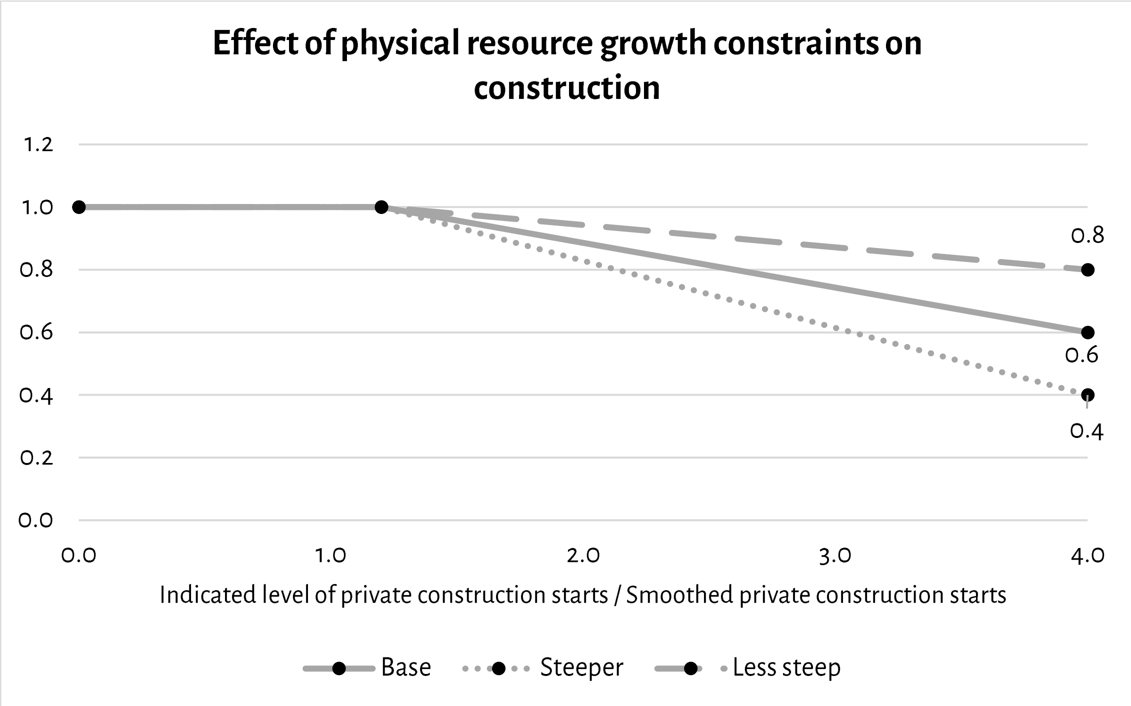

Figure 6.15 – Variations in the slope of the graph function for physical resource growth constraints in construction

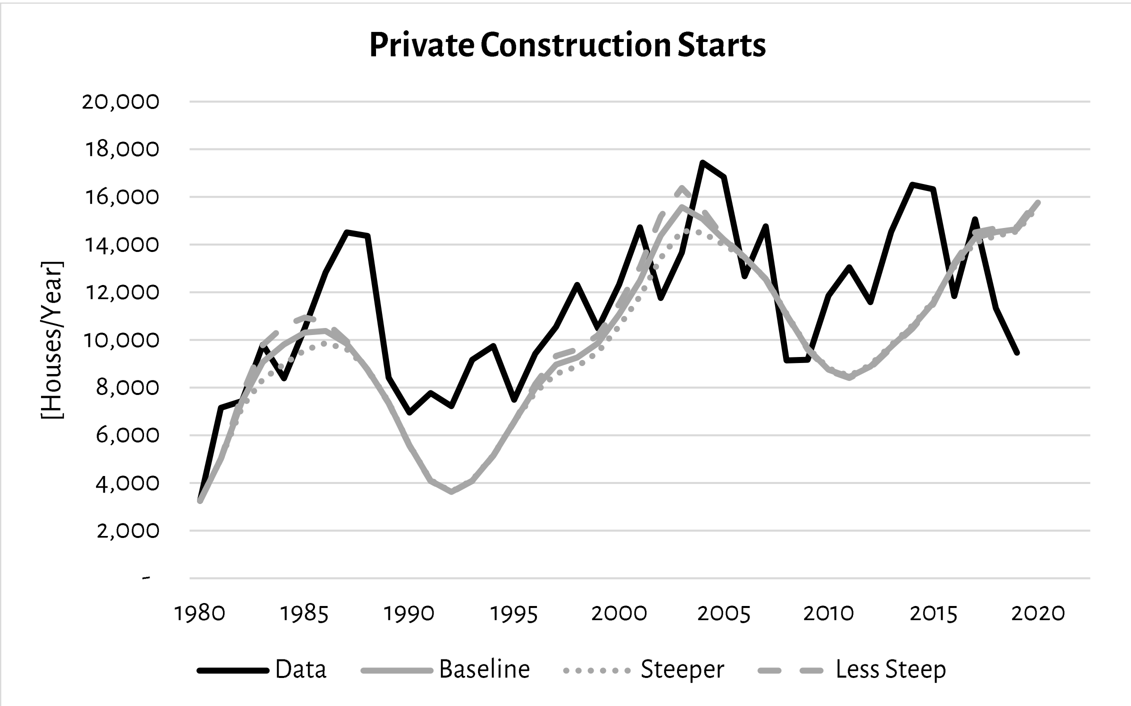

Figure 6.16 – Sensitivity of private construction starts *to the slope of the* graph function for physical resource growth constraints in construction

As seen above, in the case of the 'steeper' function, which reflects a situation where construction is more strongly impacted by physical resource constraints in times of growth (dotted curves in both figures), during particularly rapid growth periods where the effect kicks in (as previously identified in Figure 6.11), *private construction starts* lies very slightly lower than *Baseline*. In the opposite case ('less steep'/dashed curves), where the strength of the impact from physical growth constraints is assumed to be weaker, *private construction starts* is allowed to grow to slightly higher peaks. This result is as expected, and indicates that, even though the assumed variations in the slope of the graph function were considerable (±50%), the resulting impact on the behaviour of the model is not drastic. The piece of structure involving the *effect of physical resource growth constraints on construction*, as described in the previous chapter, attempts to quantify a conceptual qualitative assumption based on common sense. The results from the two sensitivity tests shown in this sub-section show that, although we do not have hard evidence in support of this quantification, the nature of our results is expected to remain the same within a reasonable range of uncertainty around our assumptions, which is reassuring in terms of the usefulness and validity of the model.

6.4. Tenure and Rent Sector Results

As detailed in the previous chapter, the fourth and final sector of the model, the Tenure and Rent Sector, captures developments in two key private tenure types—private renting and owner-occupation—as well as the dynamics of private rental prices based on the above. Having obtained these variables, the sector also calculates the shares of different social (affordable) and private tenure types in total, the average annual costs of housing for each tenure type based on inputs from this and previous sectors, as well as a final weighted average housing cost of all households. Below, we study developments in model-simulated results for this sector and compare them with data where available.

It is noteworthy that, given the slightly elaborate stock and flow structure of this sector as well as the previous one, and in order to verify the 'conservation of mass' in the stocks, a mass-balance check (Dangerfield, 2014; Schwaninger & Grösser, 2020) was performed on the key stocks in these two sectors, as a structure-oriented behaviour test. The result of the mass-balance check equation *(Cumulative sum of all inflows + initial values of stock) – (Cumulative sum of all outflows + current values of stock)* (Dangerfield, 2014, p. 47) was never greater than 0.01% of the stock value for any of the stocks, which is negligibly close to zero and demonstrates the internal consistency of the stock and flow equations, and that no mass is gained or lost in the model.[43]

6.4.1. Reference Mode Replication Tests

Figure 6.17 shows past developments in the shares of different tenure types: *owner-occupied*, *social* (which I have defined as the sum of *local authorities* and *housing association tenures*), and *private rental*. For our purposes, we have assumed that the given figures for numbers of dwelling stocks can be considered to represent figures for tenure, i.e., we have assumed that each dwelling unit is occupied by one household. Although this is not a completely accurate assumption, it is considered sufficient for our purposes.

In each case the data curve (from MHLG's Table 109) is shown in black, while the *Baseline* simulation is shown in grey. The model traces overall developments in data fairly well, although with a degree of phase incoherence. With regards to the shares of two private tenure types, owner-occupation, and private rental, both data and simulation show a period of relative stability followed by a rise in private rental and a concurrent fall in owner-occupation. The incoherence between simulation and data arises from the fact that the mentioned period of relatively steep rise/fall starts notably (several years) earlier

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[43] Ideally, the result of the mass-balance check equation should be absolute zero. However, due to computational approximations by the software, very small errors are often inevitable. In the case of this model, changing the integration method from the Euler method to a second-order Runge-Kutta method (Ventana Systems, n.d.) reduced the maximum proportional error of the mass-balance check down to $1.8e^{-5}$, which can be taken as zero for all practical purposes.

in simulation than in data. In the model, this change in trend is primarily driven by a concurrent rapid rise in *average deposit to income ratio*, which is in turn caused by an acceleration of growth in *real house prices*, starting around 1992 in the *Baseline* simulation. This accelerated growth occurs in real-world data for *real house prices* somewhat later, around 1996–1996 (see Figure 6.1). This suggests that if we were able to get a more accurate fit between simulation and data for the central *real house prices* variable, then we would probably obtain a closer fit for tenure developments as well, but it does not call into question the modelled dependence of developments in tenure to the *average deposit to income ratio*.

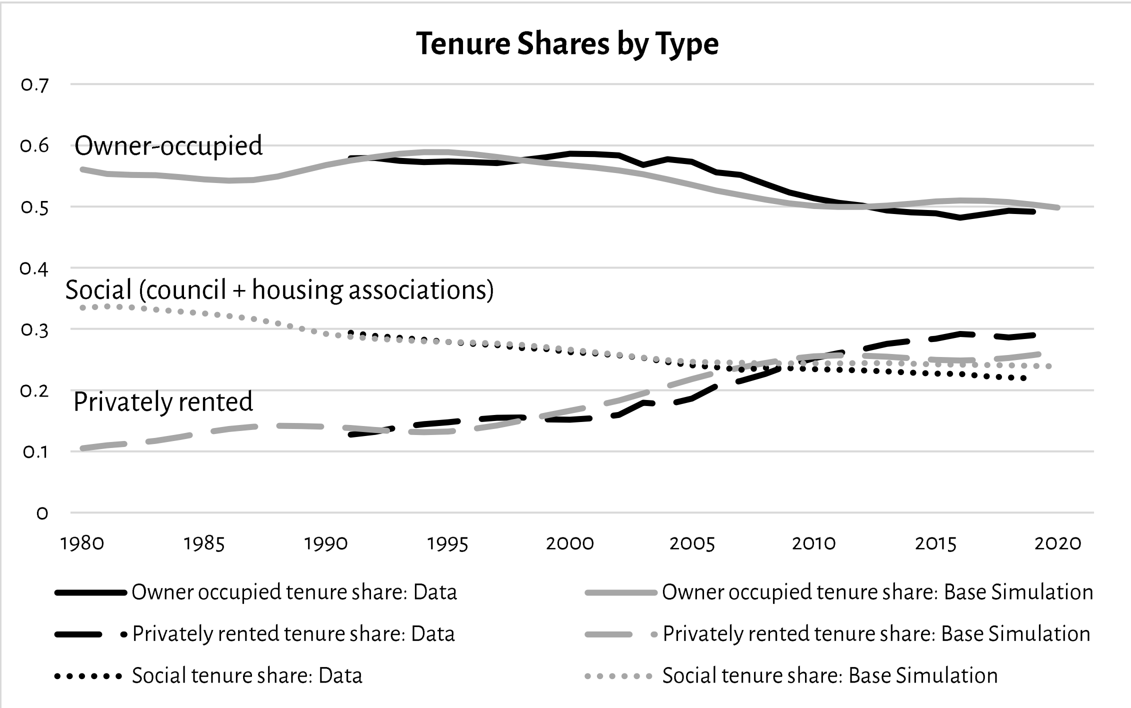

Figure 6.17 – Tenure shares *by type:* Baseline *(grey) vs.* Data *(black) from MHCLG* (2020a)

The most salient feature of developments in the shares of different tenure types, as seen in the figure above in historical data as well as in simulated model behaviour, is the rise in the privately rented share at the expense of a decline in the share of owner-occupied and social (affordable) housing during the past two decades.

A consistent long-running data series on average private rents in London is hard to come by. For the data curve shown below I have put together a series supplied by the GLA and based on the Family Resources Survey, running from 1995 to 2014. For the years prior to that, I have extrapolated the earliest figure in this series using the year-on-year growth rates from a separate data series on *mean registered rent of registered social landlords* from the discontinued *Housing and Construction Statistics* publication by the former Department for the Environment, Transport, and the Regions (DETR). Here again, based on the three endogenous driving factors described in the previous chapter, i.e., *real house prices, privately rented tenure share,* and *private sector vacant dwellings,* the model manages to broadly capture past developments in *real private rents*. Table 6.6 presents summary statistics for the two series compared (*Baseline* vs. *Data*) as well as statistics for the goodness of fit. The RMPSE is 13.2%, with 92.4% of the error being attributed to unequal covariation (U^C), and a coefficient of determination of 0.818, which all point to a sufficiently satisfactory fit.

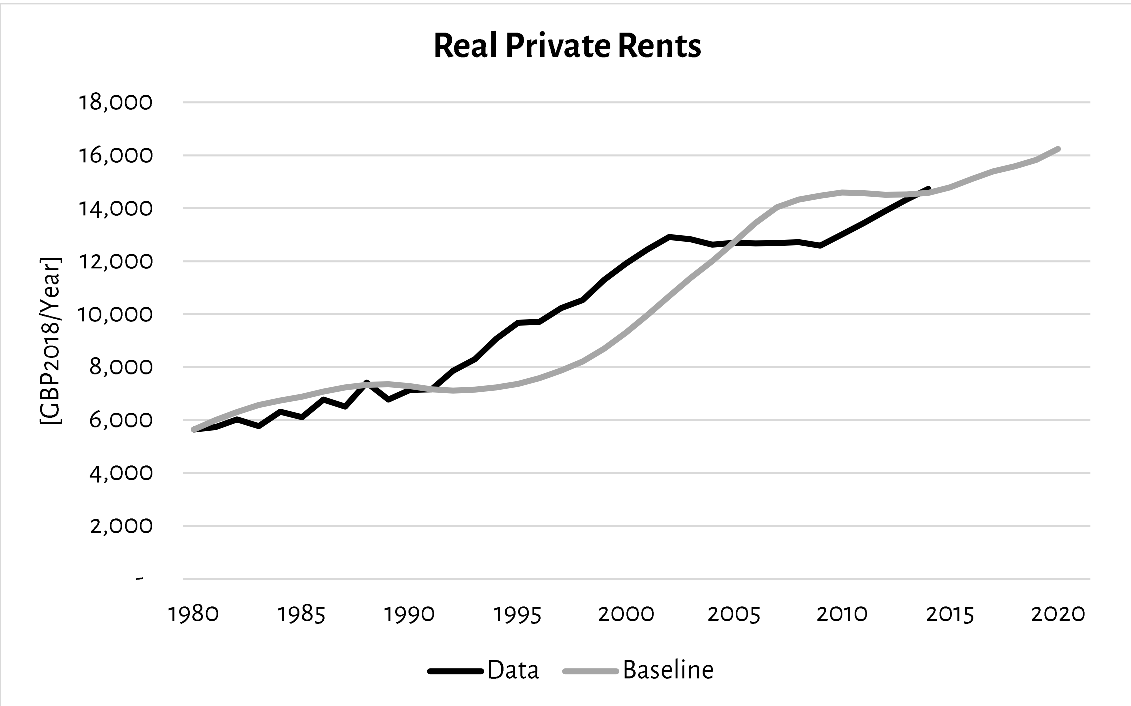

Figure 6.18 – Real private rents: Baseline *(grey) vs.* Data *(black) from the Family Resources Survey (1995–2014)*

Table 6.6 – Real private rents*: Summary statistics and goodness of fit*

Real private rents (GBP2018/year)	**Min**	**Max**	**Mean**	**St. Dev.**
Data	5,644	14,732	9,987	2,986
Baseline	5,644	16,418	10,552	3,571
Goodness of fit statistics				
RMSPE	U^M	U^S	U^C	R^2
13.2%	0.057	0.019	0.924	0.818

The most prominent feature of the past behaviour of *private rents* is its continuous rise in the past, especially during the 1990s, as broadly reproduced by the model, albeit with a degree of lag. If not exact, the value of this reproduction lies in its full endogeneity: All drivers of *private rents* are internally driven, with no exogenous factors in play (and therefore no test of endogeneity of behaviour needed). The continual growth in rents can be explained with reference to the *R5: Priced-out Loop* (see Figure 3.7) described in Section 3.5.1, with growth in *average deposit to income ratio* increasing the relative demand for privately renting and the *privately rented tenure share*, and therefore *private rents*. Note also that *private rents* obtained in this way drives *expected rents* which feeds back to drive *expected housing ROI* (return on investment), encouraging investment in housing assets and therefore contributing to the inexorable rise in *house prices*.

Another key output of this sector is *average real housing costs for all except outright owner-occupier households* (see Section 5.4). Simulation results for this indicator are shown in Figure 6.19, both in absolute terms and as a percentage of gross disposable household income.

Looking at the results shown below, *average real housing costs for all except outright owner-occupier households* appears to have risen by a factor of over three times since 1980 in absolute terms, from £3,217 to £10,270 in constant 2018 prices. In percentage terms as proportion of average disposable household income, they have risen from 9% to 14%, i.e., by over 50%. Note that these are average figures over all households who pay any rent or mortgage costs towards housing, including those who rent within the affordable sectors. Recall also that due to structural reasons explained in Section 5.4 (p. 216), these results are highly likely to be underestimates, and therefore attention should be paid to trends rather than values. These results are generally in line with recent research by the Resolution Foundation which shows that when housing costs are accounted for, over half of UK households have seen falling or flat living standards since 2002 (Clarke et al., 2016).

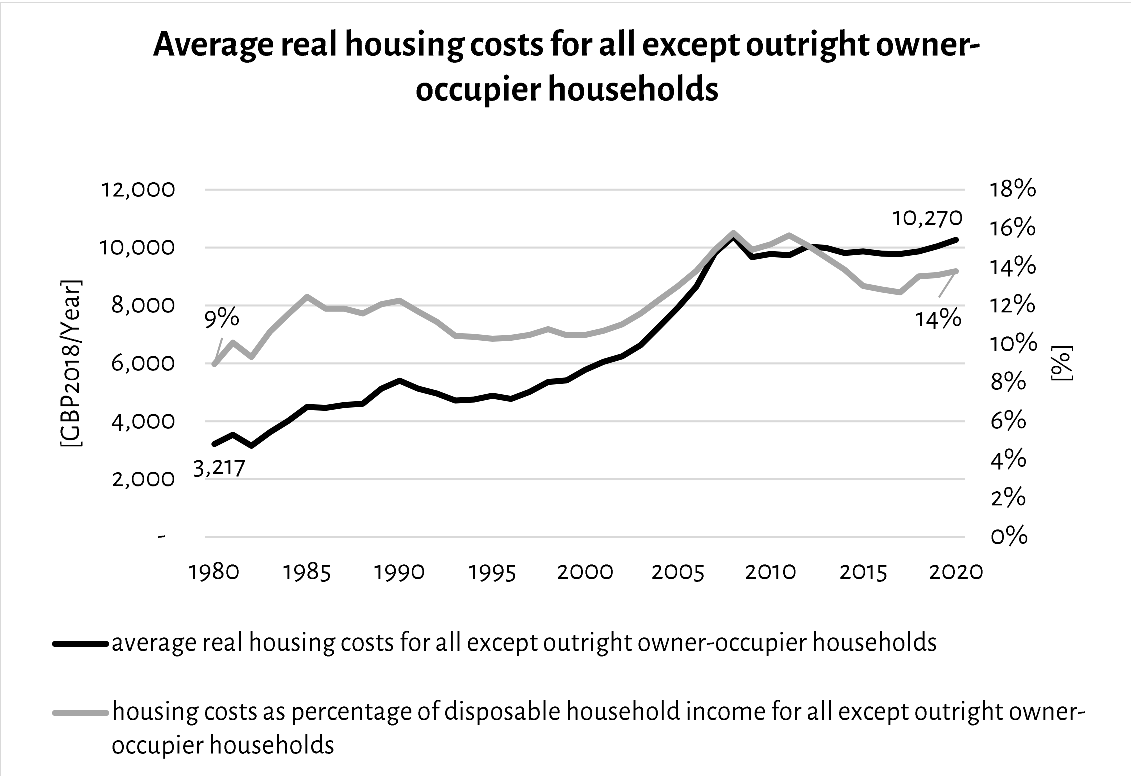

Figure 6.19 – Simulation results for average real housing costs for all except outright owner-occupier households *(absolute in black and as percentage of disposable household income in grey).*

6.4.2. Sensitivity Test

The indicator just introduced, namely *average housing costs as percentage of disposable household income for all except outright owner-occupier households* constitutes a key output of this model, and an indicator well worth tracking and looking at when designing policies for the future, as will be done in the following chapter. The key feature of this variable is its high degree of endogeneity and interconnectedness with the rest of the model, both within the sector and with other sectors. However, as mentioned earlier, there is a degree of uncertainty surrounding these results. In order to get an idea of the range of this uncertainty, in this section we run a sensitivity analysis aiming to find an expected range within which average housing costs as percentage of household income are likely to lie. Given the high degree of interconnectedness of this indicator with the rest of the model, we run a Monte Carlo sensitivity analysis where we allow virtually all uncertain parameters in the model (a total of 45 parameters)—including all elasticities, time lags and initial values—to vary in a range of ±10% around their *Baseline* values according to a uniform distribution. Each parameter's uncertainty range is taken smaller than the usual ±20% used for previous tests since in this case we are dealing with many parameters. The resulting confidence bounds around our indicator of interest are shown in Figure 6.20.

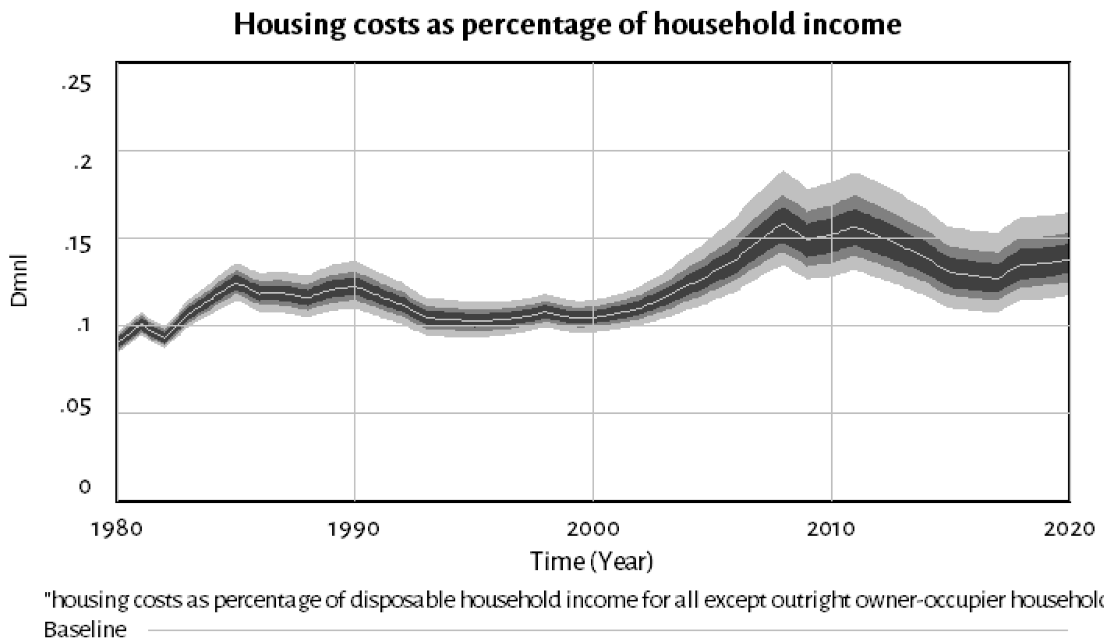

Figure 6.20 – Housing costs as percentage of household income for all except outright owner-occupier households: sensitivity to all model parameters

As with previous sensitivity analysis results, the range of the uncertainty grows over time, in particular during periods of growth. By the end of the simulation period, where in the *Baseline* average housing costs reach around 14% for households not owning their home outright, the result of this test suggests that this percentage is likely to lie roughly between 12% to 17% with a confidence of 95%. Once again, note that due to certain limitations of the model (see p. 216), these are much likely to be underestimates.

6.5. Chapter Summary

In this chapter, we set out to validate the behaviour of the model generated from the structure described in the previous chapter against existing historical data on key indicators. For each sector, we ran three main types of validation tests via investigating (a) whether the model can replicate important patterns of behaviour in historical data, (b) the extent to which the model's behaviour results endogenously, as a result of internal model interactions, and (c) the degree of sensitivity of the model's behaviour to our parameter assumptions.

As an overall verdict based on this three-pronged testing strategy, it can be said that (a) the model is generally capable of replicating trends in past behaviour with reasonable fidelity, (b) the model's dynamic behaviour is primarily driven by endogenous interactions of internal feedback loops, with occasionally notable impacts from external inputs where expected (as in the case of the effect of planning applications success rates on private construction or the impact of average loan-to-value ratios on mortgage lending), and (c) the ranges of uncertainty around model results due to random variations in uncertain parameters appear to be broadly within reason, although confidence bounds tend to grow wider over time, especially during growth periods. In particular, the model proved capable of endogenously generating both the exponential growth in house prices and mortgage lending over recent decades, as well as the housing finance-driven instability and chronic boom-and-bust cycles in the market.

The potentially promising results presented in this chapter do however come with important caveats. To start with, as a result of the quite long timeframe of our model, what can be reasonably expected from its unchanging and aggregate structure would be to replicate the key patterns in past behaviour, rather than the exact behaviours with point precision. As was seen in most of our reference mode replication tests, the model does a satisfactory job at reproducing important long-term patterns in behaviour, such as growth or oscillation in key indicators. It does not, however, accurately replicate past data point-by-point, which makes it unsuitable for short-term forecasts where precision is needed.

In particular, for most of our key indicators, the model did a less-than-satisfactory job in closely following most recent developments of the past 5-6 years. As conjectured earlier, it is probable that this mismatch has to do with (a) the exclusion of the Bank of England's post-2014 macroprudential policies, and (b) the impact of the Brexit referendum. These two exclusions—primarily due to their recency and a scarcity of peer-reviewed evidence on their impact—do nevertheless constitute important limitation to the representativeness of the model for the most recent years of study (since 2014). Each of these present high priority areas for future improvements in this work.

All in all, these validation results provide a strong basis for moving towards using the model to project into the future, both under business-as-usual and under alternative assumptions with regards to policy or external inputs, which is the topic of the next chapter.

Chapter 7. Policy Analysis and Discussion

Chapter 7. Policy Analysis and Discussion

Having built sufficient confidence in the model's ability to replicate and explain the real system's past dynamics, in this chapter, we are going to use the validated model to project into the future and generate foresight with regards to likely future developments in key indicators, both under business-as-usual and under various sets of alternative assumptions. In comparing the performance of scenarios, we are going to focus on developments in house prices, affordability, construction, and housing finance, both in terms of trends and in terms of volatility. We will also have an eye on developments in private rents, tenure, and average housing costs. The primary policy objectives against which scenarios are compared are the following: improvements in purchasing affordability (as measured by house price to income ratio), expansion in construction, reduction in average housing costs, as well as mitigation of systemic oscillations and improvements in the stability of the system, as compared to business-as-usual.

With regards to simulation results, it is important to stress once more the distinction between *foresight* and *forecast*, as highlighted by Sterman (1991). As opposed to the impossible task of forecasting, in the sense of point prediction of the future, *foresight*, which is what scenario analysis in system dynamics aspires to generate, has to do with the model's ability to set forth likely developments in the system under given assumptions regarding either external conditions or the implementation of certain policies or interventions. Far from generating point predictions, the purpose of such analysis is to warn about unintended consequences of interventions or of conditions that could lead to deleterious dynamics and unfavourable results in the future, to reveal the most promising paths of action towards desired results, and to highlight potential positive or negative synergies among considered policies that could accelerate or hinder the attainment of desired results.

On the futility of striving for point predictions in complex real-world systems, Sterman (1991) points out that 'there is substantial agreement among modelers of global problems that exact, point prediction of the future is neither possible nor necessary' (Sterman, 1991, pp. 20–21). In contrast, model-based foresight is useful for deciding on the best course of action given existing information, just as when 'your doctor tells you that you will have a heart attack if you do not stop smoking, this advice is helpful, even if it does not tell you exactly when a heart attack will occur or how bad it will be' (Meadows, Richardson, & Bruckmann, 1982, p. 279).

The rest of this chapter is structured as follows: the first section starts by asking what developments would be likely in London's housing system if current conditions continue to prevail (i.e., under business-as-usual). Next, we are going to turn our attention to the analysis of selected supply side policies in Section 7.2, followed by an analysis of selected high-level demand side policies in Section 7.3. Subsequently, in Section 7.4, we are going to investigate the likely consequences of combining supply side interventions with demand side regulations and see whether the two sets of policies together can bring us close to our desired outcomes. Section 7.5 considers the potential ramifications of an external macro-economic shock, namely a rise in mortgage interest rates, and compares the potential resilience of the system towards these shocks under business-as-usual as compared to the *Comprehensive* scenario introduced in the preceding section. Section 7.6 concludes the chapter with a summary and discussion of the insights gained through simulation in light of existing literature.

Table 7.1 gives a brief overview of the scenarios to be simulated in this chapter. The scenarios will be presented in more detail at the beginning of each section.

Table 7.1 – Scenario assumptions

Scenario title	Acronym	Assumptions	Additional remarks
Business-as-usual	BAU	No changes over *Baseline*.	*Number of households*, *gross disposable household income*, and *GDP deflator* are extended to 2060 (see Section 7.1). This applies equally to all scenarios.
Supply-side Scenarios			
Affordable Homes Programme	AHP	Starting 32,500 new affordable housing units annually in 2021 until end of simulation (70%, i.e., 22,750 units, by local authorities and 30%, i.e., 9,750 units, by housing associations).	Based on the new Draft London Plan's Affordable Homes Programme (GLA, 2019).
Relaxed Planning Restrictions	RPR	Gradual increase in the success rate of residential planning applications from the current 69% to its historical peak of 88% (1983).	Increase of 2% every year during 2021–2030. Loosely approximating the flexible zoning proposal in the government's *Planning for the Future* white paper (MHCLG, 2020f).
Integrated Supply-Side	ISS	Combination of above assumptions for AHP and RPR.	
Demand-side Scenarios			
Capital Gains Tax	CGT	Extending capital gains tax to all housing (inc. primary residences), ratcheting up to 28% in four years.	7% in 2021 14% in 2022 21% in 2023 28% from 2024 on, in line with current tax on secondary residential property sales.

Scenario title	Acronym	Assumptions	Additional remarks
Loan-to-Value Ratio	LTV	*Average loan to value ratio* for new lending reduced by 1% every year for seven years, from the current 0.66 down to 0.59.	E.g., via implementing appropriate macroprudential caps on LTV ratios by the Bank of England.
Historically Anchored Valuation	HAV	Regulatory enforcement of property valuation for mortgage lending based on 5-yr moving average of house prices, instead of open market value.	Effective immediately.
Integrated Demand-Side	IDS	Combination of above assumptions for CGT, LTV and HAV.	
Comprehensive Scenario	—	Combination of all assumptions above (i.e., ISS + IDS).	
External Shock Scenarios			
Interest Rate Rise	IRR	Doubling of *average mortgage interest rates* over five years (2.6% to 5.2% in 2025).	Applied over the BAU scenario.
Interest Rate Rise-Comprehensive	IRR-C	Same as above, applied over the *Comprehensive* scenario.	

7.1. Business-as-usual Scenario

As shown in the previous chapter, the model starts four decades ago in 1980, allowing us to use four decades of historical data for model parametrisation, calibration, and validation. Likewise, in extending the simulation into the future, we are also going to simulate for 40 years ahead until 2060, in order to let the feedback loops that involve lengthy time delays pan out, to clearly observe the occurrence and recurrence of potential boom-bust cycles in the future, and to see the long-term impact of policies that involve long implementation times and delayed effects.

To let the model run into the future, three of the model's exogenous inputs with reasonably predictable trends need to be extended into the future. These three variables are *number of households*, *gross disposable household income* and *GDP deflator*. Besides these, for the *Business-as-usual* simulation, the remaining exogenous variables are kept constant at their last existing data point. This ensures that any non-trivial dynamics arising in the future will be a result of internal interactions of feedback loops within the model, rather than arising from external shocks fed to the model via exogenous data series.

The time-series for *number of households* has been extended into the future based on the ONS's figures for past years coming from the Labour Force Survey, extrapolated into the future by the author using the implied growth rates of ONS's 2018-based official forecast on number of households (ONS, 2020e) until 2039. The ONS has published its detailed methodology for household projections on its website (ONS, 2019a). From 2040 until 2060, linear extrapolation (using Excel's FORECAST.LINEAR function and the data for the preceding five years in a rolling fashion) has been used, which in fact closely replicates the results of the ONS's more sophisticated forecast method up until till 2039.[44]

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[44] The reason the ONS's future projections were not used directly, and rather their implied growth rates were applied on past data from the Labour Force Survey (LFS) data is the following: I have used LFS-based data for the past, as this is empirical survey data. In contrast, ONS generates model-based 'projections' for past years, in the same way as it does for the future (ONS, 2018). Switching to this series in the future would have introduced an artificial 'jump' in the series immediately following the last empirically

Similarly, *gross disposable household income* (GDHI) is linearly extrapolated into the future based on historical data (1997–2018) from ONS's regional GDHI dataset (ONS, 2020h). Again, the trend in the original data for past years is well captured using simple linear regression (R^2=*0.9806*), meaning that using a linear extrapolation for projecting into the future is going to be reasonably reliable in setting the context for our policy analyses. *GDP deflator*, a standard measure of inflation, is also linearly extrapolated. In this case too, a linear regression model closely captures historical developments for the past 20 years with an R^2=*0.9961*.[45]

Based on these extrapolations (and otherwise the exact same model and parameters previously used for the *Baseline* simulation), the results for extending the simulation until 2060 under *Business-as-usual (BAU)* are shown in Figure 7.1. As clear from the graphs, simulation suggests that under business-as-usual, future behaviour of various key variables is going to be characterised by cyclical fluctuations. Considering the tight-knit interconnectedness of variables in the model, as described previously, these oscillations are a feature—of varying significance—in all of the variables shown. Note, however, that the model only captures the long-run large-amplitude cycles, and not

estimated data point, which would not have been representative of reality. I am grateful to Ian Mulheirn, who has written extensively on the topic of England's household projections (Mulheirn, 2018a, 2018b) and whose advice led me to the above choice of method for extending my time-series.

[45] Here, the astute reader might ask how come I use linear extrapolations here while previously I have argued strongly against it. Indeed, in a model of the overall economy, it would have been a serious flaw to take household incomes and inflation as exogenous and use linear extrapolation to extend them into the future. However, the focus of this model is on housing, and one must draw the boundary somewhere. Here, given the very linear trajectories of these two variables in the past and the boundaries of the model, this assumption seems justified.

short-term fluctuations (as captured for instance by Keen's (2013) highly specified monetary Minsky model of the economy).

Figure 7.1, panel (A), exhibits simulated future developments in *real house prices*, which shows roughly one and a half boom-and-bust cycles during the next forty years, as do other key variables in the system shown in the other panels. *Average house price to income ratio* (not shown here) follows a similar pattern and is projected to grow by nearly 110%, from currently 7.5 years of income to about 15.9 years in 2060, signalling a fall in affordability (by 53%) to less than half its present level.

In line with this rise in prices and fall in affordability, the private rented sector (PRS) is expected to continue to rise at the expense of the owner-occupied tenure, as shown in panel (C). Simulation shows that under *Business-as-usual*, by 2060 private renting is close to replacing owner-occupation as the majority tenure (although, given the cyclicality, there is likely to be a turnaround in the trends soon after). Private rents too are expected to rise in line with the increasing demand for private renting, as shown in Panel (B). In this scenario, *real private rents* are projected to increase by about 40% over the next four decades, from currently around £16,200 per year on average (in constant 2018 prices) to over £22,800 in 2060.

In the graph for *real new mortgage advances* (panel D), the oscillations are more pronounced. This is not surprising given that large-scale boom-and-bust cycles in housing finance are not without precedent. According to simulation, new mortgage lending per year is expected to continue to grow exponentially while also fluctuating widely, with a trough at around £12B in constant 2018 prices around 2043 to a peak at around £70B near the end of the simulation period.

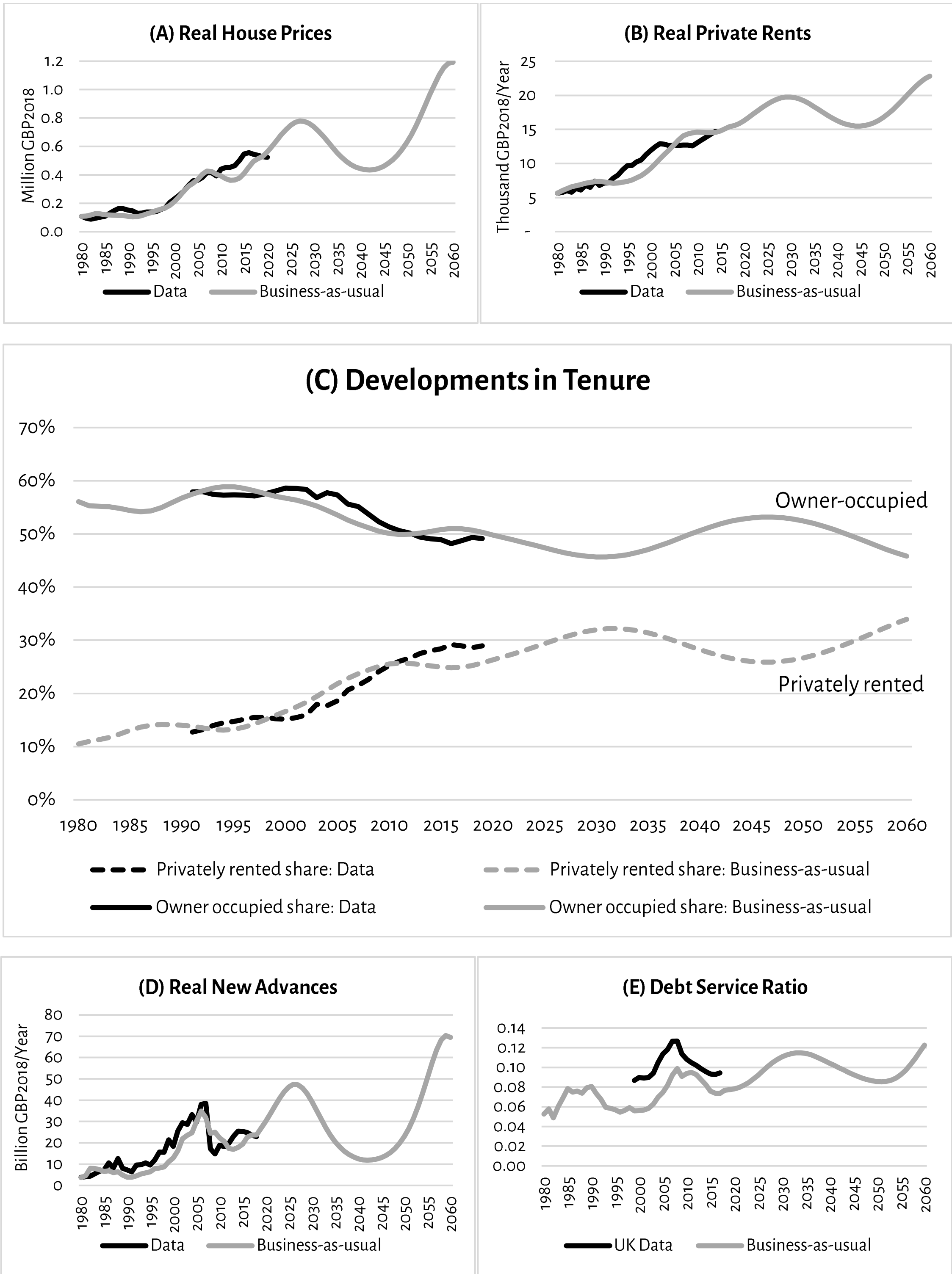

Figure 7.1 - Business-as-usual *(grey) vs. Data (black) (A)* Real house prices*; (B)* Real private rents*; (C)* Owner-occupied *and* Privately rented tenure shares*; (D)* Real new advances*; (E)* Debt service ratio[46]

Debt service ratio (DSR) lags *new mortgage advances* with a delay of several years, peaking for the first time around 2033 at 0.115, around five years after the first projected peak for *real new mortgage advances*. Also, oscillations in DSR are less accentuated than those in *new advances*. From a system dynamics perspective, the lag and the smoothing between DSR and *new mortgage advances* is a result of the intermediate stock of *outstanding mortgage debt* separating the two variables and the long maturity of housing debt. DSR, which is formulated as *mortgage repayments* divided by *gross disposable household income*, peaks when *mortgage repayments* and the stock of *outstanding mortgage debt* both plateau as a result of the total outflow (*mortgage repayments*) becoming almost equal to the total inflow (*new mortgage advances* plus *interest on mortgage debt*). This only happens several years after *new mortgage advances* has peaked and started falling, but the stock of debt continues to grow because the falling inflow is still higher than the rising outflow. Drehmann *et al*. (2017), using lending data from 16 advanced economies, empirically confirm that debt service peaks several years (4 years on average in their data) after the peak in new borrowing.

The Mortgage Sector and in particular *debt service ratio* are also at the core of the model's oscillatory behaviour. The oscillations arise mainly because of the lengthy time lag between the rising *debt service ratio* and its negative impact on the number and volume of *new mortgage advances*. In principle, long information delays in balancing feedback loops such as the *Debt Burden* and *Leverage Loops* (see Section 5.6) are sources of instability and oscillations in dynamic systems (Sterman, 2000, p. 114). As seen in Section 5.2, the model includes a time lag of several years between DSR and its impact on *number of new mortgage advances*, which is the time it takes for the impact of the debt service burden to propagate through the real economy, through contracting households' consumption, investment, the economy in general, and therefore on banks' willingness to issue further lending. This is likely to lead to excessive boom periods which Juselius and Drehmann (2020, p. 362) have called 'growthless credit booms'. This boom in credit that is invested in existing housing assets contributes to create additional wealth for existing homeowners rather than to growth in the productive economy and in wages, which sets the stage for an eventual downturn as a result of the impact of the accumulating debt overhang on the economy.

This result is also in line with seminal research by Claudio Borio (2014) from the Bank for International Settlements who—building on Minsky's earlier Financial Instability Hypothesis (Minsky, 1992)—presents an endogenous theory of financial cycles and asserts that 'the financial boom should not just precede the bust but cause it' (Borio, 2014, p. 186). Borio (2014) places this view in contrast to the dominant view on business fluctuations which relates the occurrence of cycles to random exogenous shocks. According to his appraisal of existing literature, current economic models tend not to account for the presence of disequilibrium stocks (such as the stock of accumulated *mortgage balances outstanding* as included in the present model), or if they do, they include them exogenously, rather than allowing such accumulations to be driven by preceding booms. Given the persistence of the cycles, this dominant view does not really help to further our understanding of the mechanisms behind this persistence or on how to prevent them from happening. As aptly put by Borio, 'since shocks can be regarded as a measure of our ignorance, rather than of our understanding, this approach leaves much of the behaviour of the economy unexplained' (Borio, 2014, p. 187).

The role of the delay in the effect from *DSR* to *new mortgage advances* in generating oscillatory tendencies in the model can be tested by investigating the hypothetical consequence of eliminating, or drastically reducing, this delay in the future. This could be thought of as a situation where the DSR in a particular economy is closely and centrally monitored and new mortgage lending regulated based on that information: a kind of hypothetical macroprudential policy. The result of this test is shown in Figure 7.2. In this figure, beside the historical *Data* and *Business-as-usual* curves, the dashed curve shows a simulation where, between 2020 and 2025, the time lag in the effect from *debt service ratio* to *number of new mortgage advances per year* is gradually but steeply shortened by a factor of 10, from 7.5 to 0.75 years. As can be seen, as a result of this change, *real new mortgage advances* rapidly adjusts down to a more stable trend with significantly dampened oscillations. This implies that if current DSR were to be monitored more closely and with as little delay as possible, and if this information was taken into account in a new regulatory framework towards restricting growth in new mortgage lending in case of excessive growth in DSR, then according to this simulation we could expect to see much less volatility in the housing finance sector, and by extension in the housing market in general.

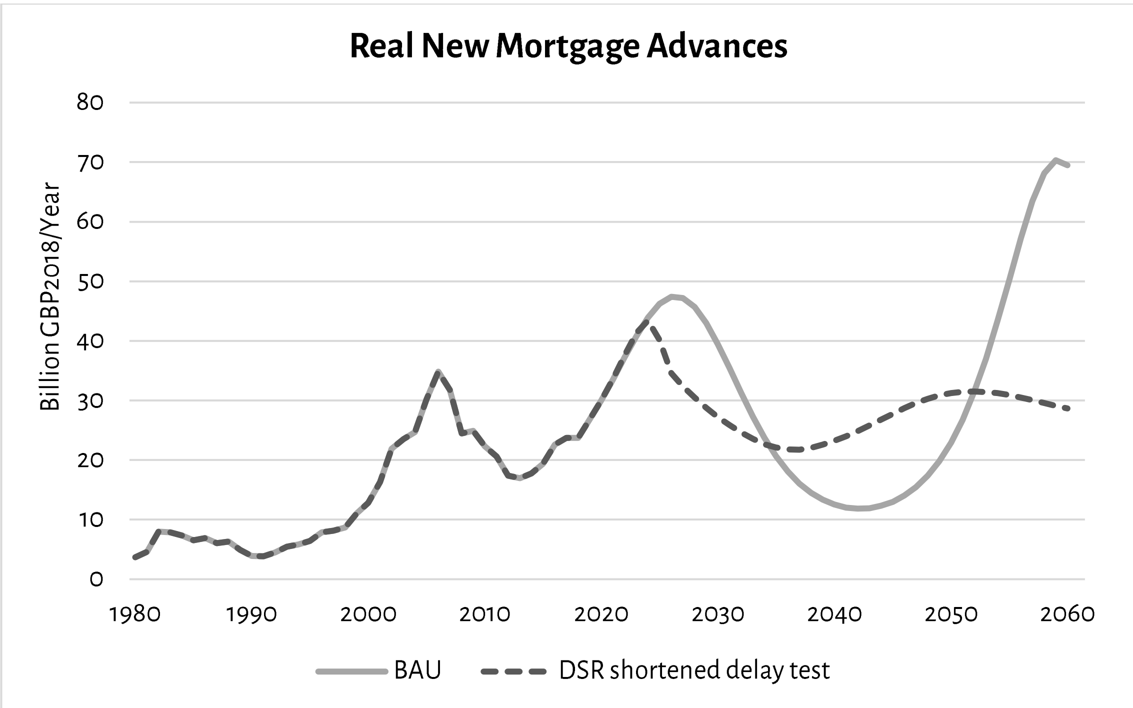

Figure 7.2 – Result of shortening time lag in effect of debt service ratio *on* number of mortgage advances

A recent publication by the European Central Bank (ECB) (Rünstler et al., 2018) studies the cyclical properties in 17 EU economies, with a particular focus on the housing-finance nexus, and finds evidence of persistent 'medium-term' cycles in credit volumes and house prices, with a cycle length of 8 to 30 years. The results presented above show cycles of about 30 years in length, which is at the higher end of the range found in the ECB and other studies. My experiments with the model revealed that shorter cycles are possible with adjustments to key parameters, e.g., with a quicker adjustment of lending to rising *leverage*. However, such changes would reduce the quality of the *Baseline* simulation's fit to historical data. It is conceivable that certain structural features of the system (such as the delay in the effect from *leverage* to new lending) would have changed over the decades, potentially shortening the periods between oscillations and making them occur more frequently. The same ECB study mentioned above reports that dynamic stochastic general equilibrium (DSGE) econometric models, which are commonly used for monetary policymaking, are incapable of generating persistent endogenous cycles (Rünstler et al., 2018), as the present model does. This persistence and endogeneity of cycles are the key features to emphasise in the resulting simulations under *Business-as-usual*.

The amplitude of future oscillations in simulated results, especially in *new mortgage advances* and in particular during the slump periods, is larger than what has been observed in the past. In reality, numerous external forces could change the course of the system. Chief among such potential exogenous factors is a likely government rescue plan coming into action in the event of an imminent 'bust' in the system of the scale seen in the simulation results in the late 2020s. Such rescue plan could potentially stabilise mortgage lending and house prices at a new elevated level, before another subsequent boom in the next cycle, and so forth. In Minsky's words, '[government] interventions may well induce a greater degree of upside (i.e., inflationary) bias to the economy' (Minsky, 1992, p. 5). As these external forces could not have been foreseen in the model, actual future trajectories of variables are bound to differ from simulated behaviour above. Therefore, the above results are not meant to convey that the boom-and-bust cycles would necessarily happen with the exact timings and/or amplitudes seen in the graphs. Nevertheless, simulation can serve to highlight tendencies to generate particular patterns of behaviour and to warn of unfavourable outcomes if appropriate measures are not taken.

In summary, simulation reveals that if current conditions continue to prevail, house purchasing affordability, as measured by *average house price to income ratio*, is likely to fall by over 50% between now and 2060, private renting will nearly overtake owner-occupation as London's primary tenure type, and it will also continue to become more and more expensive, reaching up to 40% above its current value in inflation-adjusted terms by 2060. Results also show that the tendency towards oscillation is built into the structure of the system. This is in line with Borio (2014), who argues that the financial cycle is most parsimoniously described in terms of the feedback relationship between credit and property prices. While the amplitude and consequences of oscillations are likely to be impacted by external shocks to the system, oscillations are not one-off 'black swan events' (Juselius & Drehmann, 2020, p. 360) that are primarily driven by external forces but are rather recurrent features resulting from the inherent delays in the system's balancing feedback loops.

7.2. Supply-side Policies

Having seen that under *Business-as-usual* housing can be expected to continue to become increasingly unaffordable to buy and to rent, in this section we are going to simulate two individual policies aimed at expanding the supply of new homes in London, as well as a third scenario where the two individual policies are combined. The first policy concerns affordable housing and the second one has to do with planning restrictions for private construction.

7.2.1. Affordable Homes Programme

The new draft London Plan identifies capacity for 65,000 new homes a year, 50% of which should be affordable. London's current Affordable Homes Programme, therefore envisages 32,500 new affordable homes a year between 2022 and 2032, which is foreseen to consist of 70% (22,750) social rent homes, 20% (6,500) shared ownership homes and

10% (3,250) intermediate rent homes (GLA, 2019). These are implicitly assumed to be delivered by housing associations and councils.

Thus, in the first alternative scenario, titled *Affordable Homes Programme* (AHP), we are going to assume the start of the construction of 32,500 new units of affordable housing in 2021 (to be delivered mostly in 2022 as foreseen by the Plan). The breakdown foreseen in the Plan is translated to 22,750 units (70%) local authority housing units (corresponding to 'social rent homes') and 9,750 units (30%) housing association housing units (corresponding to 'intermediate rent' and 'shared ownership' homes). This correspondence may not be fully accurate, but it represents what is feasible at the model's current level of detail and is sufficiently close to give an idea of the expected future outcomes of the current Affordable Homes Programme. It is also (rather optimistically) assumed that this new level of affordable housing construction will not stop in 2032, as in the Plan, but will rather continue up until the end of the simulation period in 2060.

It is worth pointing out that this constitutes a highly ambitious scenario in terms of the reinvigoration of social housebuilding. The latest existing figures from the MHCLG's House Building series (Table 253) (MHCLG, 2020b) for affordable housing construction starts by local authorities and housing associations in all London boroughs for the 2019–2020 period are 680 and 2,480 units, respectively, adding up to 3,160 unit in total. The aspired figure of 32,500 in the London Plan amounts up to over ten times these latest statistics. However, progress against the London Plan housing supply target, as reported in the London Plan Annual Monitoring Reports (GLA, 2021), is measured using an indicator of supply that takes into account all sources of supply (including conversions, changes of use, non-self-contained accommodation and long-term vacant dwellings returning to use), not just new building.[47] According to this measure, new supply of affordable homes of all types in 2018/19 was 6,509 units (GLA, 2021, p. 92), and the number of affordable homes granted planning permission in 2018/19 was 18,330 (GLA, 2021, p. 106). These figures make the target set in the Affordable Homes Programme seem less unrealistic, but still very much a stretch (77% higher than those approved for 2018/19).

Nevertheless, in terms of funding, it can be argued that a substantial part of the required investment for this ambitious programme would be paid back in savings on demand-side subsidies (primarily the Housing Benefit bill). For this scenario analysis, however, putting aside the question of feasibility, the aim is to investigate the likely impact of this assumption on key indicators.

The results of this scenario will be discussed in Section 7.2.4.

7.2.2. Relaxed Planning Restrictions

In the previous section, we described a scenario which entailed an optimistic expansion in the construction of affordable housing. The *Relaxed Planning Restrictions* (RPR) scenario, on the other hand, has to do with enabling an expansion in private housing construction. As seen in Chapter 5 (Section 5.3), the key variable taken to represent the restrictiveness of planning in the model is the *residential planning applications success rate*. Historically, this *success rate* has fluctuated around a generally declining trend, starting at 85% of applications in 1980 and ending up at only 69% in 2018. In this scenario, we assume a gradual relaxing of planning restrictions during the next 10 years, proxied by

[47] See Footnote 30 on page 194 for a discussion on why I have used data from the House Building series while the MHCLG recommends the Housing Supply series as the most comprehensive estimate of housing supply.

an increase in the success rate of applications from the current 69%, up to its historical peak of 88% previously seen in 1983. This implies an increase of two percentage points in this variable every year between 2021 and 2030. Implications of this assumption will be shown and compared to the other two supply-side scenarios in Section 7.2.4.

This assumption could perhaps be interpreted as the implementation of 'zoning', as implied in the government's recent *Planning for the Future* white paper (MHCLG, 2020f) which blames a complex, slow and uncertain process of obtaining planning permissions for the housing undersupply which, as assumed in the white paper, is at the root of the housing crisis. Towards streamlining the planning process, the government proposes that democracy should take place more at the plan-making stage, and that 'automatic permission' should be issued to compliant residential (and other forms of) development in growth and renewal areas (Gallent, de Magalhaes, & Freire Trigo, 2021; MHCLG, 2020f). Other commentators have concurred that the implementation of such flexible zoning could accelerate housing supply and mitigate the housing crisis (Breach, 2020a; Gallent et al., 2021).

7.2.3. Integrated Supply-Side Scenario

The third and final supply-side scenario simply entails a combination of the assumptions in the two previous scenarios, i.e., a significant and immediate rise in affordable housing construction starts to 32,500 units annually, as well as a gradual increase in the success rate of planning applications. This *Integrated Supply-Side* (ISS) scenario represents a strong and concerted effort towards increasing both social and private housebuilding via direct investment as well a streamlined and less restrictive planning.

The next section presents a comparison of results from the three supply side scenarios described above.

7.2.4. Comparing Results from Supply Side Scenarios

The set of figures below compare the results of the three scenarios described above against each other and against the *Business-as-usual* scenario. Figure 7.3 shows results for two key supply-side variables *private construction starts* (panel A) and *total housing stock* (panel B).

As seen in panel (A), *private construction starts* are expected to increase drastically as a result of relaxing planning restrictions. This is a direct result of the high level of dependence of *private construction starts* to *planning applications success rate*, as indicated by the high *elasticity of private construction to planning applications success rate* (see Section 5.3). This means that raising this *success rate* back to its peak levels in the early 1980s could have a significant impact on new housing supply and aligns with the emphasis of Hilber (2017), Cheshire (2018), and Breach (2020a), among others, on the importance of reforming the planning system for increased flexibility, and efficiency and lower restrictiveness, aimed at expanding supply.

It is also worth noting that in the *Affordable Homes Programme* (AHP) as well as the *Integrated Supply Side* (ISS) scenarios, *private construction starts* stands at a slightly lower level than *Business-as-usual* and *Relaxed Planning Restrictions* (RPR), respectively. This implies a small 'crowding out' effect, with the higher local authority and housing association housebuilding occurring at the expense of a slight decline in private construction. The main channel through which this effect operates in the model is via the additional supply of new affordable homes slightly bringing down prices and new mortgage lending along with that, both of which exert a downward pressure on *private construction starts*. Although historically, during the post-war years of expansive government housebuilding, such government intervention did not appear to crowd out private housebuilding (see Figure 2.1 on page 23), it is worth noting that, among various other factors, the structure of the housebuilding industry has changed since then, having become increasingly concentrated and oligopolistic. As discussed previously in Chapter 2 (Section 2.4.2), this has given the large developers who are dominating the industry the power to increasingly prioritise their profit margins over volume (Archer & Cole, 2014), and therefore it would be plausible to expect that direct government involvement in housebuilding could affect private housebuilding differently under current circumstances than it did in post-war years.

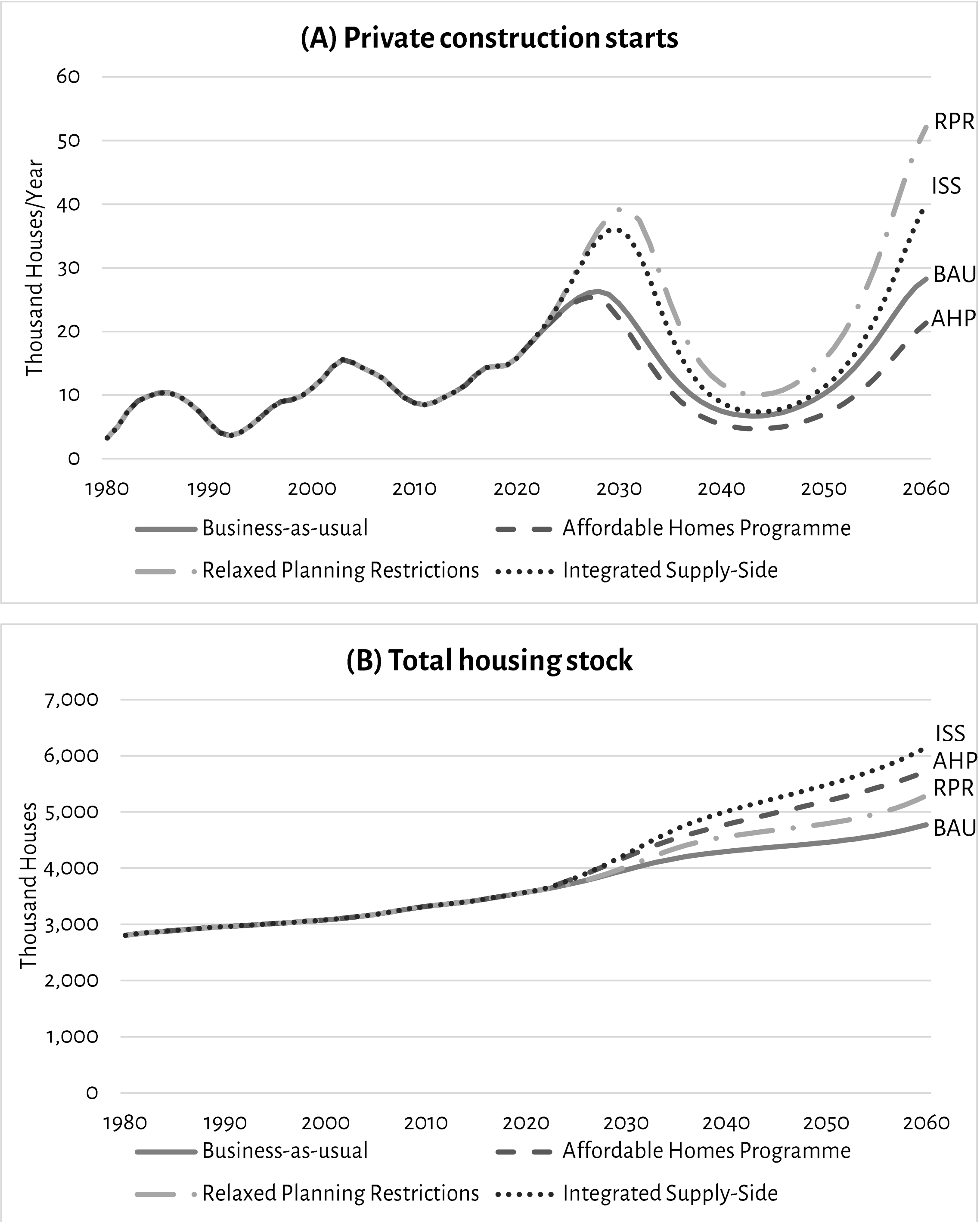

Figure 7.3 – Comparing supply-side scenarios: (A) Private construction starts *and (B)* Total housing stock

At the same time, however, the amplitude of the oscillations is much larger in the two market-oriented scenarios as compared to the AHP scenario, since in the former scenarios supply is more closely related to market forces (i.e., house prices and availability of mortgages) and thus more exposed to the oscillations brought on by the interaction of the *Housing-Finance* and the *Burden of Debt* feedback loops (see Section 5.6).

Note that, based on the structure of the model (see Section 5.2), an increase in the private housing stock, *ceteris paribus*, increases housing wealth and can contribute to a credit boom via that channel (*R7: Collateral* Loop), while an increase in the affordable housing stock does not entail this effect as this stock is assumed not to be financialised. Indeed, in his analysis based on the canonical 4QM stock-flow model (see Section 4.2.2.2), Wheaton (1999) finds that higher supply elasticity than demand elasticity is conducive to more oscillations as it leads to overbuilding during boom times. In practice, this occurred in countries such as Spain and Ireland in the lead-up to the 2008 GFC (Burriel, 2016; Klotz, Lin, & Hsu, 2016). A laxer planning, as in the RPR scenario, increases supply elasticity and in doing this, may make the housing system more exposed to oscillations (Duca, Muellbauer, & Murphy, 2010).

As seen above, the ISS scenario entails the most aggressive expansion in construction, with both a substantial increase in government-sponsored local authority and housing association housebuilding and a relaxation of planning restrictions leading to the rapid expansion of private residential construction. The result is that in this scenario, as can be seen in panel B of Figure 7.3, we see the fastest rise in *total housing stock* which ends up at around 6.1M units, 29% above its final level under BAU at 4.8M. Between the two other scenarios, it is shown that the *Affordable Homes Programme* gives the faster and stabler rise in the *housing stock*, reflecting the ambitious assumption of an over ten-fold increase in the supply of affordable housing in a short time span. By the end of the simulation period, *total housing stock* in the AHP, RPR, and ISS scenarios stands at 20%, 11% and 29% higher than BAU, respectively.

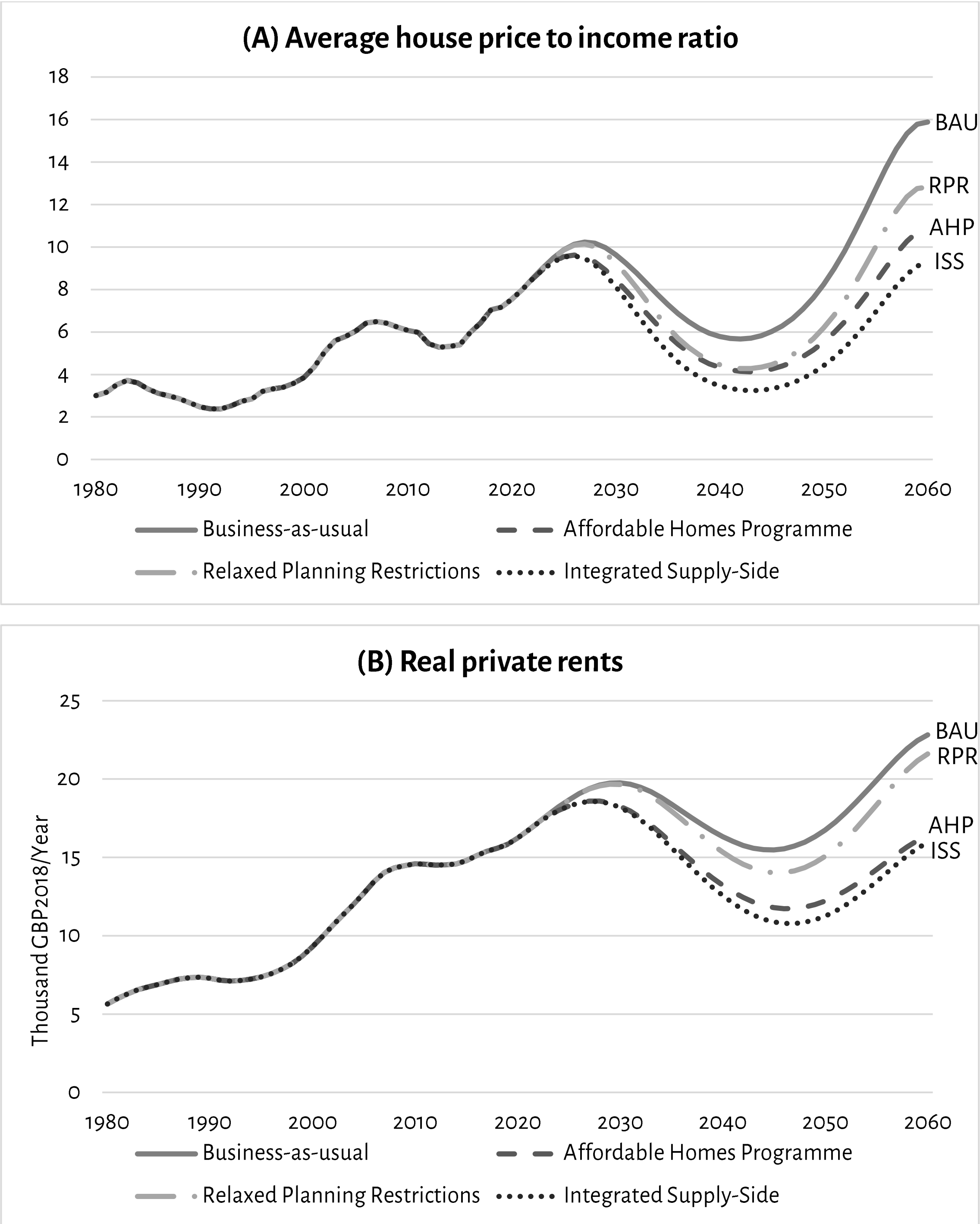

Figure 7.4 – Comparing supply-side scenarios: (A) Average house price to income ratio *and (B)* Real private rents

This acceleration in supply under our supply-side scenarios is reflected proportionately in price indicators, both for homebuyers and for renter. Figure 7.4, panel A, compares results of the three supply side scenarios for a key indicator of affordability, i.e., *average house price to income ratio*. As expected, as a result of the significant expansion in supply, affordability improves in all three supply side scenarios. The mean of *house price to income ratio* over the future simulation period (2020–2060), measured in number of income years, is improved by 2.0, 1.3, and 2.8 years in the AHP, RPR, and ISS scenarios, respectively (Table 7.2)—showing improvements in the same order as that seen above in the *total housing stock*. As a measure of variability, relative standard deviation[48] is lowered by 0.8% in the AHP scenario and increased by 2.0% and 5.5% in the RPR and ISS scenarios, reflecting the slight increase in volatility in the market-oriented scenarios, as discussed earlier. The cyclical property is still visibly present in all supply-side scenarios. In sum, the ISS scenario offers the best results in terms of affordability levels and the AHP scenario gives the best results in terms of variability of the same.

Simulated results for *real private rents,* as shown in Figure 7.4, panel B, show that all three supply-side scenarios lead to slower growth in private rental prices than in BAU. However, as expected, in the AHP scenario which prioritises the expansion of affordable housing and thus reduces demand for private renting, the reduction in *private rents* as compared to BAU is much starker than in RPR. In the *Integrated* scenario, the mean of *real private rents* over the 2020–2060 period is slightly lower than AHP (around £14,500 vs. £15,000 annually in constant 2018 prices) while volatility remains high: relative standard deviation is 19% in ISS versus 16% in AHP (Table 7.2). Under *Business-as-usual,* by 2060, *real private rents* reaches around £22,800 per year in constant 2018 prices, while in the *Integrated* scenario it reaches £16,000, a break of approximately 30%. This improvement in the affordability of the PRS sector, as captured by the model, can be attributed to a similar trend in *house prices,* comparably lower demand for private

[48] Relative standard deviation, also known as the coefficient of variation, and often expressed as a percentage, is a standard measure of dispersion and is defined as the ratio of the standard deviation to the mean.

renting, as well as greater availability of *vacant dwellings* due to the faster delivery of new homes enabled by the expansion in new supply.

Let us now turn to look also at projected changes in tenure by the end of the simulation period, as depicted in Figure 7.5. In the AHP scenario, as expected, we see a substantial increase in the share of affordable housing (local authority and housing association) tenure—15.9 percentage points by 2060. This is a result of the fact that the combined affordable housing stocks are expected to reach a level of around 115% higher than BAU in this scenario, while the private housing stock is expected to end up around 4.5% lower—a reflection of the expected 'crowding out' effect and the resulting contraction of the private sector. About two thirds of the 15.9 percentage point increase in the affordable tenure comes out of the privately rented sector and about one third from the owner-occupied sector. This is mainly because *house price*s (which is not shown here but whose dynamics are very similar to those of the *average house price to income ratio* shown earlier) are expected to grow more slowly than BAU under the AHP scenario, which results in lower-than-otherwise *deposit to income ratios* and higher affordability, meaning that the balance would lean towards owner-occupation rather than private renting.

In the RPR scenario, with the expansion in private housebuilding and the associated improvement in purchasing affordability (Figure 7.4, panel A), the model projects a small 1.3 percentage point increase in owner-occupation, which comes at the expense of the affordable tenure due to the fact that, without any foreseen expansion in affordable housebuilding, the *local authority* and *housing association stocks* are expected to grow much more slowly than the private housing stock (by 2060, total affordable housing stocks are expected to be almost equal to the BAU scenario, while the *private housing stock* is expected to be around 13.5% higher in this scenario).

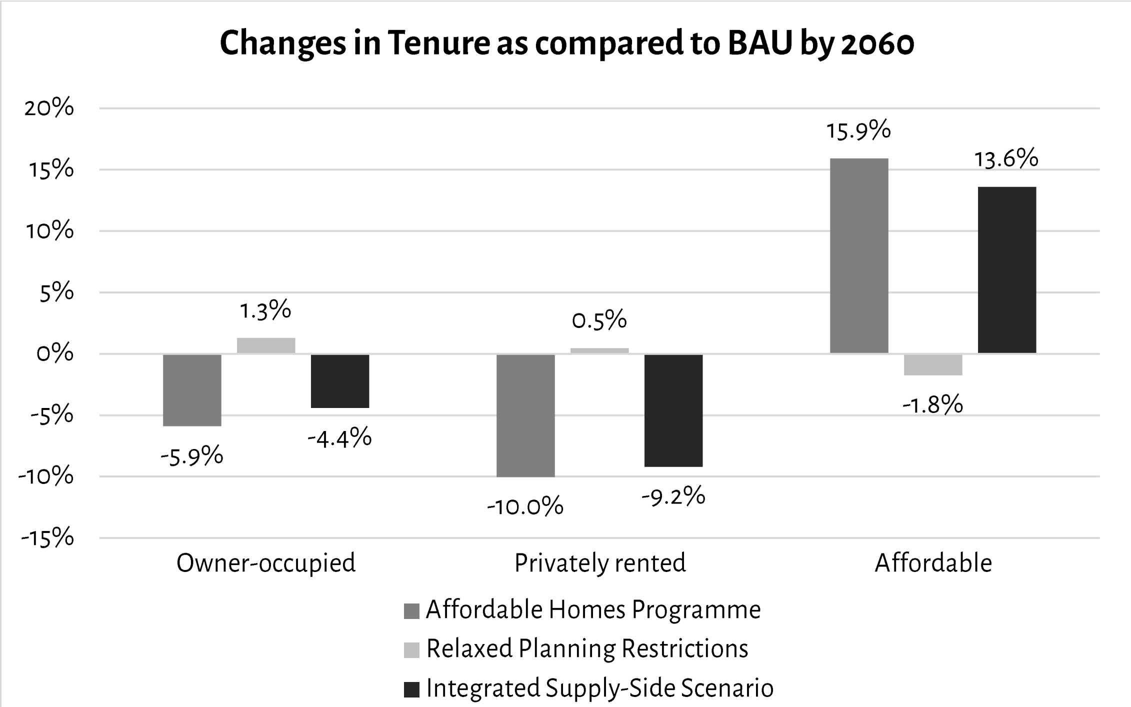

Figure 7.5 – Comparing supply-side scenarios: Changes in tenure against Business-as-usual *by 2060*

Finally, in the ISS scenario, we see a significant expansion in affordable homes (115% above BAU by 2060, as in the AHP scenario) over and above the expansion in the private housing stock (6.7% above BAU by 2060) which leads to a redistribution of tenure shares towards the affordable tenure by only 13.6 percentage points which is lower than in the AHP scenario. This is because in the *Integrated* scenario, the private housing sector is expected to grow along with the affordable housing sector, although less rapidly.

Figure 7.6 portrays simulated developments in *debt service ratio* under our different sets of assumptions. As seen previously, given oscillations in mortgage lending, *debt service ratio* is also expected to oscillate with a similar frequency, although with a phase lag due to the intermediate stock of *mortgage balances outstanding*. In all three scenarios involving higher housing supply, house prices are expected to grow more slowly relatively to BAU. This will entail lower gain and potency in the *Housing-Finance Loops* (see Section 3.5.1) and a slower growth in housing debt along with that. As seen in Figure 7.6, this will be reflected in a generally lower *debt service ratio* (DSR) in the supply-side scenarios. This improvement is expected to be highest in the ISS scenario, where mean DSR over the

2020–2060 period is projected to be 11% lower than BAU (0.088 in ISS versus 0.099 in BAU). In terms of volatility in DSR, however, we see no improvement, but rather a slight increase in relative standard deviation in all three supply-side scenarios Table 7.2.

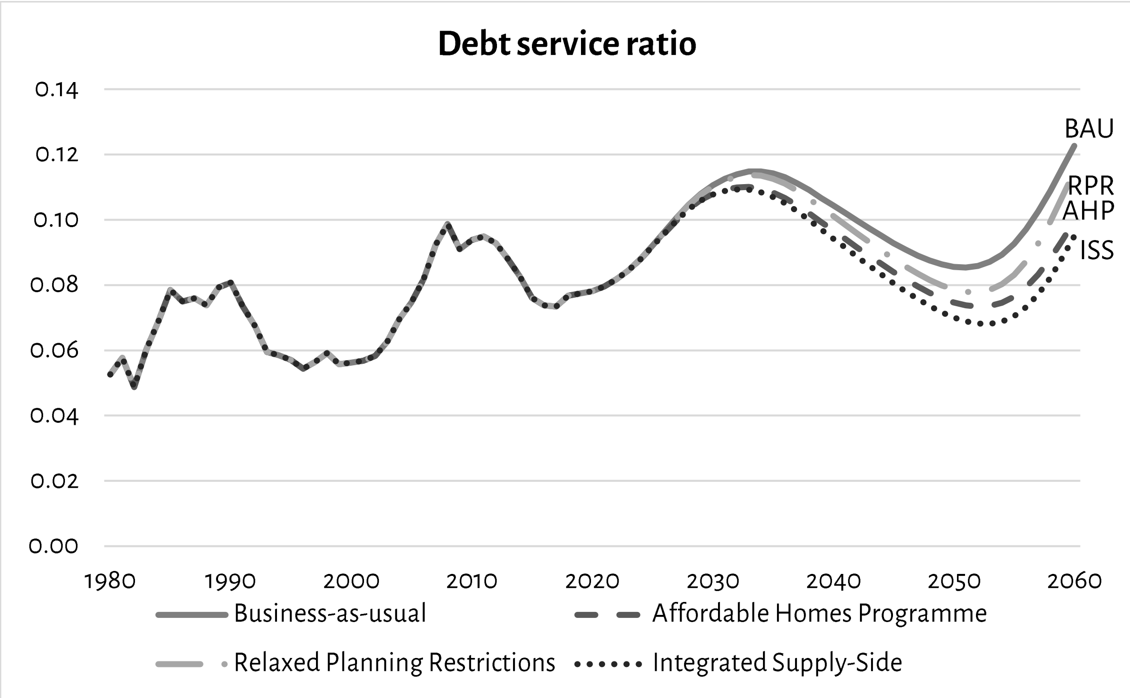

Figure 7.6 – Comparing supply-side scenarios: Debt service ratio

In the past, as in the early 1990s and in the early 2000s, rapid growth in DSR has been followed by financial crises. This is the key structural driving force behind the observed simulated oscillations in the model. Although supply-side scenarios show some limited promise in slowing down the growth of DSR via exerting a downward pressure on prices, they do not significantly reduce the observed volatility in the system. In fact, as discussed earlier, as a result of a higher elasticity of supply, the RPR and ISS scenarios are projected to lead to slightly higher volatility in all indicators, as seen in the figures for relative standard deviation in Table 7.2.

Lastly, as a combined result of changes in tenure, in house prices, in rents, and in the burden of debt, simulated average *housing costs as percentage of disposable income for all except outright owner-occupier households* (Figure 7.7), is 7%, 3% and 8% lower than BAU by the end of the simulation period in the AHP, RPR, and ISS scenarios, respectively. It must be noted that in calculating this indicator, the denominator used, i.e., *average disposable household income*, is identical for all tenure types, which makes this an approximation. This is because regional data for households' average income by distinction of type of tenure is hard to come by. As can be seen, all scenarios yield improvements in housing costs as a result of slowing down the growth in *house prices* and *private rents*. Predictably, these improvements are more noteworthy in the case of the two scenarios (AHP and ISS) that involve large-scale government-backed expansions in affordable housing.

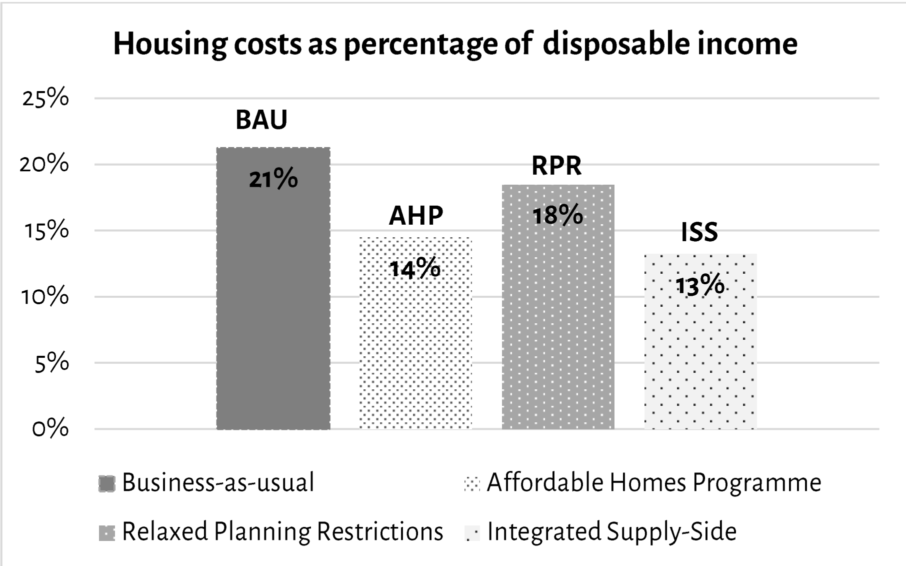

Figure 7.7 – Comparing supply-side scenarios: Housing costs as percentage of disposable income for all except outright owner-occupier households *by 2060*

Note, however, that a potential unintended consequence of a large-scale government-backed affordable housebuilding programme such as that envisaged in the AHP scenario could be that, as argued by Forrester (1970, p. 65) in *Urban Dynamics*, it can attract a large 'underemployed' population to the city which, if unaccompanied by a comparably ambitious job creation programme, could result in high unemployment and economic stagnation and decline.

Table 7.2 below presents summary statistics (mean, standard deviation and relative standard deviation) for the 2020–2060 simulation period for a selection of indicators under *Business-as-usual*, as well as the three supply-side scenarios introduced in this section.

Table 7.2 – Summary statistics of key simulated indicators between 2020 and 2060 for supply-side scenarios

Variable/Scenario	**Min**	**Max**	**Mean**	**Standard deviation**	**Relative St. Dev.**
House price to income ratio [*years*]					
Business-as-usual	5.7	15.9	8.9	2.8	31%
Affordable Homes Programme	4.1	10.9	7.0	2.1	31%
Relaxed Planning Restrictions	4.3	12.8	7.6	2.5	33%
Integrated Supply-Side Scenario	3.2	9.6	6.2	2.3	37%
Housing costs as percentage of disposable household income [%]					
Business-as-usual	13.8%	21.2%	16.3%	1.8%	11%
Affordable Homes Programme	10.6%	16.8%	13.4%	2.2%	16%
Relaxed Planning Restrictions	12.1%	18.5%	14.9%	2.0%	14%
Integrated Supply-Side Scenario	9.4%	16.7%	12.6%	2.6%	21%
Private construction starts [*houses/year*]					
Business-as-usual	6,702	28,223	15,900	7,077	45%
Affordable Homes Programme	4,687	25,391	13,165	7,090	54%
Relaxed Planning Restrictions	10,022	52,076	24,041	11,409	47%
Integrated Supply-Side Scenario	7,335	40,165	19,912	10,079	51%
Real house prices [*GBP2018*]					
Business-as-usual	433,880	1,193,370	679,838	209,610	31%
Affordable Homes Programme	315,763	820,814	529,483	159,690	30%
Relaxed Planning Restrictions	326,446	964,514	578,812	190,346	33%
Integrated Supply-Side Scenario	247,681	728,341	470,026	171,590	37%
Real new advances [*Billion GBP2018/year*]					
Business-as-usual	11.8	70.4	32.2	17.1	53%
Affordable Homes Programme	8.9	60.8	27.3	15.5	57%
Relaxed Planning Restrictions	9.2	73.8	30.4	18.3	60%
Integrated Supply-Side Scenario	7.2	64.2	26.2	16.5	63%
Real private rents [*GBP2018/year*]					
Business-as-usual	15,473	22,825	18,121	1,920	11%
Affordable Homes Programme	11,726	18,607	15,049	2,396	16%
Relaxed Planning Restrictions	14,014	21,608	17,262	2,142	12%
Integrated Supply-Side Scenario	10,774	18,584	14,557	2,747	19%

7.2.5. Summary of Supply-Side Scenarios

In this section, we investigated the likely outcomes of two supply-side interventions, as schematically depicted in the highly simplified CLD in Figure 7.8, as well as their combination. We saw that expanding housing supply, whether via ramping up direct government intervention and provision of affordable homes or rather through the market system by relaxing planning restrictions (e.g., via moving towards a rule-based zoning system), can have a positive impact on not only house prices but also household indebtedness and the burden of housing costs on the household wallet (with potential benefits for the broader economy). Predictably, the *Integrated Supply-Side* scenario seems to hold the biggest promise in expanding supply and slowing down the self-reinforcing *Housing-Finance Loops*. Moreover, the *Affordable Homes Programme* and *Integrated Supply-Side* scenarios (especially the former) are expected to rein in the steady rise in the privately rented sector, with important ramifications for tenure security and rent affordability. Finally, all scenarios promise improvements in average housing costs for those households that are not outright owners of their homes, with the AHP and ISS scenarios appearing to fare better for household finances than the free market oriented RPR scenario.

Despite the improved performance of the three supply-side scenarios as compared to *Business-as-usual* in terms of affordability, in all scenarios *average house prices to income ratio* still follows a generally uphill trend. While this *ratio* is around 7.5 in 2020, by 2060 it reaches 15.9 in BAU, 10.9 in AHP, 12.8 in RPR, and 9.3 in the ISS scenario. It is noteworthy that as a rule of thumb a ratio of about 3 is generally considered affordable (Sani & Rahim, 2015). In 2020, we are already 2.5 times above this desired level, and by 2060, even in the most optimistic supply-side scenario, we risk ending up at over three times the acceptable ratio of affordability; a worrying worsening of the affordability crisis. Furthermore, the supply-side scenarios appear to slightly increase the volatility of the already unstable system, which should be a cause for concern.

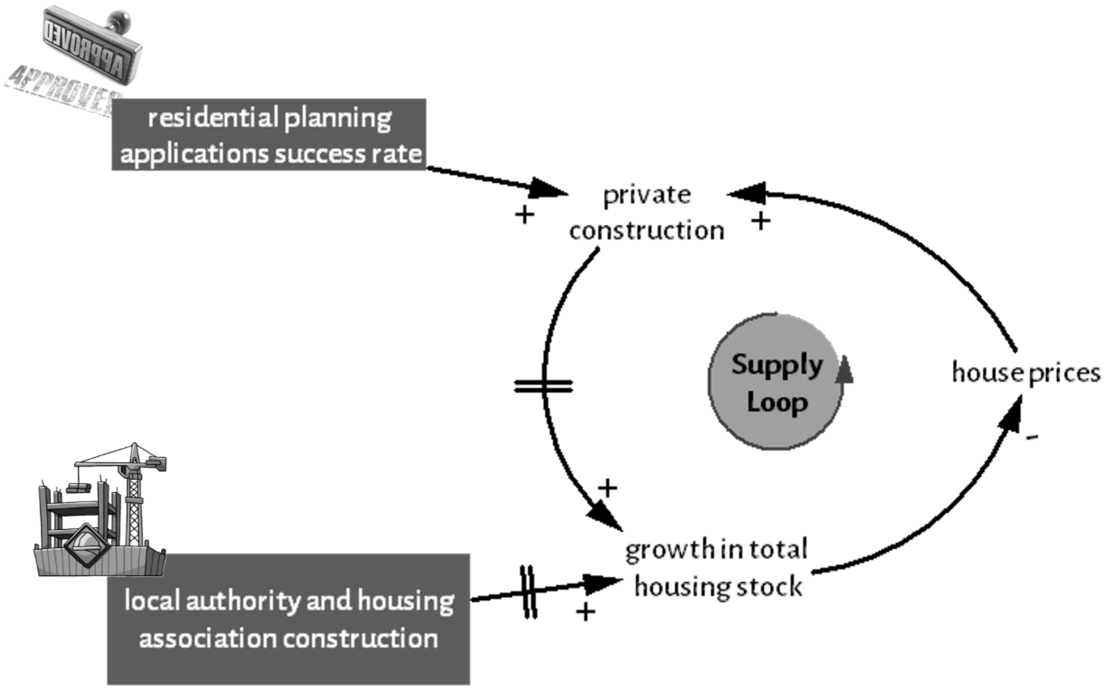

Figure 7.8 – Supply-side policies: schematic causal loop diagram (CLD)

We now turn to investigating simulated future developments under demand-side policies to find out in what different ways they can impact the housing system and whether they hold farther-reaching promises in terms of halting the worsening of affordability and reducing the system's volatility.

7.3. Demand-side Policies

In this section, we look at simulated results for three potential future policies targeted towards the demand side of housing, as well as their combination. The first policy aims to restrict speculative demand for housing via establishing a capital gains tax on all housing assets. The second policy is a macroprudential measure which enforces a tighter restriction on maximum loan to value ratios. The third scenario entails the enforcement of a rule which requires mortgage lenders to use a moving average of house prices over recent years, rather than current market price, in their property valuations for mortgage issuance. The final scenario integrates the above three interventions to study their combined impact on limiting over-inflation and volatility in house prices.

7.3.1. Capital Gains Tax

Capital gains tax, first introduced in the UK in 1965 (Seely, 2010), is a tax on the profit from the sale of an asset which has increased in value. At present, this tax is payable on the sale of property only if it is not a primary residence, i.e., primary homes are exempt. Current tax rate on gains from residential property is 28% (UK Government, n.d.-a). The exemption of primary residences from capital gains tax is believed to drive overconsumption of housing, over-inflation in the price of existing assets, and thus a widening wealth gap between 'haves and have-nots' in the housing market (Barker, 2019). Therefore, a form of the capital gains tax on primary homes has been advocated as one of the potentially promising measures towards tackling the housing crisis (Barker, 2019).

In this scenario, titled *Capital Gains Tax* (CGT), we simulate a hypothetical situation where, gradually over a period of four years, a tax on all house price appreciation, including primary residences, comes into place, ratcheting up year by year to 7% in 2021, 14% in 2022, 21% in 2023, and finally 28% in 2024, in line with current tax on secondary residential property sales. Thus, this describes a situation where investment in residential property is taxed on equal grounds with other types of investment assets. Potential practical and political difficulties in implementing such policy were briefly discussed in the dedicated section on Capital Gains and Imputed Rent Taxes in Chapter 3. The way this tax is implemented in the model, as seen previously in Chapter 5 (see Section 5.1), is via deducting this percentage from *expected price appreciation*, therefore reducing the gain of the central *R4: Investment Loop* (see Sections 3.5.1 or 5.6) in the House Prices Sector of the model.

Results from this scenario will be shown and compared to the other demand-side scenarios in Section 7.3.5.

7.3.2. Loan to Value Ratio

In Chapter 3 (Section 3.3), we argued that mortgage credit is a primary driver of excessive growth in house prices, an unsustainable accumulation of housing debt, and growing volatility in housing since the 1980s. We also discussed how the self-reinforcing feedback relationship between house prices and deregulated finance is responsible for exponential growth in both variables. Therefore, it follows that housing finance policy should focus on breaking this powerful feedback loop in order to suppress the excessive flow of money into residential property (Ryan-Collins, 2018, pp. 109–110).

Housing finance-related regulatory policy measures can target either lenders or borrowers. For lenders, for example, stricter real estate sector-specific capital requirements could be enforced. Lender-targeted policies are thought to be more effective in making banks more resilient against borrower defaults than in controlling price inflation or credit growth, where borrower-oriented instruments are expected to work better. For borrowers, the maximum amount of mortgage debt can be limited via lower loan-to-value, loan-to-income, or debt-service-to-income limits. These measures are expected to be more effective in curbing price inflation and credit growth via an effect on borrower demand (Hartmann, 2015).

In the UK, the Financial Policy Committee (FPC) was established in 2013 as part of the Bank of England's new post-GFC system of regulation aimed at improving financial stability (Bank of England, n.d.). The 2015 *Bank of England Act 1998 (Macro-prudential Measures)* 'prescribes macro-prudential measures in relation to the residential housing market and permits the Financial Policy Committee to make directions to the PRA [Prudential Regulation Authority] or the FCA [Financial Conduct Authority] to address the risks posed by the residential housing lending market to the systemic stability of the financial system' (UK Government, 2015, p. 5). As mortgage lending is the largest asset class on banks' balance sheets (see Figure 3.3), such measures are expected to improve the overall stability and resilience of the financial system.

The FPC exerts influence through two key policy measures which have to do with placing limits on the loan-to-value ratio (LTV) and the debt-to-income ratio (DTI) for new lending. In this study, I only simulate a scenario where *average loan-to-value ratio of new mortgage advances* is manipulated as a proxy for borrower-oriented macroprudential measures. Higher loan-to-value (LTV) ratio loans are associated with a higher probability of default and also expose lenders to higher losses given the potential default of such loans (Bank of England, 2016). Therefore, within the wider framework of macroprudential policies, it is expected that limits to LTV ratios could improve financial stability via lowering the likelihood of borrowers with high LTV mortgages defaulting on their mortgage payments.

The LTV policy instrument 'allows the FPC to issue a direction to limit lenders from issuing more than a certain proportion of new mortgages where the loan-to-value ratio of the mortgages exceeds a level specified by the Financial Policy Committee' (UK Government, 2015, p. 5). Here, however, we implement this policy in a simplified way allowed by the structure of the model, using the exogenous input variable *average loan to value ratio for new mortgage advances*. In this second demand-side scenario, entitled *Loan-to-Value Ratio* (LTV), we assume that, through implementing the appropriate caps on LTV ratios by the FPC, *average loan to value ratio* for new lending will be reduced by one percentage point every year for seven years, from the current 0.66 down to 0.59, a level last seen in 2010 following the financial crisis.

Results from this scenario are shown in Section 7.3.5.

7.3.3. Historically Anchored Valuation

In their cross-country comparison of what drives house price dynamics, Tsatsaronis and Zhu (2004) find that the feedback from house prices to credit growth is strongest in countries with market-based property valuation practices for loan accounting, such as the UK and the US, as opposed to those which use valuations anchored to historical levels of prices, such as Germany and Switzerland. Others in the literature have also presented the historical anchoring of property valuations for mortgage lending as an effective countercyclical measure (Z. Adams & Füss, 2010).

Therefore, we envisage a third demand-side scenario where, effective immediately, the amount of mortgage advances is determined by a five-year moving average of house prices, instead of the current open market value as is currently the case. We call this scenario *Historically Anchored Valuation* (HAV). It must be noted that the time duration of the moving average (five years) is an arbitrary assumption which, as will be seen, does affect the outcome of the scenario. This will be discussed further in Section 7.3.5, where results from this scenario are compared against the other demand-side scenarios.

7.3.4. Integrated Demand-Side Scenario

Like what was done for the supply side, for this final demand-side scenario we are going to combine the three individual policies, i.e., the implementation of a capital gains tax on all housing, lowering average loan to value ratios, and switching to historically anchored valuations for mortgage lending.

Results are compared against the other three scenarios and the BAU scenario in the next section.

7.3.5. Comparing Results from Demand Side Scenarios

Since our first demand-side policy—*Capital Gains Tax* (CGT)—directly targets excessive returns on residential property as an asset, we will first look at projected developments in total *housing return on investment* (ROI) which, as introduced in Chapter 5 (see Section 5.1), is calculated as the sum of average annual house price appreciation and average annual private rents (which could be interpreted as either actual or imputed rents), minus average mortgage interest costs and divided by average house prices. Simulated future results for this variable under our various demand-side scenarios described above are shown in Figure 7.9.

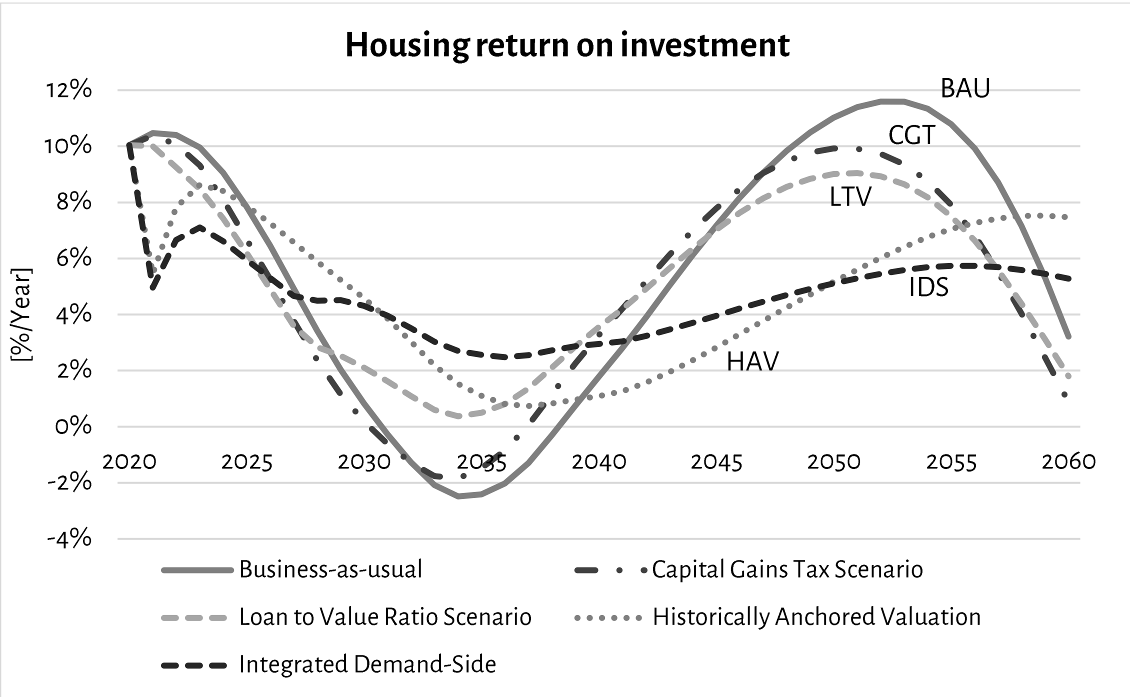

Figure 7.9 – Comparing demand-side scenarios (2020–2060): Housing return on investment

As can be seen, in the CGT scenario, there is a small decrease in housing ROI and a slight decrease in volatility, which means that during much of the upturn in housing ROI between around 2033 to 2047, the return is in fact higher in the CGT scenario, before falling again slightly less precipitously during the last 10 years of simulation. Under the CGT scenario, mean ROI is around 5.1% over the entire 40-year period versus 5.6% in the BAU scenario, while standard deviation is 4.0 percentage points versus 4.7 in BAU (Table

7.3). Overall, this indicates around 10% decrease in housing ROI and 15% decrease in its volatility over the 2020–2060 period—perhaps an underwhelming but still non-negligible impact.

The LTV scenario, which involves a substantial decrease in average loan to value ratios, however, is shown to have a more notable impact, visibly reducing the volatility in housing ROI. This is perhaps better illustrated in Figure 7.10, where results for *real house prices* and *average house price to income ratio* are shown. The graphs show that the LTV scenario is expected to be more effective than the CGT scenario in reducing both volatility and the growth in prices, which highlights the important role of the *Housing-Finance Loops* (see Sections 3.5.1 or 5.6) in both driving house prices up as well as making the housing system more volatile. These results align with the argument of the Financial Policy Committee in describing the channels through which they expect such housing finance instruments to operate, where they stress how such instruments could moderate self-reinforcing loops between mortgage lending and price expectations in the housing market (Bank of England, 2016, p. 20).

More striking still is the case of the *Historically Anchored Valuation* (HAV) scenario, which substantially reduces the volatility and growth in *real house prices* (Figure 7.10), and therefore in *housing return on investment* (Figure 7.9). Relative standard deviation in *real house prices* over the 2020–2060 period is reduced from 30.8% under *Business-as-usual* down to 11.7% in the HAV scenario, while mean *real house prices* is reduced by 64.6% (Table 7.3). This demonstrates the powerful countercyclical force of anchoring property valuations in a moving average of past prices, as a single standalone policy, as also observed by Tsatsaronis and Zhu (2004). These results relate to a five-year duration for obtaining the valuation moving average used in issuing loans. As mentioned earlier, model behaviour (and by extension, system behaviour) is sensitive to the choice of this parameter. The longer the time constant, the stronger the effect of the policy in reducing system volatility.

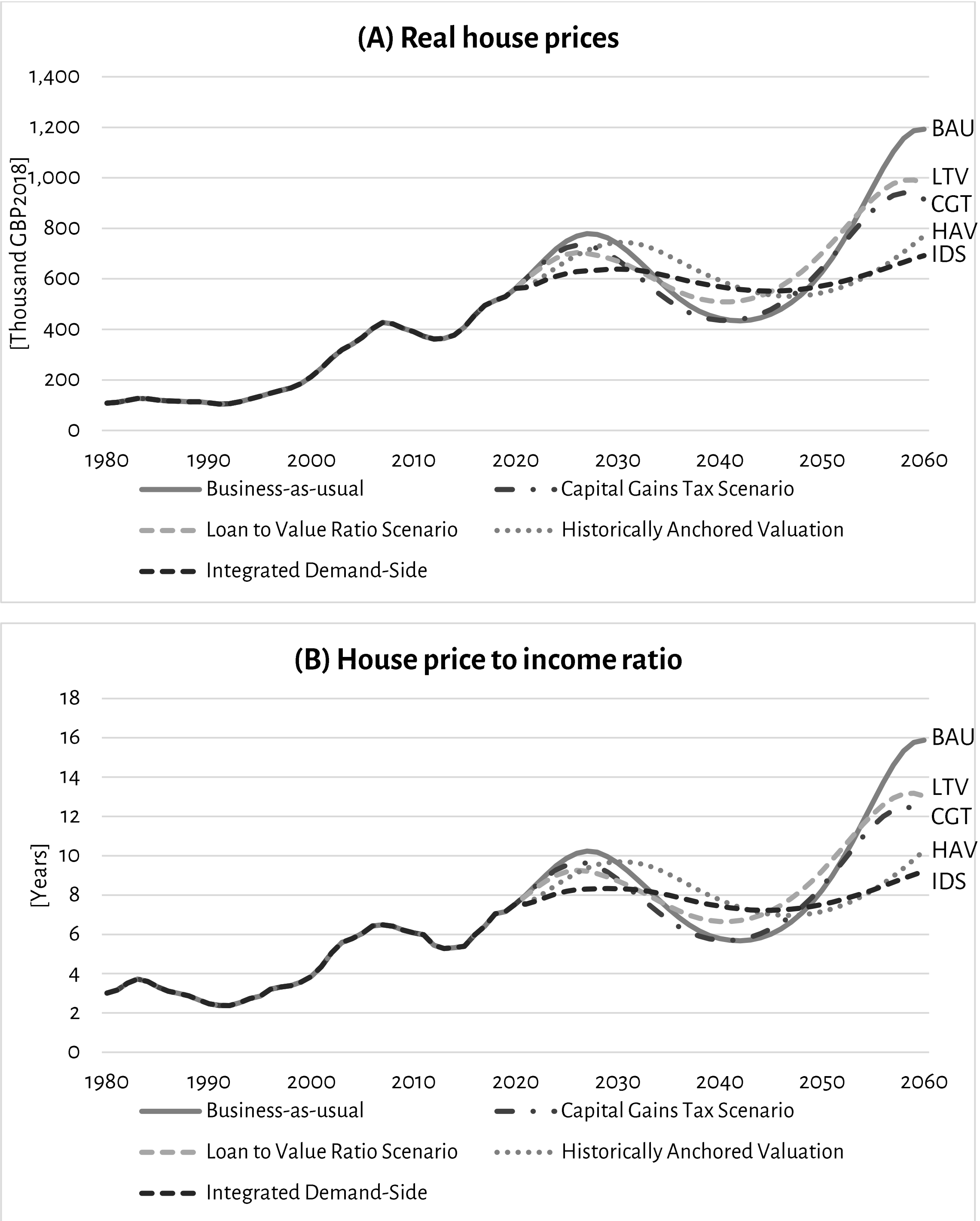

Figure 7.10 – Comparing demand-side scenarios: (A) Real house prices*; (B)* Average house price to income ratio

While both LTV and HAV interventions reduce volatility, they affect the oscillations in different ways: Lowering average loan-to-value ratio reduces the amplitude of oscillations (by weakening the effect from changes in house prices to changes in new mortgages), while anchoring property valuations in past values both dampens the amplitude of oscillations *and* reduces their frequency (by introducing a smooth function between changes in house prices and its effect on loans).

As seen in the figures above, the most promising results are obtained in the *Integrated Demand-Side* scenario which combines all of the above policies. This scenario is visibly the most effective in terms of reducing volatility, almost fully eliminating the oscillations in *real house prices*, for example (Figure 7.10, panel A), thanks primarily to the LTV and HAV interventions. As seen earlier, the CGT intervention does not notably affect the oscillations but does serve to slow down the rate of growth in prices. This can be tested by removing this policy from the *Integrated* package, which results in prices 6.8% higher than the IDS scenario by 2060.[49]

In the IDS scenario, relative standard deviation (2020–2060) in *real house prices* is reduced to 6.1% from 30.8% under BAU, while mean *prices* is 82.6% lower. By the end of the simulation period, *average house price to income ratio* is expected to be 58% lower in the IDS scenario as compared to BAU (Table 7.3). It is important to note, however, that despite the better performance of the demand-side scenarios as compared to BAU, even in the most effective IDS scenario, we are still likely to face an increase in average *house price to income ratio*, indicating a worsening of purchasing affordability. In our simulations, this *ratio* grows from the current 7.5 years to 9.2 years under the IDS scenario, against 15.9 under BAU (Figure 7.10 panel B and Table 7.3).

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[49] This test is not included in the graphs.

Figure 7.11 shows scenario runs for the number and volume of new mortgage advances. As seen in panel (A), the CGT scenario appears to have a very small effect on the *number of advances* and only serves to bring down the volume of *new advances* especially towards the peak at the end of the simulation, via reducing *house prices* as we just saw in Figure 7.10. However, the LTV and HAV scenarios notably bring down *real new mortgage advances* as well as make it less volatile. Their combination, therefore, acts to almost eliminate the oscillations in the IDS scenario once again. In terms of mean over the 2020–2060 period compared to BAU, *real new mortgage advances* is 17.5%, 39.4%, 55.1% and 77.5% lower in the CGT, LTV, HAV, and IDS scenarios, respectively. This variable's relative standard deviation between 2020 and 2060, which is 53.1% in BAU, is lowered by 7.3, 17.6, 24.8 and 37.7 percentage points in the CGT, LTV, HAV and IDS scenarios, respectively. Therefore, to varying extents, each intervention contributes to both slow down the growth in new mortgage lending and iron out the oscillations. In both regards, CGT appears to have the smallest impact, with LTV coming up next with substantially higher impact, and the HAV intervention standing out as the most effective single policy.

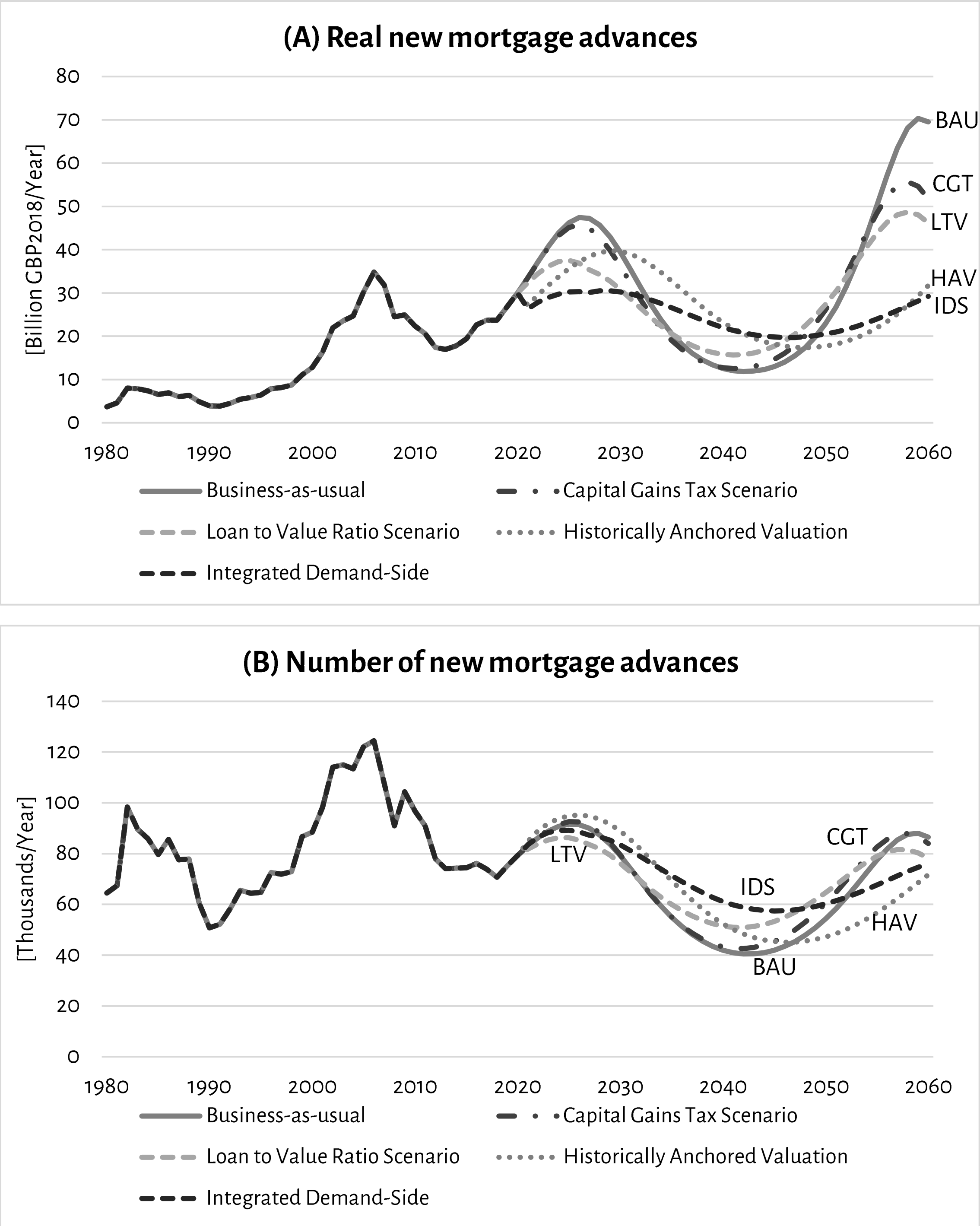

Figure 7.11 – Comparing demand-side scenarios: (A) Real new mortgage advances*; (B)* Number of new mortgage advances per year

Interestingly, however, as seen in Figure 7.11 panel (B) showing results for *number of new mortgage advances per year*, while the oscillations are made progressively smaller in each scenario with the following order of impact (CGT < HAV < LTV < IDS), the mean *number* *of new mortgage advances* over the 40-year future period is in fact projected to be higher in our demand-side scenarios, rising by 3.1%, 4.6%, 0.8% and finally 8.0% over BAU in the CGT, LTV, HAV and IDS scenarios, respectively (Table 7.3). This result—which could be characterised as counter-intuitive—can be explained based on the *B3: Leverage* and *B4: Burden of Debt* feedback loop mechanisms in the model (see Sections 3.5.1 or 5.6). In case of the LTV scenario, for example, although lower LTVs lead to a higher *average deposit to income ratio*, which results in an initial decrease in the *number of new mortgage advances* due to fewer households being able to afford mortgages with higher initial deposits, the dampened oscillations and the generally slower growth in house prices soon make up for that and allow *number of new mortgage advances* to be, on average, higher than BAU. Thus, one can argue that imposing stricter caps on LTVs and lowering the *average loan to value ratio* could in this way—contrary to immediate expectation—provide access to a larger number of households, even though they will be required to put up more substantial deposits (Figure 7.12, panel B). Similarly, in the case of HAV, one sees an instant increase in *new mortgage advances* due to lower property valuations anchored in lower past prices being used. Lower mortgage lending leads to lower than otherwise *house prices*, which lowers *average deposit to income ratio*, and therefore increases loan affordability and demand, increasing the proportion of households who can afford to put up the initial deposit for house purchases.

Therefore, in the case of lending-related demand-side policies, and especially the IDS scenario, *number of new mortgage advances* can be higher than BAU while the total *volume* of lending stays lower. Thus, we may witness broader access to mortgage loans without a faster accumulation of housing debt, promising a slower (and much more stable) rise in the level of debt servicing ratio (Figure 7.12, panel A). In a sense, therefore, substantially smaller 'slices' (i.e., loans) allow a smaller pie (i.e., total lending) to be divided among a larger number of households. Arguably, this could prove to be particularly promising in the IDS scenario where, as a result of the additional capital gains tax policy, speculative purchasing of residential property has been disincentivized and therefore a larger proportion of borrowers could be expected to be first-time buyers or those buying for utility rather than speculative investment purposes.[50] Note that in the HAV scenario, with lower prices and without manipulating the LTVs, the *deposit to income ratio* will be lower, signalling more affordable upfront deposits, leading to the highest peak in *number of new advances* at over 95,000 in 2026, at the expense of a generally higher burden of debt (DSR) than in the LTV scenario (Figure 7.12, A and B and Table 7.3).

Importantly, note also that the slower rise in *debt service ratio* in the LTV, HAV and especially the IDS scenarios as compared to BAU, is also at the root of the much smaller amplitude of oscillations, bearing in mind the central role of the *Burden of Debt* feedback in generating the oscillations (see Sections 3.5.1 or 5.6). By reducing the gain of the reinforcing *Housing-Finance Loops*, the LTV and HAV policies show this reinforcing loop also plays a crucial role in the system's oscillatory tendency. In fact, the coupling of this reinforcing loop with the slow-response balancing *Burden of Debt* loop provides a textbook archetypal structure (Wolstenholme, 2003) conducive to repeated endogenous cycles without any external disturbances to the system.

[50] This potential dynamic cannot be seen in our results because the model does not distinguish between types of buyers (e.g., first-time buyers or speculative buyers), and therefore this statement is only reasonable speculation.

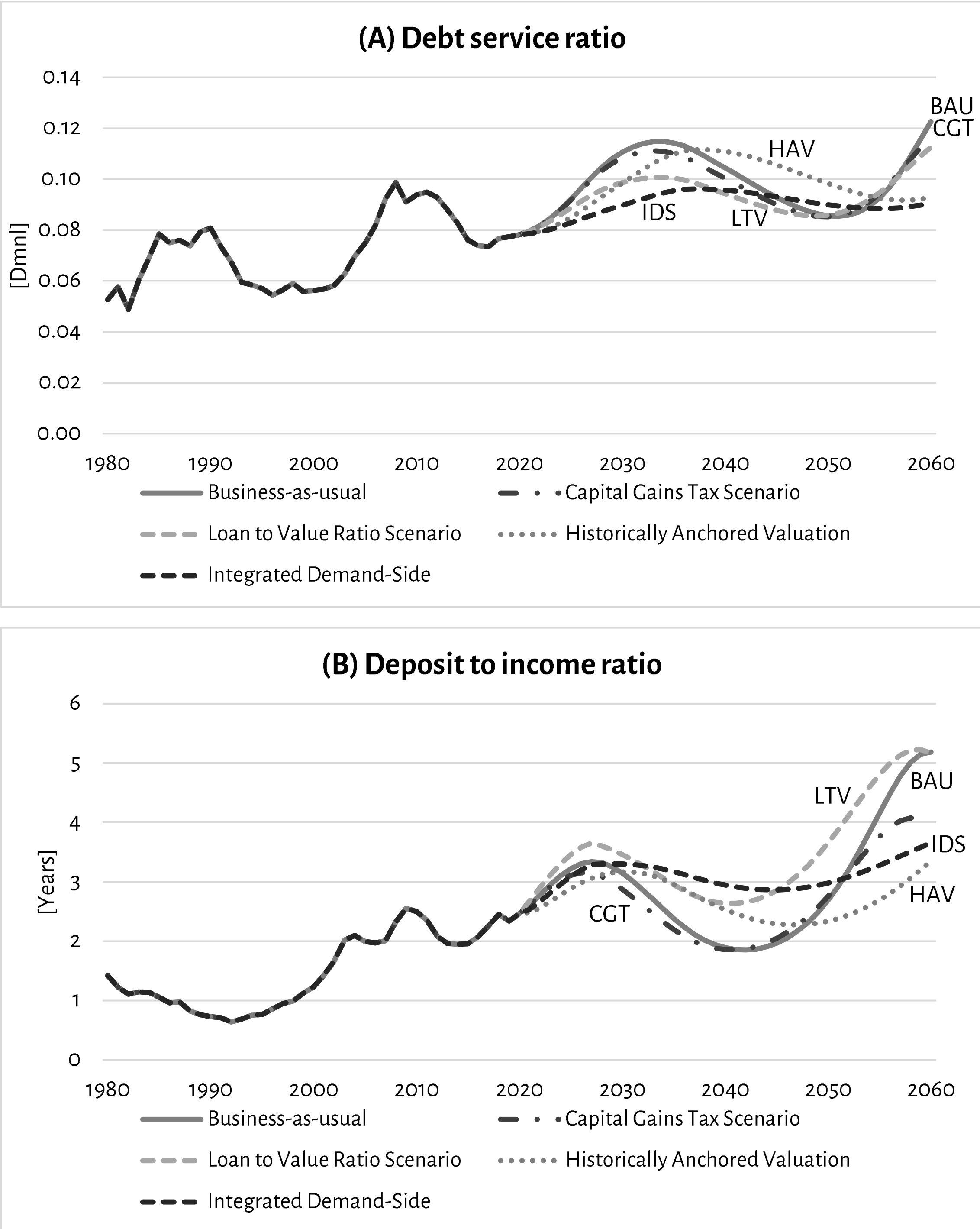

Figure 7.12 – Comparing demand-side scenarios: (A) Debt service ratio; *(B)* Deposit to income ratio

Notwithstanding the promising results presented above, a key caveat of the demand-side scenarios is that, at least within the structure of the model built for this study, they do not stimulate faster housebuilding. While certain channels could be conceived through which slower growth in house prices, via for example disincentivising 'sitting on' undeveloped land for speculative purposes (Murray, 2020), could possibly encourage faster homebuilding, such mechanisms have not been built into the model. Instead, as seen in Section 5.3, a key driver of private construction in the model is the volume of *new mortgage advances*, which indirectly provides an important part of the cash flow for developers. With the lower volume of mortgages under the demand-side scenarios (Figure 7.11), the model predicts that private construction would be slightly lower (e.g., on average around 15,560 units per year in the IDS scenario versus 15,900 in BAU during the 2020–2060 period).

Table 7.3 below presents the mean, standard deviation, and relative standard deviation of selected key indicators over the 2020–2060 period.

Table 7.3 – Summary statistics of key simulated indicators between 2020 and 2060 for demand-side scenarios

Variable/Scenario	**Min**	**Max**	**Mean**	**St. Dev.**	**Relative St. Dev.**
Average deposit to income ratio [Years]					
Business-as-usual	1.9	5.2	2.9	0.9	31.3%
Capital Gains Tax Scenario	1.9	4.1	2.7	0.7	24.7%
Loan to Value Ratio Scenario	2.5	5.2	3.5	0.8	23.0%
Historically Anchored Valuation	2.3	3.3	2.7	0.3	11.7%
Integrated Demand-Side Scenario	2.5	3.7	3.1	0.2	7.8%
Average house price to income ratio [Years]					
Business-as-usual	5.7	15.9	8.9	2.8	31.3%
Capital Gains Tax Scenario	5.7	12.5	8.4	2.1	24.7%
Loan to Value Ratio Scenario	6.6	13.2	8.9	2.0	22.0%
Historically Anchored Valuation	7.0	10.3	8.3	1.0	11.7%
Integrated Demand-Side Scenario	7.2	9.2	7.9	0.5	6.3%
Debt service ratio					
Business-as-usual	0.078	0.123	0.099	0.011	11.6%

Variable/Scenario	**Min**	**Max**	**Mean**	**St. Dev.**	**Relative St. Dev.**
Capital Gains Tax Scenario	0.078	0.117	0.097	0.010	10.4%
Loan to Value Ratio Scenario	0.078	0.113	0.093	0.007	7.8%
Historically Anchored Valuation	0.078	0.112	0.098	0.010	10.0%
Integrated Demand-Side Scenario	0.078	0.096	0.090	0.005	5.5%
Housing costs as percentage of disposable household income					
Business-as-usual	13.8%	21.2%	16.3%	1.8%	10.9%
Capital Gains Tax Scenario	13.8%	19.6%	15.9%	1.5%	9.4%
Loan to Value Ratio Scenario	13.8%	19.8%	16.1%	1.3%	8.1%
Historically Anchored Valuation	13.8%	17.9%	16.1%	1.1%	7.0%
Integrated Demand-Side Scenario	13.8%	16.2%	15.4%	0.6%	3.7%
Housing return on investment [%/Year]					
Business-as-usual	-2.5%	11.6%	5.6%	4.7%	83.8%
Capital Gains Tax Scenario	-1.9%	10.4%	5.1%	4.0%	79.3%
Loan to Value Ratio Scenario	0.4%	10.2%	5.3%	3.0%	57.6%
Historically Anchored Valuation	0.7%	10.1%	4.6%	2.6%	55.9%
Integrated Demand-Side Scenario	2.5%	10.1%	4.6%	1.4%	30.3%
Number of advances per year					
Business-as-usual	40,455	91,687	65,949	18,596	28.2%
Capital Gains Tax Scenario	42,560	92,717	68,002	17,928	26.4%
Loan to Value Ratio Scenario	50,879	86,378	68,986	12,457	18.1%
Historically Anchored Valuation	45,100	95,162	66,480	17,955	27.0%
Integrated Demand-Side Scenario	57,443	89,253	71,196	10,994	15.4%
Owner occupied tenure share					

Variable/Scenario	**Min**	**Max**	**Mean**	**St. Dev.**	**Relative St. Dev.**
Business-as-usual	45.6%	53.2%	49.2%	2.5%	5.2%
Capital Gains Tax Scenario	46.2%	53.0%	49.4%	2.3%	4.6%
Loan to Value Ratio Scenario	44.9%	50.0%	47.8%	1.5%	3.1%
Historically Anchored Valuation	46.3%	51.6%	49.0%	1.9%	3.8%
Integrated Demand-Side Scenario	47.0%	49.8%	48.3%	0.9%	1.8%
Privately rented tenure share					
Business-as-usual	25.9%	33.9%	29.2%	2.3%	7.8%
Capital Gains Tax Scenario	25.9%	32.8%	28.9%	2.0%	7.0%
Loan to Value Ratio Scenario	26.3%	35.0%	30.4%	1.8%	5.9%
Historically Anchored Valuation	26.3%	31.8%	29.5%	1.4%	4.9%
Integrated Demand-Side Scenario	26.3%	31.3%	29.9%	1.1%	3.5%
Real house prices [GBP2018]					
Business-as-usual	433,880	1,193,370	679,838	209,610	30.8%
Capital Gains Tax Scenario	435,166	940,554	638,613	154,667	24.2%
Loan to Value Ratio Scenario	508,850	992,672	675,911	145,764	21.6%
Historically Anchored Valuation	531,293	770,268	632,301	74,138	11.7%
Integrated Demand-Side Scenario	551,675	692,025	601,259	36,490	6.1%
Real new advances [Billion GBP2018/Year]					
Business-as-usual	11.8	70.4	32.2	17.1	53.1%
Capital Gains Tax Scenario	12.5	55.7	30.8	14.1	45.7%
Loan to Value Ratio Scenario	15.7	48.7	29.2	10.4	35.5%
Historically Anchored Valuation	17.3	39.8	27.2	7.7	28.2%
Integrated Demand-Side Scenario	19.7	30.5	25.1	3.8	15.3%

Variable/Scenario	Min	Max	Mean	St. Dev.	Relative St. Dev.
Real private rents [GBP2018/Year]					
Business-as-usual	15,473	22,825	18,121	1,920	10.6%
Capital Gains Tax Scenario	15,487	20,969	17,769	1,578	8.9%
Loan to Value Ratio Scenario	16,239	22,284	18,663	1,476	7.9%
Historically Anchored Valuation	16,239	19,566	18,056	945	5.2%
Integrated Demand-Side Scenario	16,239	19,057	18,004	548	3.0%

7.3.6. Summary of Demand Side Scenarios

In summary, in this sub-chapter we saw that demand-side policies show promising results both with regards to curbing the inherent volatility in the system and with regards to reining in house price and credit growth. We also saw that, as individual measures, the LTV policy fared better than the CGT policy and the HAV policy better than both, with their combination proving to be the most effective, as one would expect. The combined IDS scenario gave encouraging results, significantly slowing down the growth in house prices and credit, as well as almost eliminating the oscillations. Perhaps counter-intuitively, as a result of this combination of policies the number of new available mortgage loans showed a likelihood to increase on average, potentially widening access to more buyers who are furthermore more likely to be 'utility' and first-time buyers, given the capital gains tax which disincentives speculative buying to some extent.

Figure 7.13 schematically portrays how the three demand-side interventions operate via, not quite cutting any links as shown illustratively in the figure, but rather weakening the central reinforcing feedback loops: the *Investment Loop* and the *Housing-Finance Loops* (see Sections 3.5.1 and 5.6), the former via the introduction of the *Capital Gains Tax* policy which weakens the link between *house prices* and speculative *investment demand* and the latter via enforcing lower loan-to-value ratios (LTVs) and the anchoring of property valuations to past prices in mortgage lending, and thus weakening the link between changes in *house prices* and subsequent changes in *housing credit*.

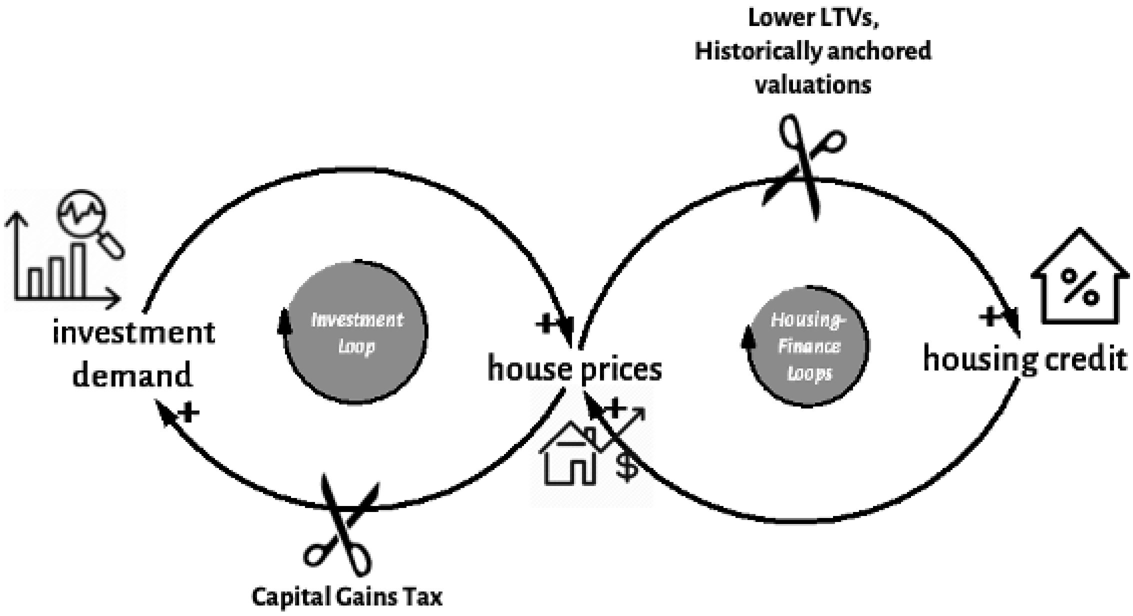

Figure 7.13 – Demand-side policies: schematic causal loop diagram (CLD)

These results are in line with the findings of a growing body of literature, such as Cerutti, Claessens and Laeven (2017) who study the implementation of macroprudential policies for 119 countries over the 2000–2012 period and find that borrower-based macroprudential measures are associated with lower growth in credit to households and conclude that such measures are useful in dampening house price growth and household indebtedness, as well as financial cyclicality. Similarly, Akinci and Olmstead-Rumsey (2018) build a macroprudential 'index' for 57 advanced and emerging economies covering the period 2000–2013 and, using a dynamic panel data model, find that macroprudential policies, which have been much more prevalent since the global financial crisis, are associated with lower housing credit growth and house price appreciation. Furthermore, Hartman (2015) reports increasing theoretical support as well as empirical evidence for the effectiveness of borrower-based regulatory macroprudential measures, and in particular the LTV instrument. These were but a few examples of articles in support of borrower-oriented macroprudential policies. What has not been sufficiently researched, and perhaps warrants more attention given the promising results shown here, is empirical research on the effectiveness of historically anchoring property valuations in mortgage lending as a countercyclical policy. The results shown here provide further theoretical grounding in support of macroprudential policies and explain how they can help reduce the cyclicality of the housing market from a systemic perspective. In addition, these results suggest the counter-intuitive possibility that such policies could indeed broaden, rather than constrain, access to homeownership over the long-term.

However, existing literature also seems to suggest that growth in house prices is more difficult to moderate using macroprudential policies (Cerutti, Claessens, et al., 2017). It could be said that our scenario analysis results support this, since we saw that even in the IDS scenario *real house prices* are projected to grow by 23% and *average house price to income ratio* by 1.7 years of income between now and 2060. We also saw that, in the absence of any stimulus on the supply side, private residential construction could be hurt by the tighter financial regime, potentially leading to a rise in the backlog of need (see Section 2.1).

Therefore, the previous two sections covering strictly demand-side or strictly supply-side policies showed that such one-sided measures fail to curb excessive growth and volatility in house prices and household indebtedness simultaneously and sufficiently, while at the same time ensuring that new supply keeps up with the growth in demand and that affordability does not deteriorate any further. At this point, one might naturally wonder what the result of concurrently implementing a package of both supply and demand side policies would be. This is the focus of the following section.

7.4. Comprehensive Scenario

The *Comprehensive* scenario combines all five interventions described so far, including the two supply-side policies (the *Affordable Homes Programme* and *Relaxed Planning Restrictions*) along with the three demand-side policies (*Capital Gains Tax*, lowering *Loan-to-Value* ratios and the *Historically Anchored Valuation* of properties in mortgage lending). In other words, this is our most optimistic scenario where an integrated and concerted set of interventions is implemented, aimed towards keeping house price inflation and volatility in check. Below, the results of this scenario for some key indicators are shown and compared against the *Business-as-usual (BAU)*, *Integrated Supply-Side (ISS)*, and *Integrated Demand-Side (IDS)* scenarios.

Figure 7.14 shows results for *real house prices* and *average house price to income ratio* for the three 'integrated' scenarios (ISS, IDS, and *Comprehensive*) against *Business-as-usual*. As we saw in Section 7.2.4, in the ISS scenario affordability is significantly improved compared to BAU as a result of a (perhaps unrealistically) vast increase in new build supply, while the oscillations are not curbed. In the IDS scenario, the oscillations are almost flattened out, but affordability continues to deteriorate, albeit at a much slower rate. Combining the two sets of interventions in the *Comprehensive* scenario, however, succeeds in addressing both the affordability and volatility problems. Oscillations are significantly dampened, and *real house prices* is projected to decline at an average rate of -0.8% per year between now and 2060, versus +2.0% per year in BAU and +4.4% per year during the (simulated) past four decades. The projected decline in *real house prices* in the *Comprehensive* scenario is expected to result in a substantial improvement in affordability, equal to 2.2 years of income between now and 2060, from 7.5 at present to 5.3 in 2060 (Figure 7.14, panel B). On average, between now and 2060, the *ratio* is projected to be on average as low as 5.7, lower than its current level and well below the BAU average of 9.0 (in years of income). Similarly, relative standard deviation of *house* *price to income ratio* is reduced to 24.7% over this period, versus 31.7% under BAU (Table 7.4).

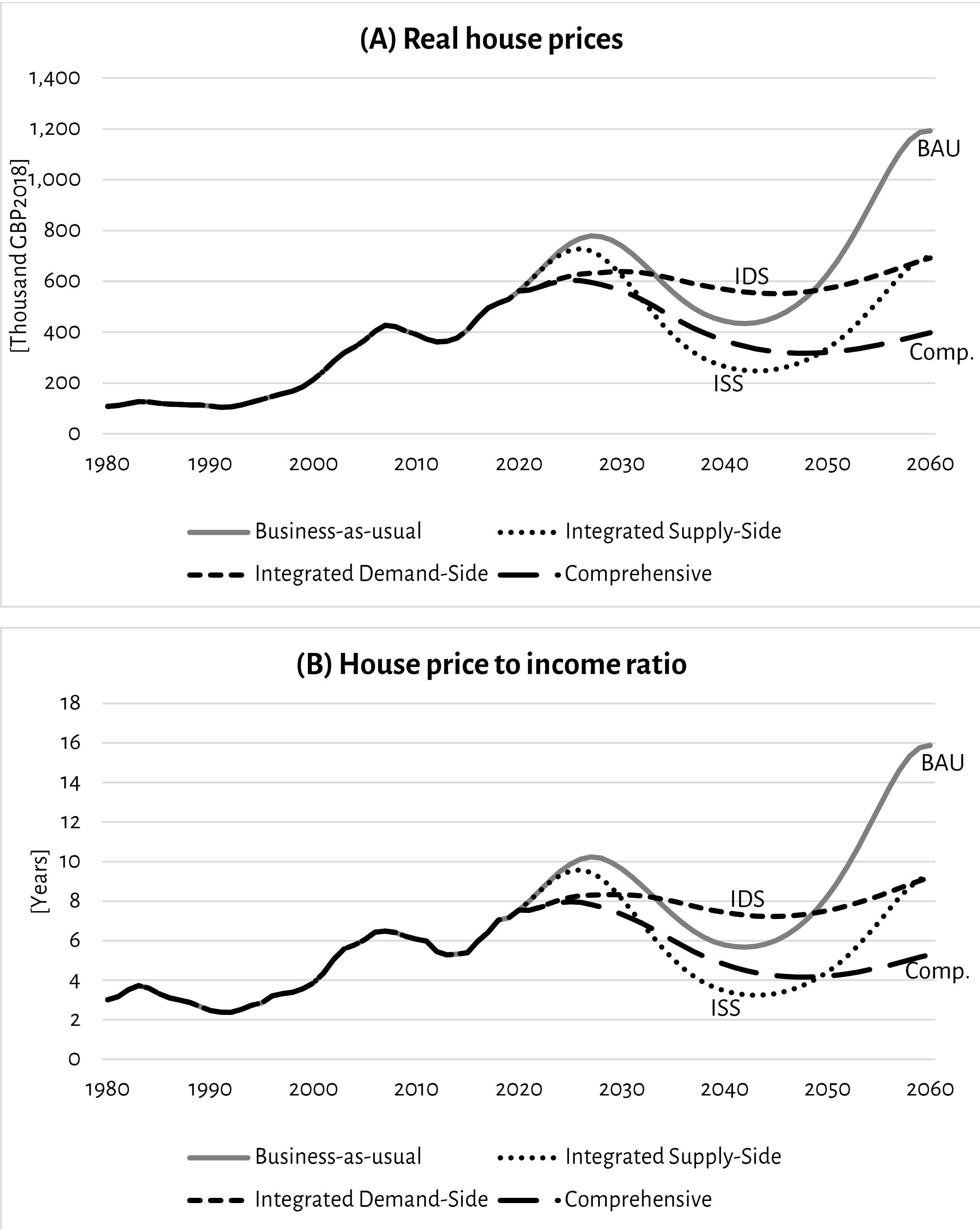

Figure 7.14 – Comparing Integrated *scenarios against* BAU: *(A)* Real house prices; *(B)* House price to income ratio

These results indicate that this most ambitious *Comprehensive* scenario could prove to be effective in reversing the continuous worsening of affordability throughout the past decades, as well as reducing the volatility of house prices. All individual interventions contribute, to varying degrees, to this slower growth in prices. Later, under the next sub-heading, we will look at the shares of individual interventions in this improvement.

As for *new mortgage advances*, Figure 7.15 panel (A) shows how in the *Comprehensive* scenario, *real new mortgage advances* lies well below the IDS curve due to the additional effect of the supply-side policies which put downward pressure on house prices and, by extension, on mortgage lending. The mean is £21.1B (at constant 2018 prices) in the *Comprehensive* scenario, versus £25.2B in the IDS scenario and £32.5B under BAU (Table 7.4).

Note, however, that the oscillations are the smallest in the IDS scenario, which means that the added assumptions of the supply-side scenarios in the *Comprehensive* scenario slightly increase the model's oscillatory tendency. This is due to the rapid rise in new housing supply with the supply-side assumptions which leads to a steeper-than-otherwise fall in prices around 2026, further lowering housing leverage and leading to a deeper-than-otherwise downturn in housing finance (see Section 7.2.4). Hence, relative standard deviation in *real new mortgage advances* is 29.3% in the *Comprehensive* scenario, much lower than the 53.1% of *Business-as-usual*, but higher than the 15.3% in the *Integrated Demand-Side* scenario.

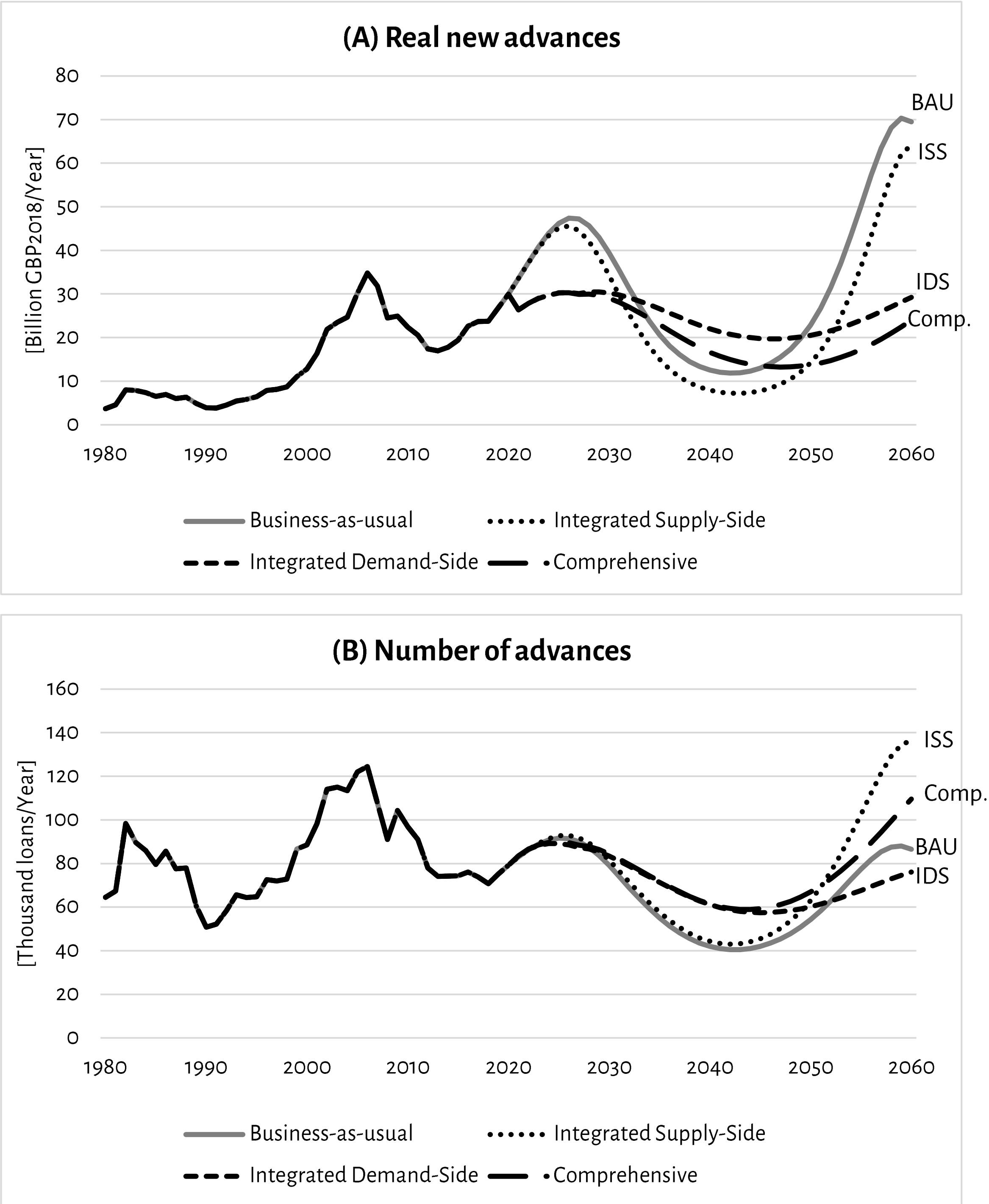

Figure 7.15 – Comparing Integrated Scenarios against BAU: (A) Real new mortgage advances*; (B)* Number of new mortgage advances per year

Number of new mortgage advances per year, on the other hand, manages to exceed all other scenarios under the *Comprehensive* scenario in terms of its mean over the 2020–2060 period, at an average of nearly 77,000 new mortgages per year, which is 16% higher than

Business-as-usual at around 66,300. We already looked at the reasons behind this (see Section 7.3.5), which have to do with lower prices and lower loan-to-value ratios enabling a higher number of advances without causing the stock of debt to grow as much.

Moreover, the broader combination of policies in the *Comprehensive* scenario appears to make it possible to lower LTV ratios while at the same time achieving a lower *average deposit to income ratio* than *Business-as-usual* over the future simulation period, 2.2 years versus 2.9 years respectively (Figure 7.16, panel A). *Average deposit to income ratio* is on average higher, however, than the ISS scenario with a mean of 2.0 years over 2020–2060, where we see lower house prices accompanied by LTV ratios which stay the same as before (as opposed to lowered in the IDS and *Comprehensive* scenarios). The higher average deposit affordability in the ISS scenario is not surprising given the assumption of the immense government investment in housebuilding and without the assumption of lowered loan-to-value ratios.

With the slower growth in mortgage lending (Figure 7.15), *debt service ratio* (DSR) is almost always lowest in the *Comprehensive* scenario (Figure 7.16, panel B). Mean DSR over 2020 to 2060 is 0.083 in the *Comprehensive* scenario versus 0.099 in BAU, 0.088 in ISS, and 0.090 in IDS scenarios. The slower growth in DSR, thanks to the less fierce coupling of house prices and housing credit in the *Housing-Finance Loops*, is also a key dynamic responsible for less pronounced oscillations. DSR is most stable in the IDS scenario, with a relative standard deviation of 5.6%, versus 12.0% in BAU. As mentioned earlier, the aggressive rise in new housebuilding due to the supply-side scenario assumptions present in the *Comprehensive* scenario introduces a deep trough in several of the studied indicators which results in an increase in measures of instability as compared to the IDS scenario.

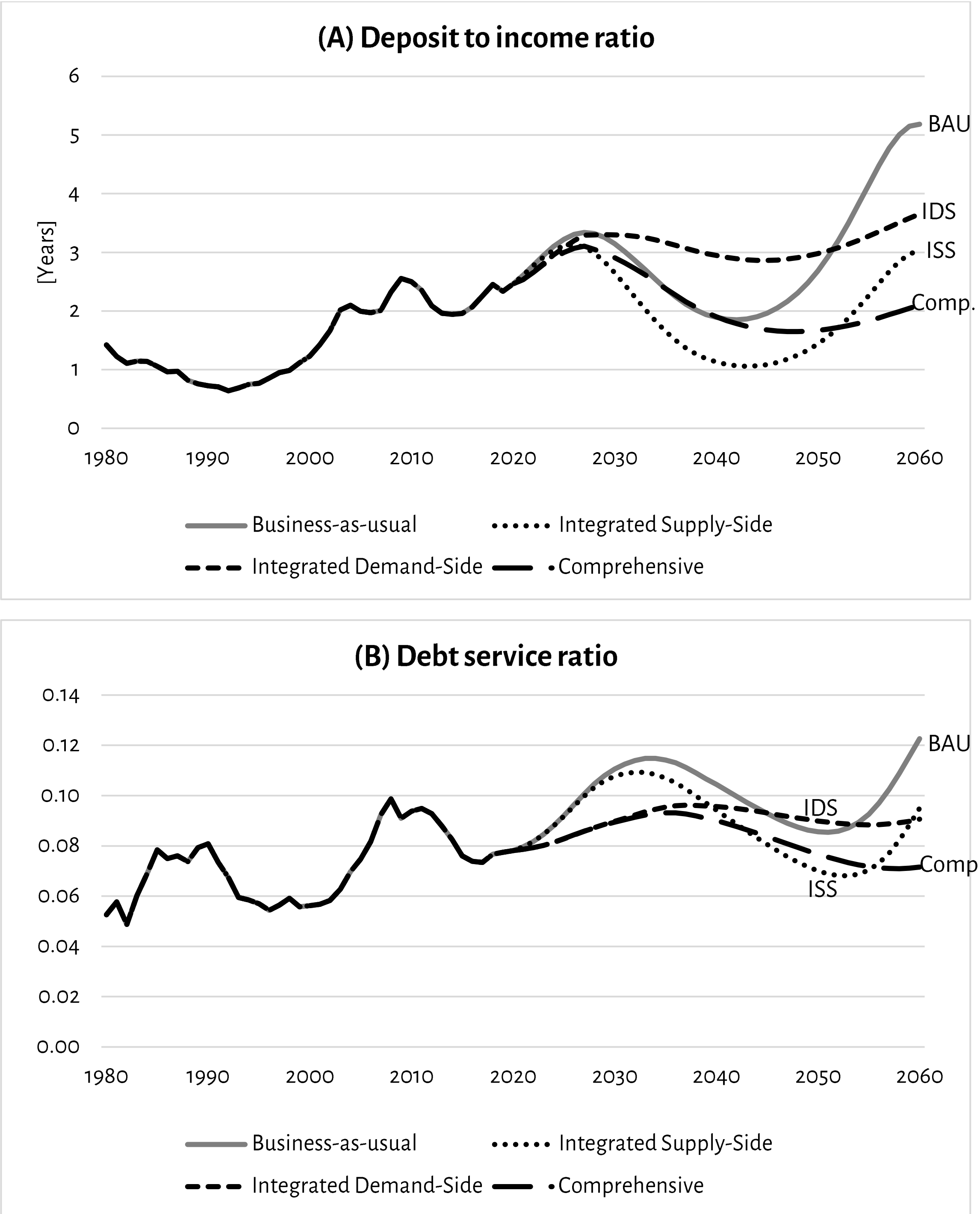

Figure 7.16 – Comparing Integrated Scenarios against BAU: (A) Deposit to income ratio*; (B)* Debt service ratio

As for the supply of housing, predictably, *total housing stock* grows the fastest in the ISS and *Comprehensive* scenarios (Figure 7.17, panel A), finishing about 29 and 32% higher than BAU by 2060, respectively. This is of course thanks to the affordable homes programme and the relaxation of planning restrictions. In the *Comprehensive* scenario, however, the growth is more consistent and stable, thanks to the additional countercyclical demand-side policies.

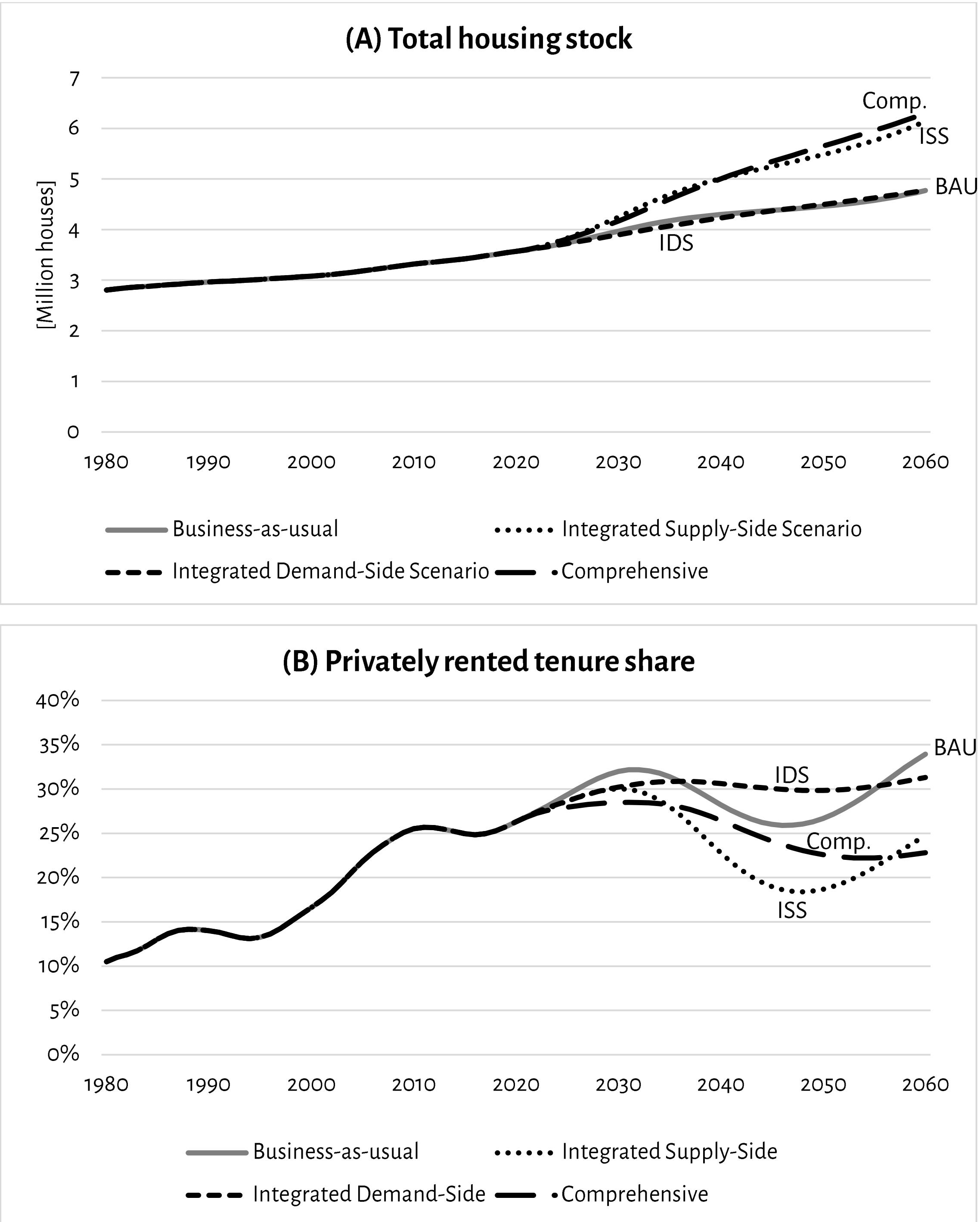

Figure 7.17 – Comparing Integrated Scenarios against BAU: (A) Total housing stock; *(B)* PRS tenure share

Similarly, with regards to tenure, unlike the BAU and IDS scenarios, the share of the private rental sector (PRS) (Figure 7.17, panel B) does not grow any further in the ISS and

Comprehensive scenarios due to the assumption of the highly ambitious increase in the supply of affordable homes. Once again, the advantage of the *Comprehensive* over the ISS scenario is the added stability. In the *Comprehensive* scenario, the PRS share falls from the current (simulated) 26.3% down to 22.8% in 2060, versus 33.9% in the *Business-as-usual* scenario. At the same time, the share of the affordable housing sector (not shown here for brevity), currently at a simulated 23.9%, reaches 33.0% by 2060 in the *Comprehensive* scenario, versus 20.3% under *Business-as-usual*, which reflects the higher availability of affordable homes in the former case. Following a similar trend, by 2060, *real private rents* (not shown here) is expected to be 41.7% lower than *Business-as-usual* under the *Comprehensive* scenario, as well as lower than the two other *Integrated* scenarios.

Given the combined effect of the above developments, housing costs and the share of housing costs in household incomes are also predicted to go down substantially in the *Comprehensive* scenario (Figure 7.18). Various forces reviewed above contribute to this reduction, including lower private rents, higher share of affordable homes with lower rents, as well as lower burden of debt and therefore lower mortgage interest costs. As a result, by 2060, average housing costs for households who are not outright owners of their homes is projected to be 10.0% of disposable household income in the *Comprehensive* scenario, 11.2 percentage points lower than *Business-as-usual*, lower than all other scenarios, and lower than the current 13.8%, indicating a small improvement in the toll of housing costs on the household wallet over the years. Recall that, due to a couple of modelling caveats, the figures related to housing costs as share of household income are most likely to be underestimates, and attention should rather be paid to the direction of the trends and the relative performance of scenarios. Note also that, although during much of the future simulation period (i.e., 2036–2053), the *Integrated Supply-Side* scenario gives the best results in this regard, the ISS curve soon rises above the *Comprehensive* curve since the recurrent boom and busts are not addressed by supply-side policies. On average, over the entire 2020–2060 period, *housing costs* is similar between the ISS and the *Comprehensive* scenarios, although the *Comprehensive* still fares slightly better.

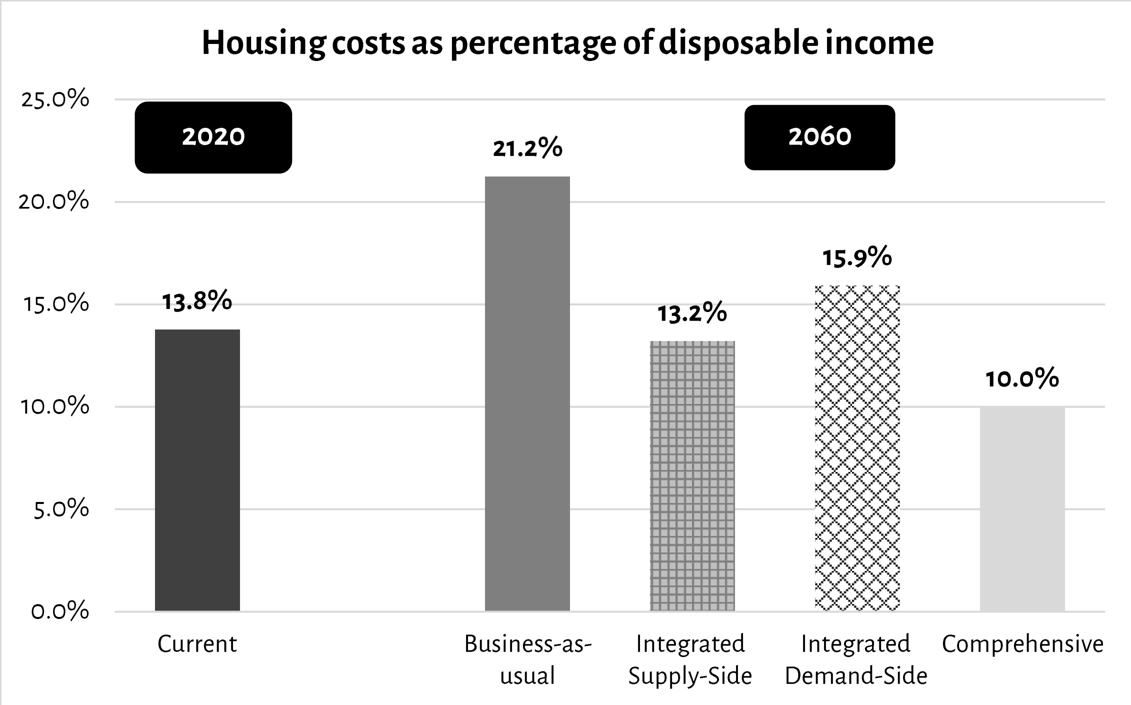

Figure 7.18 – Comparing Integrated *scenarios against* BAU: Housing costs as percentage of disposable household income

Table 7.4 – Summary statistics for Integrated scenarios

Variable/Scenario	**Min**	**Max**	**Mean**	**St. Dev.**	**Relative St. Dev.**
Average house price to income ratio [Years]					
Business-as-usual	5.7	15.9	9.0	2.9	31.7%
Integrated Supply-Side Scenario	3.2	9.6	6.2	2.3	36.5%
Integrated Demand-Side Scenario	7.2	9.3	7.9	0.5	6.4%
Comprehensive	4.2	8.0	5.7	1.4	24.7%
Debt service ratio					
Business-as-usual	0.078	0.126	0.099	0.012	12.0%
Integrated Supply-Side Scenario	0.068	0.109	0.088	0.014	15.5%
Integrated Demand-Side Scenario	0.078	0.096	0.090	0.005	5.6%

Variable/Scenario	**Min**	**Max**	**Mean**	**St. Dev.**	**Relative St. Dev.**
Comprehensive	0.071	0.093	0.083	0.007	9.0%
Housing costs as percentage of disposable household income					
Business-as-usual	13.7%	21.6%	16.3%	2%	11.3%
Integrated Supply-Side Scenario	9.4%	16.7%	12.7%	3%	20.3%
Integrated Demand-Side Scenario	13.7%	16.2%	15.4%	1%	3.9%
Comprehensive	9.8%	14.7%	12.3%	2%	15.3%
Number of advances per year					
Business-as-usual	40,455	91,687	66,279	18,540	28.0%
Integrated Supply-Side Scenario	43,002	136,471	75,301	26,128	34.7%
Integrated Demand-Side Scenario	57,443	89,253	71,326	10,913	15.3%
Comprehensive	58,874	111,398	76,992	13,421	17.4%
Real house prices [GBP2018]					
Business-as-usual	433,880	1,193,370	682,932	213,463	31.3%
Integrated Supply-Side Scenario	247,681	728,341	473,109	171,362	36.2%
Integrated Demand-Side Scenario	545,096	696,303	601,506	37,603	6.3%
Comprehensive	317,088	604,827	434,271	106,878	24.6%
Real new advances [Billion GBP2018/Year]					
Business-as-usual	11.8	70.4	32.5	17.3	53.1%
Integrated Supply-Side Scenario	7.2	64.2	26.6	16.7	62.9%
Integrated Demand-Side Scenario	19.7	30.5	25.2	3.9	15.3%
Comprehensive	13.2	30.3	21.1	6.2	29.3%
Real private rents [GBP2018/Year]					
Business-as-usual	15,473	22,920	18,140	1,966	10.8%
Integrated Supply-Side Scenario	10,774	18,584	14,589	2,727	18.7%
Integrated Demand-Side Scenario	16,021	19,118	17,991	591	3.3%
Comprehensive	12,654	17,361	14,892	1,821	12.2%

It should be noted that the purpose of this policy analysis exercise has been to compare the relative merits of different high-level approaches from an aggregate perspective, rather than achieve specific optimised outputs. If a more detailed operational planning were to be made, it is possible within the system dynamics methodology to optimise future behaviour of the model via varying policy parameters to be most closely fitted to a desired set of reference modes of behaviour, as carried out for instance in Zainal Abidin *et al.* (2014).

Individual Contributions and Synergies

Having seen the results of the *Comprehensive* scenario, one might wonder about the contribution of each individual policy in the aggregate improvements obtained in various indicators, in terms of magnitude as well as volatility. This can be found by stacking up the changes occurring due to the implementation of each policy individually and comparing the sum of the changes from single interventions with the aggregate change obtained in the *Comprehensive* scenario. Due to the existence of nonlinearities and numerous reinforcing and balancing feedback loops in the model, the sum of the changes from single policies in every case does not equal the change obtained from implementing all changes together in the *Comprehensive* scenario. The difference between the two values can be thought of as the synergy between policies, which can be favourable (i.e., in the desired direction) or unfavourable (i.e., against the desired direction). For several selected indicators, contributions of individual interventions as well as synergies (identified by the white dotted sections against a black background) in terms of changes in both the mean and the standard deviation over the 2020–2060 period are portrayed in Figure 7.19. In the graph, the final changes in the *Comprehensive* scenario against BAU in 2060 are shown in the white connected boxes. Figures of individual contributions <5% are not shown to avoid clutter.

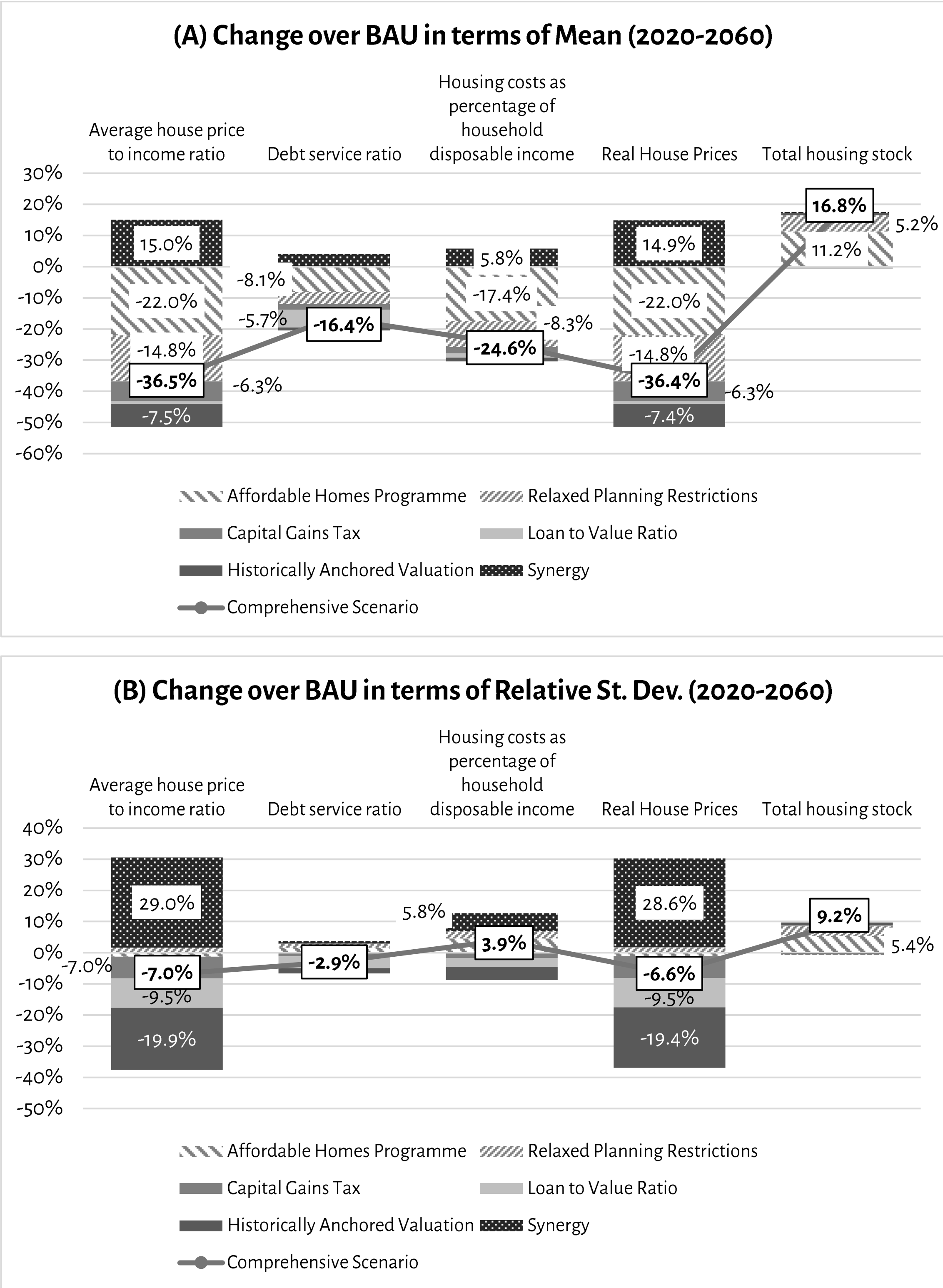

Figure 7.19 – Contributions of individual policies and (negative) synergies in changes in mean and standard deviation (2020–2060) for selected indicators. Figures relating to the Comprehensive *scenario in the connected boxes.*

What insights can be gained from studying these results? Upon a closer look, a few points stand out. Firstly, while all policies contribute to varying degrees to improvements in both the means and in the standard deviations over the period, it is evident that the supply side policies have the greater combined impact on changes in the magnitude (means) of the selected indicators, while the demand-side policies have the greater combined impact on reducing volatility (standard deviation). Looking at the bars for *average house price to income ratio*, for example, the two supply-side policies, *Affordable Homes Programme* and *Relaxed Planning Restrictions*, contribute to improve this measure of affordability by 22.0% and 14.8%, respectively—a total of 36.8%—while the three demand side policies contribute a total of 14.7% to this improvement. Similarly, the total impact of supply side policies on *housing costs as percentage of disposable household income for all except outright owner-occupier households* amount up to around 25.7% (17.4% from AHP and 8.3% from RPR) while the impact of demand-side policies is more modest at around 4.7% combined. In interpreting these results, it is important to stress once again that the supply side policies, and in particular the assumption of the drastic increase in the supply of new affordable homes, do appear to be highly optimistic.

As for changes in volatility, measured by relative standard deviation, the demand-side policies have the greater combined effect, as seen in Figure 7.19, panel B. Concerning the *average house price to income ratio*, for example, combined change from the three demand-side policies is 36.4%, completely overshadowing the negligible total change expected from the supply-side policies at around 0.4%. For *debt service ratio*, the combined effect of demand-side policies is a reduction of 6.6%, while supply-side interventions in fact increase relative standard deviation by 2.9%. This is expected given the especially counter-cyclical nature of the demand-side policies which target both the reinforcing loops (*Investment Loop* and *Housing-Finance Loops*) as well as the balancing loops (*Debt Burden Loop* and *Leverage Loops*) at the heart of the oscillation-inducing mechanism in the model. Among the three demand-side scenarios, the role of the *Historically Anchored Valuation* (HAV) policy in reducing volatility is especially remarkable. Among the five indicators shown, HAV reduces standard deviation by an average of 8.8%, more than the LTV and CGT policies combined, with 5.0% and 3.4% average reduction respectively.

The second salient feature of the contribution charts above is the role of an unfavourable synergy ('dissynergy') among the complete set of interventions in the *Comprehensive* scenario. For *real house prices*, for example, this negative synergy is 14.9% for the mean, which means that the total reduction in average house prices in the *Comprehensive* scenario over 2020–2060 is 14.9% lower than the sum of the impact from individual policies. This can be understood by considering the contractionary nature of the demand-side policies which, as we saw earlier, slow down the growth in both house prices and housing credit. Both these effects can contribute to slower-than-otherwise private housing construction, which in turn feeds back to bolster house prices and to some extent counteract the impact of other interventions such as the policy of relaxation of planning restrictions that is intended to boost private construction.

With respect to unfavourable synergies in relative standard deviation (i.e., positive contributions towards increasing volatility), as we saw in most of the graphs previously presented in this section, results for the IDS scenario show a smoother, more stable behaviour in the future, while adding the supply-side interventions, in particular the AHP policy, introduces an external shock which disturbs the balance of the system and adds some volatility to the otherwise near-linear growth behaviours (e.g. in *real house prices* shown in Figure 7.14), which can explain the unfavourable synergy observed among the *Comprehensive* package of policies in terms of reducing the standard deviation of selected indicators.

7.5. External Shock Scenarios

In this final scenario analysis experiment, we are going to look at the simulated consequences of an external shock to the system, namely a situation where *average* *mortgage interest rates* rise over the coming years, likely as a result of a rise in Bank of England's Base Rate. The latest available data point for average mortgage interest rate from the Building Societies Association is 2.59% (average Tracker rate over the second half of 2020). In this external shock scenario, we assume that this average rate is going to double over the next five years, rising linearly to 5.2% in 2025. We simulate two scenarios in this section, once adding this assumption to the *Business-as-usual* scenario, calling it the *Interest Rate Rise* (IRR) scenario, and once adding it to the *Comprehensive* scenario, calling it *Interest Rate Rise in Comprehensive* (IRRC) scenario.

It must be stressed, however, that in reality, a change in interest rates would affect the wider economy, as well as the housing economy, in numerous interconnected ways, most of which are not accounted for within the limited scope of our model. As regards the model, a rise in interest rates has two effects: reducing the *number of new mortgage advances per year* on the one hand and increasing *mortgage repayments* and therefore the *debt service ratio* on the other hand. Both these impacts have further consequences in model behaviour, as we will see. The results presented here can be insightful as regards these ramifications but should nevertheless be taken with caution, as the current model does not include the level of sophistication necessary to yield results that can be confidently relied upon in decision-making when it comes to the question of changes in interest rates.

With that in mind, we now turn to studying the simulated results of the two interest rate rise scenarios (IRR and IRRC) against their no-external-shock counterparts. Figure 7.20 shows future simulated results for *real new mortgage advances* and *real house prices* under these four scenarios. The rise in interest rates creates different and opposing short-term and long-term dynamics, which give rise to non-trivial and perhaps unexpected results. In the short term, as seen in Figure 7.20, the number and volume of *new mortgage advances* fall (panel A), leading to a fall or slowed growth in *house prices* (panel B). At the same time, the rise in interest rates leads directly to an immediate rise in *debt service ratio* and the fall in *house prices* leads to a rise in *leverage* (Figure 7.21). These changes may not affect lending in the short term, but over the long term—after several years—they feed back to limit the number and volume of *new mortgage advances*.

Concurrently, the short-term effect of lower lending (Figure 7.20, panel A) over time results in slower growth in the stock of outstanding debt, which drives down *debt service ratio* and *leverage* in the long run. However, due to the inherent inertia against changes in large stock variables, changes in the stock of debt occur much more slowly than the short-term changes in *DSR* or *leverage*. The decline in *DSR* and *leverage*, after several years, leads to an increase in lending, an effect in the opposite direction of the short-term effect of the rise in interest rates. The opposite directions of the short- and long-term effects of this change lead to a see-saw dynamic characterized by lower lending and lower prices in the short term but a subsequent rise in both once the burden of debt and *leverage* have gone below their 'normal' levels. These results are not dissimilar to the findings of Juselius and Drehmann (2020) who use a vector auto-regression (VAR) model involving a set of feedback relationships between mortgages and house prices in which the interaction between deviations from long-run trends in leverage and debt service ratio creates cyclical dynamics.

In other words, what happens in practice is that the rise in interest rates precipitates the fall in lending and in house prices that would have happened under *Business-as-usual* (and to a lesser extent in the *Comprehensive* scenario) just after 2025, and thus brings forward the subsequent oscillations by around 5-6 years in terms of phase, as seen clearly when comparing the peaks in both *mortgage advances* and *house prices* which happen around 2059 under *Business-as-usual* but much earlier, around 2053, in the IRR scenario. Notwithstanding this shift in phase, the oscillations themselves—entrenched in the feedback structure of the system—keep occurring with a similar period, which is a function of the unchanged time constants in the model.

The results of this test also make it evident that the *Comprehensive* package of policies serves to make the system considerably more resilient in the face of such an external shock. As seen in panel B of Figure 7.20, for example, the resulting peak in *real house prices* in the IRRC scenario (in year 2056) of £529,000 in 2018 prices is 55% lower than the peak in the IRR scenario at around £1.17M (in year 2053).

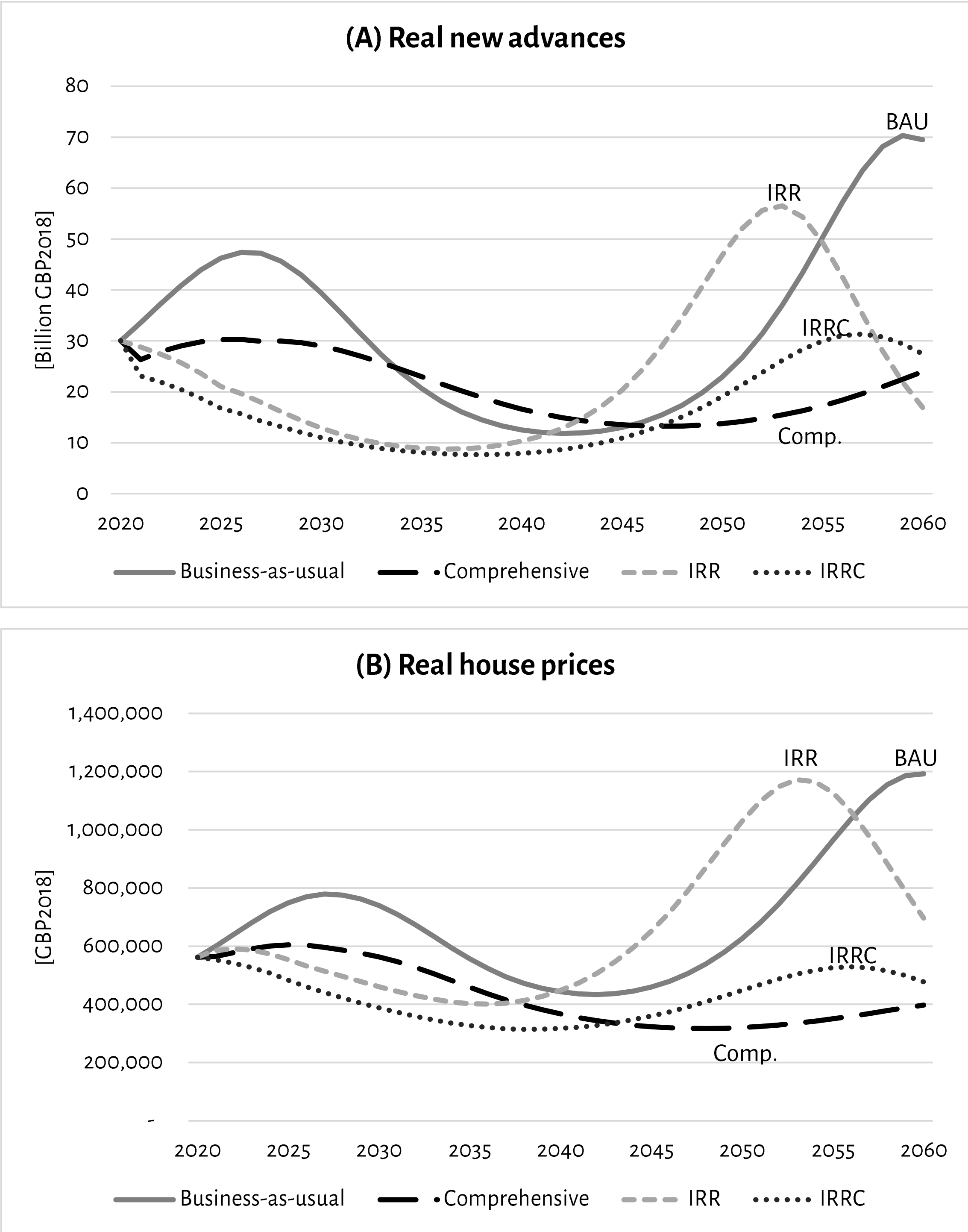

Figure 7.20 – Interest rate rise scenarios: (A) Real new advances*; (B)* Real house prices

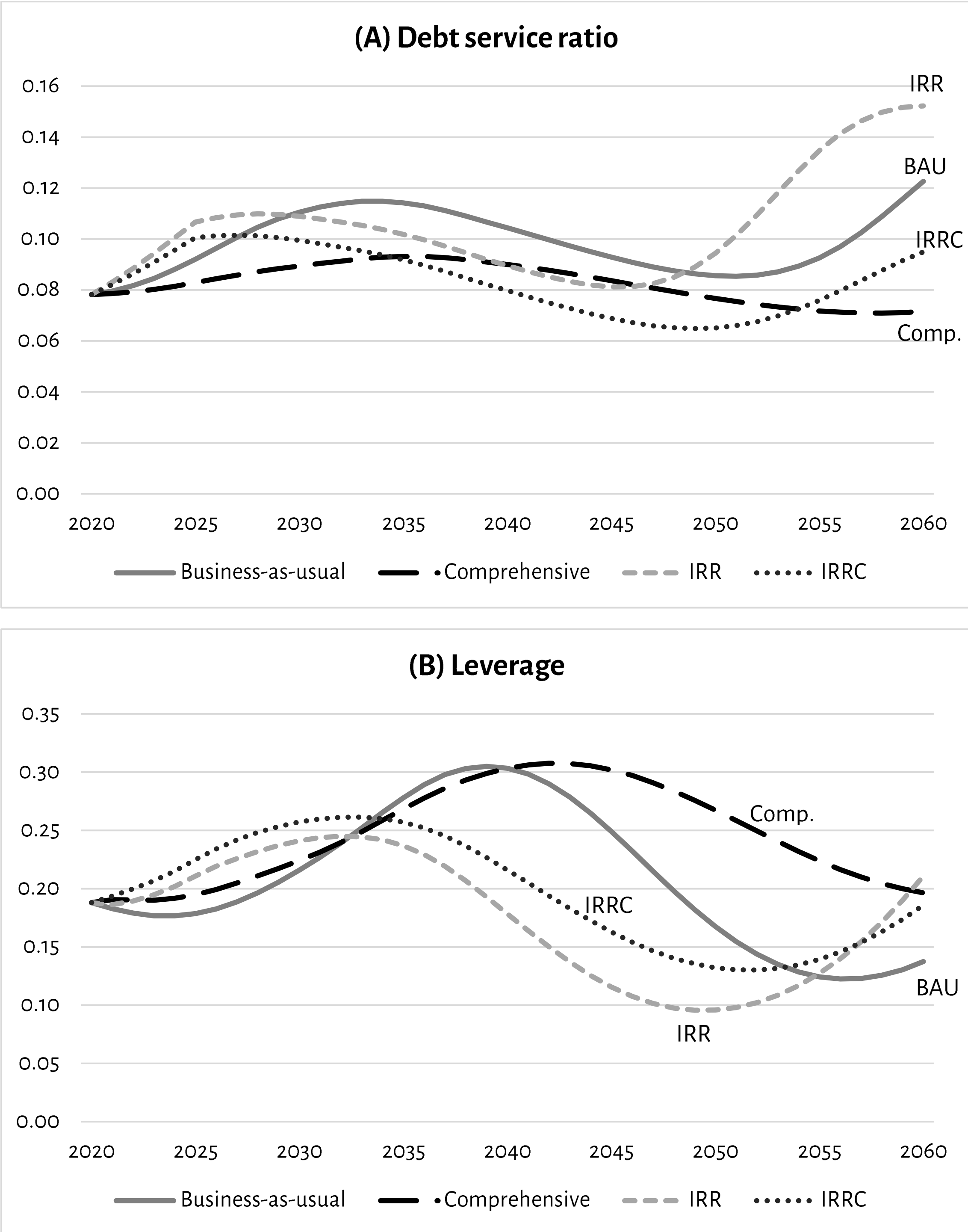

Figure 7.21 – Interest rate rise scenarios: (A) Debt service ratio*; (B)* Leverage

Table 7.5 presents summary statistics for the four indicators discussed. Predictably, in most cases the external perturbance of a rise in interest rates has increased relative standard deviation, our indicator of volatility in the system. In all cases, however, volatility is reduced via the *Comprehensive* package of policies in the event of the external rise in interest rates, as seen in the figures for standard deviation under the IRR and IRRC scenarios.

Table 7.5 – Summary statistics for interest rate rise scenarios

Variable/Scenario	Min	Max	Mean	St. Dev.	Relative St. Dev.
Debt service ratio					
Business-as-usual	0.078	0.126	0.099	0.0118	12.0%
Interest Rate Rise	0.078	0.153	0.104	0.0206	19.7%
Comprehensive	0.071	0.093	0.083	0.0074	9.0%
Interest Rate Rise in Comprehensive	0.065	0.101	0.083	0.0122	14.7%
Leverage					
Business-as-usual	0.12	0.30	0.21	0.06	28.6%
Interest Rate Rise	0.10	0.24	0.17	0.05	29.5%
Comprehensive	0.19	0.31	0.25	0.04	16.9%
Interest Rate Rise in Comprehensive	0.13	0.26	0.20	0.05	23.4%
Real house prices (GBP2018)					
Business-as-usual	433,880	1,193,370	682,932	213,463	31.3%
Interest Rate Rise	401,011	1,173,570	667,537	252,652	37.8%
Comprehensive	317,088	604,827	434,271	106,878	24.6%
Interest Rate Rise in Comprehensive	314,180	566,426	424,616	81,571	19.2%
Real new advances (Billion GBP2018)					
Business-as-usual	11.8	70.4	32.5	17.3	53.1%
Interest Rate Rise	8.7	56.6	24.4	14.6	60.1%
Comprehensive	13.2	30.3	21.1	6.2	29.3%
Interest Rate Rise in Comprehensive	7.7	31.4	16.6	8.0	48.4%

7.6. Chapter Summary

Upon having gained sufficient confidence in the ability of the model to explain past behaviour of the system in the previous chapter, and therefore deeming it useful for policy scenario analysis, in this chapter we set out to simulate the model into the future, both under business-as-usual and under several alternative policy scenarios. We compared the effectiveness of various individual policies and portfolios of policies in controlling both the excessive long-term inflation in house prices and decline in affordability, as well as the volatility in the housing-finance system. Subsequently, we also investigated the likely impact of an external shock on the system, namely a rise in average mortgage interest rates over the next few years.

The *Business-as-usual* scenario revealed that, in the future, we are likely to continue to see major boom-and-bust cycles with long time periods in all key variables in the system, from house prices to construction to housing finance and so forth. The tendency for oscillations is built into the structure of the system and is a dynamic consequence of the powerful reinforcing relationship between house prices and housing finance on the one hand and the lengthy time lags existing in the balancing mechanisms that involve the level of debt, the debt service ratio, and future levels of lending. The ability to endogenously produce persisting long-term cycles is a key distinct feature of this model, where conventional economic models have failed (Gilchrist et al., 2018). This is thanks to the fact that, since the present model follows the endogeneity principle in best practice system dynamics modelling (Richardson, 1991), its behaviour is primarily driven by its internal feedback structure, rather than exogenous time-series data series.

With regards to policies on the supply side, we simulated London's highly ambitious Affordable Homes Programme in the social sector, a relaxation of planning restrictions in the private sector, as well as a combination of the two. Both policies served to substantially slow down the growth in house prices, with the combination of the two policies predictably giving the biggest improvement with respect to business-as-usual in terms of slower growth in prices. This slower growth in prices was accompanied by a less vicious cycle between house prices and housing finance, slower growth in housing debt and a lower burden of housing costs for households. Despite the slower worsening of affordability in supply-side scenarios, affordability still declined in all scenarios, with average house price to income ratio reaching a peak of 9.3 in 2060, from a current value of 7.5, under the *Integrated Supply-Side scenario*. More importantly, supply-side scenarios did little to rein in the large-amplitude oscillations observed in the system. Indeed, the scenarios involving a relaxation of planning restrictions showed a slight increase in oscillations, which is in line with the literature suggesting that in countries with more price-elastic housing supply, swings in effective housing demand have induced large swings in construction (Duca et al., 2010; Sentance, Taylor, & Wieladek, 2012), contributing to the overall volatility of the housing market.

Turning on to the demand-side, we simulated a capital gains tax on all residences, a lowering of average loan-to-value ratios, a policy of anchoring property valuations in past prices when deciding the amount of mortgage loans, as well as a combination of these policies in the *Integrated Demand-Side* scenario. Demand-side policies showed various degrees of promise in curbing both house price inflation and the volatility of the system. Once again, predictably, the most encouraging results were obtained under the *Integrated* scenario, where house price growth was significantly slowed down, and large-amplitude oscillations were nearly eliminated. A somewhat counter-intuitive result of demand-side policies was that, although the overall volume of mortgages in monetary terms grew much more slowly than *Business-as-usual*, the number of new mortgage advances was actually higher on average, potentially making mortgage loans available to a wider swathe of the population. Given the capital gains tax policy and the consequent lower attractiveness of speculative investment in housing, these are more likely to be 'utility' buyers, purchasing houses as homes to live in rather than assets to invest in.

As discussed earlier, the effectiveness of demand-side macroprudential policies on reducing oscillations on the demand side has been supported in the literature, both theoretically and empirically, especially since the Global Financial Crisis. The literature also seems to support the limited effectiveness of such policies on curbing excessive house price growth, as demonstrated in our simulations, where we saw that even in the *Integrated Demand-Side* scenario *real house prices* are projected to grow by 23% and *average* *house price to income ratio* by 1.7 years (of income) between now and 2060, and new housebuilding is expected to be slower than *Business-as-usual.*

This brought us to the *Comprehensive* scenario, where we combined all supply-side and demand-side interventions in an effort to improve housing affordability as well as dampen the large-amplitude oscillations. Only with this highly ambitious portfolio of policies were we able to achieve these goals. Besides these, under the *Comprehensive* scenario, *number of new mortgage advances* exceeded all other scenarios while *debt service ratio* stayed the lowest, affordability improved, and average housing costs as share of households' income went down (both compared to BAU and compared to its current level) as a result of lower private rents, more affordable homes, and lower mortgage repayments.

Next, we looked at the contributions of each individual policy in improvements over *Business-as-usual* for several selected indicators, which revealed that supply-side policies were more impactful in slowing down growth in house prices while demand-side policies were more effective in dampening oscillations. We also learnt that there is a degree of 'dissynergy' between the two sets of policies insofar as they appear to counteract each other to some extent. In case of *real house prices* for example, the sum of the reductions in the mean over 2020–2060, obtained from individual policies, is 15% higher than that obtained as a result of combining all policies in the *Comprehensive* scenario. This can be understood by considering the contractionary nature of demand-side policies, which could restrict private housebuilding as an unintended consequence and therefore cancel some of the potential improvement in affordability.

Finally, we also simulated the likely impact of a rise in average mortgage interest rates as an external shock to the system. This revealed opposing changes in levels of lending in the short-term versus the long-term as a result, which led to an increase in the oscillatory tendency of the system. A rise in interest rates is expected to reduce lending in the short-term but increase it in the long-term when the lower level of accumulated debt causes the balancing feedback loops involving *debt service ratio* and *leverage* to drive lending up once again. The combined effect of these different short- and long-term dynamics was that the original oscillations under *Business-as-usual* are phase-shifted and brought forward in time by several years.

It must be noted that, even considering the limited number of policy levers implemented in the existing model, there is an infinite number of what-if questions we could investigate using the model through simulating various combinations in terms of chosen policies, their extent or intensity, as well as their timing. For example, in this chapter, we only considered policies to be implemented within the next few years and kept them constantly in place thereafter. However, with the aim of dampening system oscillations, one could conceive policies designed to be counter-cyclical, such as ones that are designed to slow down the provision of affordable homes or to re-raise loan-to-value ratios when prices are falling too rapidly. While this remains an interesting area that could be explored using the model presented in this thesis, note that, given the long time lags involved in various parts of the system—from planning and construction to the accumulation of debt and its interaction with the wider economy—designing counter-cyclical policies needs be done with utmost care or it might indeed exacerbate the tendency of the system to fluctuate. Since trial-and-error on such policies in the real world would be extremely costly and results of policies would take years (sometimes decades) to become clear, learning via trial-and-error is hardly feasible or sensible (Sterman, 1994). Within such complex real-world systems, integrated dynamic simulation models such as the one presented in this thesis are indispensable for holistic and coherent policy design. In the absence of such holistic 'management flight simulators', it is easy to be taken by surprise by unintended consequences of well-intentioned policies, which often appear far from the place of intervention in both time and space.

Chapter 8. Conclusion

8.1. Summary of Findings

8.2. Policy Implications

8.3. Limitations and Future Research

8.4. Concluding Remarks

Chapter 8. Conclusion

In this final chapter, I will first give a brief summary of the results and insights obtained throughout this thesis with reference to the central research questions set out in the first chapter. Next, I will discuss some of the implications of these findings for policy. Subsequently, some of the important limitations of this modelling study will be enumerated. Finally, I will end the thesis with a few concluding remarks, including key contributions.

8.1. Summary of Findings

Having characterised London's housing crisis as one which involves continually worsening affordability and periodic large-amplitude oscillations, back in Chapter 1 (Section 1.4) we set out to provide an answer to the following two main research questions:

a) What are the key underlying mechanisms and central feedback loops responsible for the excessive growth and periodic oscillations in house prices, housing finance and residential construction in London since 1980?

b) What are the implications of this underlying structure for the future of London's housing market under business-as-usual and under alternative policies aimed at dampening excessive house price inflation and oscillation?

Towards answering the first question, an extensive review of the literature was distilled into a 'dynamic hypothesis' in the form of a causal loop diagram (see Sections 3.5.2 and 5.6) which proposed an endogenous feedback loop-centred theory of the observed exponential-like growth in house prices and housing credit and the associated oscillations. This theory involved mainly the *Investment Loop* and the *Housing-Finance*

Loops which together established a self-reinforcing engine of growth in house prices on the one hand and housing credit on the other. This has led to an excessive accumulation of housing-related household debt which, over the long term, feeds back to reverse the direction of the abovementioned reinforcing loops towards an eventual downturn. In other words, the coupling of the powerful *Housing-Finance Loops* with the balancing *Debt Burden* and *Leverage Loops* that involve significant time delays makes the system inherently prone to recurring boom-and-bust cycles. This dynamic hypothesis was tested and satisfactorily validated against historical data via simulation of the quantitative system dynamics model built around it.

With regards to the second question, extending the simulation into the future decades revealed that one can expect to see such large-scale boom-bust cycles in house prices and housing credit, such as the still recent 2008 credit crunch, to recur with a period of a few decades (versus the shorter period of the more commonly discussed business cycle). The *Business-as-usual* scenario demonstrated that, rather than being one-off 'black swan' events that occur due to external shocks to the system, as often theorised by mainstream economists in explaining away housing and financial market collapses (Borio, 2014), such boom-bust cycles are the natural outcome of the way the current housing finance system creates its own growing demand through a deregulated creation and allocation of credit towards inflating residential property prices.

Still on the second question and with regards to alternative policies, simulating various individual and portfolios of policies showed that, in order to flatten the oscillations and stop or reverse the continually deteriorating affordability, a highly ambitious and coordinated portfolio of policies which spans both the supply and demand sides of the housing and housing finance markets is called for. Simulation showed that policies on the supply side, including an approximation of the GLA's Affordable Homes Programme (GLA, 2019) as well as attempting to accelerate private housebuilding via a relaxation of planning restrictions, serve to slow down the growth in house prices and the worsening of affordability, as expected, but do nothing to abate the inherent oscillatory tendency of the system. In fact, results presented concurred with the literature suggesting that increased responsiveness of housebuilding to changes in house prices—e.g., via a relaxation of planning restrictions—without addressing the demand-side induced oscillations risks adding further volatility to the system due to larger-amplitude swings in construction (Duca et al., 2010; Sentance et al., 2012). The demand-side policies, conversely, directly targeted this volatility and together succeeded in almost eliminating the long financial cycles, as well as slowing down the decline in affordability to a certain extent, but not completely. Individually, the macroprudential policy of imposing caps on loan-to-value ratios appeared more effective than extending the capital gains tax to all residential properties, and the structural modification policy of requiring banks to use a historically anchored moving average of house prices, instead of current market values, in the valuation of properties when issuing mortgages seemed to hold more promise than both. A comprehensive package of policies including all simulated policies on both supply and demand sides managed to improve affordability and bring house prices down to a new relatively stable near-equilibrium level and make the system more resilient to external shocks such as an increase in interest rates.

Simulation also brought the counter-intuitive insight that although the macroprudential policy of lowering of average loan-to-value ratios is expected to raise the value of initial deposits required, and therefore make it on average less affordable for would-be house-buyers to obtain a mortgage, over the longer time horizon, the policy in fact appears to help procure a larger number of loans as a result of the higher stability in the system. In this regard, via bringing additional stability, the policy of anchoring property valuations for mortgage lending in past house prices can boost this impact. Furthermore, if the capital gains tax on all residential property is additionally implemented, it can be reasonably argued that these wider number of potential buyers served through a larger number of loans available—on average—are more likely to be first-time buyers rather than those looking to buy housing as an investment asset or to 'move up the housing ladder'. Note, however, that due to the slightly more expensive initial deposits required which the lower deciles in terms of income would be challenged to put up, it is essential that such a package of demand-side macroprudential policies be accompanied with some sort of support to the provision of affordable housing, such as the one described in the GLA's ambitious Affordable Homes Programme.

Although the analysis revealed that a highly ambitious and coordinated package of policies is required to address the housing crisis in a comprehensive way, it also showed that relatively straightforward interventions such as requiring banks and financial institutions to anchor property valuations for the purposes of mortgage lending in past prices, i.e., use a moving average of past prices rather than current market values, as in the HAV scenario, can be impressively effective in improving the stability and reducing the volatility of the housing-finance system. Given its apparent straightforwardness and highly promising results, this may be seen as low-hanging fruit against some of the more ambitious policies which require significant levels of investment, such as the Affordable Homes Programme or improving the efficiency of the planning system on the supply side, or the extending of the capital gains tax to all properties which will meet with substantial opposition from vested interests.

8.2. Policy Implications

Via policy interventions (or non-interventions), '[t]he state [...] plays a crucial role in creating, recreating, changing, and restricting development of housing markets, thereby tipping the balance of power between different housing-related interest groups' (Stockhammer & Wolf, 2019, pp. 55–56). In fact, regulating land and private property was among the fundamental and primary reasons for the development of states (Aalbers & Christophers, 2014)As the evidence reviewed in this thesis (see Section 3.4) showed, the central imperative that has shaped housing policy on both sides of the political spectrum throughout past decades has been the promotion of homeownership. However, as increasingly highlighted in the literature (Arundel & Ronald, 2020; Ryan-Collins, 2018, p. 3), the promise of widespread homeownership and the social inclusion and economic security to go along with it now appears to be an unfulfilled, 'false promise', given the declining access to homeownership, increasing inequalities in concentrations of housing wealth and intensifying house-price volatility undermining asset security.

From a political economy perspective, in the words of Aalbers and Christophers (2014, p. 384), 'the ideology of housing today *epitomizes* capitalist ideology' and 'debates on the privatization, neoliberalization and financialization of housing go to the core of debates about capitalist ideology and practice'. Therefore, once examined in depth, the policy questions around the current housing crisis in London and more generally in the UK, give rise to much bigger questions surrounding the social and economic structure of the liberal market variety of residential capitalism implemented in major Anglo-Saxon economies including the UK, the US, and Australia (Schwartz & Seabrooke, 2008). This overarching economic paradigm—characterized by privatized Keynesianism, house price-based economic growth, and housing asset-based welfare, as reviewed in more detail in Chapter 3 (Section 3.4)—which no longer appears to be a sustainable path for modern economies such as the UK (Ryan-Collins, 2018, p. 126) is, however, not the only possible policy framework governing the housing-finance systems. For example, as compared to the UK, the housing-finance system in Germany is characterized by a lower homeownership rate but a much more secure, affordable, and higher-quality renting sector (both social and private) (Voigtländer, 2009), a much more stable housing market

(Voigtländer, 2014), and a banking sector with deep structural differences[51] which drives productivity in the economy rather than housing asset price inflation and volatility (Hoggarth, Milne, & Wood, 2001; Ryan-Collins, 2018, pp. 101–103).

The portfolio of policies simulated in this thesis (see Table 7.1 for a reminder on the scenario assumptions), as combined in the *Comprehensive* scenario (see Section 7.4 for results), appears to hold significant promise in improving housing affordability and stability in the long run. However, this policy programme implies at least a partial reversal of two major trends in housing policy and the overall political economy since the 1980s, namely a move towards deregulation and privatisation, as well as a shift from supply-side to demand-side subsidies (see Section 3.4). The demand-side policies simulated (CGT, LTV and HAV), entail stricter regulation of investment in housing and of housing finance. The AHP scenario on the supply side entails shifting some of the enormous and rising housing benefit budget (Figure 3.2) towards a renewal of large-scale government support of affordable housebuilding.

Therefore, in order to make a shift towards a more stable and sustainable housing-finance system, deep systemic reforms are necessary (Ryan-Collins, 2018, p. 8; Ryan-Collins et al., 2017, p. 126). But these changes will have far-reaching consequences beyond the scope of the analysis in this thesis, with potential winners and losers. For

[51] Chief among these structural differences are ownership structure (shareholder banks which operate a 'transaction banking' model and tend to favour property lending in the UK versus stakeholder banks which operate a 'relationship banking' model and are focused on business lending in Germany) and diversity of the banking sector (dominated by large commercial banks in the UK versus a variety of local, cooperative, specialized, state-owned and other types of banks in Germany) (Ferri, Kalmi, & Kerola, 2014; Hoggarth et al., 2001; Ryan-Collins, 2018, pp. 100–101).

example, the investigated policies on the demand side involve 'attempting to circumvent the current dominance of financial markets, [which makes] these options difficult politically' (Kohl, 2018, p. 196). Such important political aspects and implementation challenges were not delved into in this thesis, but are important considerations left for future research.

8.3. Limitations and Future Research

The system dynamics model used in this study, representing a distilled and simplified picture of reality, by definition excludes infinitely more variables, notions, and mechanisms than it includes. Nonetheless, the vast majority of these exclusions do not constitute limitations as they have to do with matters that lie outside the scope of the study or are impertinent to its purpose. Still, within the scope of the present model, there exist several important exclusions, over-simplifications or shortfalls which are the topic of this section. In the following sub-sections, I enumerate some of the most important limitations of the model sector by sector. This PhD being primarily a modelling and policy/scenario analysis study, these are therefore the aspects I have focused on in this section. I end the section with suggesting some additional possible paths for future research.

8.3.1. House Price Sector Limitations

- *Exclusion of Brexit and Covid-19 pandemic:* In recent years, two major external events have occurred with important consequences for the housing market in London, namely Brexit and the Covid-19 pandemic. Neither of these two external effects have been included in the present model, for two main reasons. Firstly, being quite recent, there is still a lack of empirical studies on their impact on the housing market. Secondly, the focus of the current model being endogenous and long-term mechanisms means that this exclusion does not pose a major disadvantage. Nevertheless, accounting for these effects, especially that of Brexit, present fruitful opportunities for improving the model.

- *Exogenous disposable household income:* In terms of the notion of affordability represented by *average house price to income ratio*, the model only captures the numerator—i.e., *house prices*—endogenously and takes the denominator—i.e., *household disposable income*—as external data input. In other words, the model does not endogenously generate household earnings. This is a limitation because housing and housing-related businesses constitute a significant part of the economy. Housing's contribution to GDP, including residential investment and consumption spending on housing services, generally averages between 15% to 18% (National Association of Homebuilders, 2021). Therefore, changes in the housing market can feed back and make a non-negligible impact on household earnings; an important feedback loop which is absent in the present model. However, including this would have entailed a significant extension of the boundaries of the model, from a model of the housing system towards a model of the economy as a whole—an unrealistic feat within this PhD.
- *Exclusion of transaction activity:* In the model, transaction activity (number of housing market transactions per unit of time) is not included as a driver of *house prices*. Transaction activity does, however, have an impact on *house prices,* at least in the shorter term (Ling, Marcato, & McAllister, 2009), but its effect was deemed too short-term to fit within the long timeframe of this study.

8.3.2. Mortgage Sector Limitations

- *Exclusion of recent macroprudential measures by the Bank of England:* As mentioned previously in Section 6.2.1, since 2014 and based on recommendations from its Financial Policy Committee, the Bank of England has put in place certain macroprudential measures, including 'a loan to income (LTI) flow limit to restrain the proportion of new mortgages extended at or above 4.5 times a borrower's income (Bank of England, 2019, p. 49),' plus a requirement towards lenders to apply more stringent interest rate stress tests on prospective loans (Bank of England, 2019). The effect of these interventions was not included primarily because, being relatively recent and given that the micro-level data are not publicly available, there were still not many studies published on its material impact on lending volumes during the model development stage of my work. The inclusion of this effect presents an important future improvement in the model. As speculated earlier in Chapter 6, were we able to include this effect as well as that of Brexit, the model would be likely to capture the recent downturn (in both *house prices* and *new mortgage advances*) since 2014–2016.

- *Exclusion of lending for remortgages*: Remortgages constitute a substantial share of total mortgage loans, reaching a peak of nearly 55% of total residential loans in the third quarter of 2008, later falling sharply to just below 30% by the end of 2009, and having since generally stabilised in that region (FCA, 2020). Since available data for remortgages only extend back until 2007 while my model starts in 1980, this component does not form part of the present model. Given the important impact of home equity withdrawal on consumption (Aron et al., 2012), this addition would be crucial especially if the model were to be extended to include the feedback from housing to household earnings and consumption, alluded to above.
- *Exogenous average loan-to-value ratio:* As explained in Section 5.2, *average loan-to-value ratio for new loans* is currently an exogenous input to the model, driven by historical data in the past and by policy in the future. However, this variable demonstrates non-trivial dynamics in the past that cannot be explained by policy changes alone and are bound to be driven by factors endogenous to the model, such as changes in the *house prices* growth rate. Therefore, making average LTV of new loans partly driven by policy and partly endogenously determined presents an interesting challenge for future work.

- *Crude formulation of effect of debt burden on new lending:* At present, the way the long-run effect of the level of *debt service ratio* on *number of new mortgage advances* is modelled is unsophisticated and does not elaborate the macroeconomic mechanisms through which this effect takes place (see Section on Number of New Mortgage Advances). An improved version of the model should unwrap the way the burden of debt affects the real economy over time via making explicit intermediate variables such as consumption, consumer confidence, savings, bank capital, and so forth.

8.3.3. Construction Sector Limitations

- *Lack of a Land Sector:* Earlier in Box 5.2 of Chapter 5, I elaborated in detail on my decision to exclude the notion of land values or a separate Land Sector in the model. Although residual valuation of land means that *house prices*, which is included in the model, holds the key in explaining developments in land values, it is highly likely that there is a feedback relationship between the two (Knoll et al., 2017), which is certainly worth exploring in future work. This means that loop *R1* on the supply side (see Figure 2.8) is not included in the quantitative model. Some interesting new studies have applied hedonic land price modelling as an alternative to residual valuation (Clapp, Cohen, & Lindenthal, 2020; Diewert, Haan, & Hendriks, 2015), which may be worth exploring further.
- *Lack of a Housebuilding Industry Sector:* Earlier in Section 2.4, we saw how developments in the housebuilding industry, in particular increasing consolidation, driven in turn by the dynamics in the housing and land markets, are believed to have made a significant impact on the rates of housebuilding. In the spirit of the operational worldview of system dynamics (Olaya, 2016), it should be considered a limitation that housing construction is modelled without including the key agents of it, i.e., housebuilders. Although I did make substantial efforts towards this inclusion, the dynamics of changes in the

number of construction of firms involved complex circularities which proved too difficult to capture within this PhD. This means that loops *R2* and *R3* on the supply side (see Figure 2.8) are not included in the quantitative model.

- *Undershooting data between 1985 and 1995:* Looking at the results of the reference mode replication test for *private construction starts* (see Figure 6.11), we saw that our *Baseline* simulation visibly undershoots historical data between 1985 and 1995. This mismatch, which may or may not have to do with the two main conceptual exclusions listed above, has been puzzling for me and is worth exploring in future research.

8.3.4. Tenure and Rent Sector Limitations

- *Simplistic formulation of flows in-between tenure types:* There are a few oversimplifications in formulating the movement of households between stocks representing different tenure types in this sector. This includes taking as constants certain parameters which should ideally be made time-varying. These include, for example, *time to rent*, *time to sell*, and *fraction of owner-occupied housing remarketed per year*. In reality, these parameters change over time depending on market conditions and the regulatory environment. Assuming them to be constant is a simplification, and relaxing this assumption presents a potentially fruitful area for furthering this research.

8.3.5. Other Opportunities for Future Research

- *Extending the policy analysis:* The policy analysis presented in the previous chapter could be extended in countless ways. Besides playing with the timing and intensity of the policy levers implemented in the model, there are also many additional policies recommended within the rich UK housing literature which were not included in this study, mainly due to time and data limitations, but are certainly worth exploring in further research. On the supply side, these include for instance policies to support the provision of more abundant and cheaper land for housing, such as public land banks and community land trusts (Ryan-Collins et al., 2017, pp. 193–199), revisions to the Green Belt as advocated by Hilber (2015), as well as curbing excessive land banking via giving local authorities 'use it or lose it' powers towards developers (Payne, 2016) or a long-awaited *land value tax* as advocated in Labour's recent *Land for the Many* report (Monbiot et al., 2019). Another potentially promising supply-side policy has to do with supporting SME housebuilders, e.g., via shifting a proportion of the Help to Buy funds into a new 'Help to Build' scheme to provide loan guarantees for SME housebuilders, as recommended by Jefferys *et al.* (2014). On the demand side, additional policies to explore include rent regulation and control (Slater, 2016) towards curbing investment demand for housing. Concerning the mortgage finance aspect, further policies to consider include credit guidance and structural reforms to the banking sector as extensively argued by Ryan-Collins (2018, pp. 96–106) (see e.g., footnote 51 on page 353). Note that simulating each of the above alternative policies will require extending the structure of the present model and will entail a substantial amount of work.

- The model presented in this thesis being a high-level aggregate model, it does not distinguish among various classes of people in terms of income and wealth, and therefore is unable to capture the important distributional implications of the housing crisis. Such distributional effects, which are considered outcomes of class struggle, are important focus areas in the political economy literature (Aalbers & Christophers, 2014; Harvey, 1978), and investigating them must be part and parcel of any comprehensive policy review in the housing domain.
- Ideally, the model could be enhanced into a management flight simulator which would allow policymakers to play with and learn from the model while simulating various individual or portfolios of policies with desired intensities and with the option to start and end policies at different points in time. Such an

interactive simulator would be useful both as a decision support tool and as a safe learning environment for policymakers.

- As the housing crisis seems to be endemic in many large cities around the world (Ryan-Collins, 2018), and since similar dynamics and structural modules hold true in many of these contexts, it could be a fruitful path for further research to adapt this model to other cities, or perhaps develop a conceptual generic model of house price inflation and credit-induced boom-and-bust cycles for major cities in liberalised (especially Anglo-Saxon) advanced economies.

8.4. Concluding Remarks

Notwithstanding the above limitations, as seen in Chapter 6, the model manages to explain and replicate the most salient long-term trends and tendencies in existing data on key variables in the system, and as shown in Chapter 7, it offers a useful tool for the analysis of the likely impacts of various policies on the future of housing in the long run. Nevertheless, rather than claiming to have built *the* definitive model of London's housing, I believe the model presented in this thesis presents a successful proof of concept; a strong case in support of using such integrated feedback-centred dynamic simulation models in long-term planning for the affordability and stability of the housing market in London and in the UK. Some key advantages of the model presented here as I believe has been shown throughout this study, and closely related to the arguments in support of my choice of methodology as listed in Section 4.2.1, include the following:

- *Useful for policymaking:* The model is not only capable of replicating the long-run cyclical behaviour of the housing system, but it is also useful to policymakers as a tool for analysing different scenarios and policy interventions.
- *Feedback-oriented theory*: Based on my review of the literature, linear narratives seem to dominate current thinking in the housing domain: in response to the

question *'why are we facing a housing crisis in London?'*, the responses given most often offer simplistic linear explanations such as *'it is because developers are not building homes fast enough'*, or *'it is because of a broken planning system'*. Based on the analysis presented in this thesis, I argue that the unit of analysis in housing policy and discourse must become *feedback loops* rather than individual factors. Feedback loops should be called upon to explain trends in the housing system, and terminology such as the *Housing-Finance Loops*, the *Investment Loop*, the *Debt Burden Loop* (Figure 5.20), as well as other important loops identified in future research, must enter the scientific and the political discourse around housing, gradually making their way into the general public's mental models.

- *Endogenous mindset:* Another typical answer given to the fundamental question of the reason for the housing crisis is often *'foreign investment is to blame!'*; a narrative which tends to seek explanatory factors coming from the outside, not unlike how mainstreams economics tends to explain market downturns with reference to external shocks. However, as aptly put by Borio (2014, p. 187), 'shocks can be regarded as a measure of our ignorance, rather than of our understanding'. In this sense, through expanding the boundary of our mental models to include key feedback loops, the model and analysis presented here helps shrink the boundaries of our 'ignorance'. This view lies in stark contrast to many neoclassical models of the housing market which tend to refer to endogeneity as a 'problem' to be somehow addressed and avoided, rather than to be taken as the foundation of the model-building process, as clearly called for by the feedback complexity of the problem at hand.
- *Transparency:* As detailed in Chapter 5, all assumptions are made clear and explicit, in a way that should not be prohibitively technical for most researchers from different backgrounds. In this sense, unlike mainstream econometric models most commonly applied within the field, the model is not a black box and can be scrutinised, understood, and learnt from by a wider audience.

- *Holistic 'non-debunking' theory:* The model proposes a novel 'non-debunking' theory (Baggini, 2018, p. 165), which does not primarily or necessarily aim to debunk or replace any existing theories but rather to integrate them in a more holistic picture that contains within it the most important narratives aiming to explain the housing crisis found in the literature.
- *Structure-behaviour link*: The system dynamics approach links the behaviour of model variables to its structure and makes it possible to trace any observed behaviour along the causal chains and feedbacks in the model to improve our understanding of how internal interactions in the system give rise to observed behaviours.
- *Framing the housing research agenda:* The present model can help set a systematic research agenda on well-formulated research questions on particular uncertain links, parameters, and time lags involved in different effects in the system.

In summary, some of the key contributions made in this thesis include the following:

- Distilling and organising the daunting complexity of the existing knowledge on the UK's/London's long-term housing developments in a set of clear, communicable, causal loop diagrams (Chapters 2 and 3) highlighting key feedback loops, which is useful both for understanding past developments and for communicating this understanding.
- Shedding light on possible trends in house prices and housing finance if current conditions continue to prevail.
- Comparing the relative effectiveness of some key policies on both supply and demand sides and demonstrating that curbing the continued decline in affordability as well as the unhealthy volatility in the system requires an ambitious portfolio of policies on both sides of the market.

Glossary: Housing

Term	Definition
Affordable housing	Refers to low-cost local authority or housing association rental housing in the context of this thesis.
Buy-to-let	Buying homes to rent to others. Also refers to special-purpose mortgages for buy-to-let investors in housing.
Debt Burden Loop	The balancing feedback loop introduced in this thesis (Section 3.5.1) which describes how an over-accumulation of housing debt becomes a burden over household consumption and investment, weighing down over the real economy and feeding back to restrict future lending over the long term.
Global Financial Crisis	The financial crisis of 2007–2008 which led to a severe worldwide economic recession.
Help to Buy	A housing programme launched by the Coalition government in 2013 which includes a Shared Ownership scheme where the government provides an equity loan of up to 20% (or up to 40% in London) of the value of a new home, as well as a mortgage guarantee scheme which provides a bank guarantee for purchasers with small deposits of as low as 5 percent of home value.

Housing association Private, non-profit organisations that provide low-cost housing for people in need of a home.

Housing-Finance Loops The reinforcing feedback loops introduced in this thesis (Section 3.5.1) which describe how an increase in house prices leads to an increase in housing credit, which feeds back to further increase house prices.

Imputed rent An estimate in economic theory of the rent a house owner would be willing to pay to live in his or her own house.

Investment Loop The reinforcing feedback loop introduced in this thesis (Section 3.5.1) which describes how an increase in house prices leads to an increase in speculative investment demand for housing, which feeds back to further increase house prices.

Large-Scale Voluntary Transfers The large-scale transfer of housing from local authorities to housing associations starting in 1988 following the passing of the Housing Act 1988

Residential mortgage-backed securities A debt-based security (similar to a bond), backed by the interest paid on mortgage loans.

Right to Buy A housing scheme launched by Margaret Thatcher's administration in 1980 which encouraged local authorities to sell off council housing units to tenants at significant discounts.

Glossary: System Dynamics

Term	Definition
Balancing (feedback) loop	A feedback loop where an initial change in one variable in a certain direction propagates through one or more other variable(s) in the system and feeds back to cause a change in the original variable in the opposite direction of the original change. Therefore, it is a mechanism that resists further changes in one direction and thus seeks to stabilise a system.
Calibration	A process whereby model simulation is fitted to historical data via manipulating parameters of a model.
Causal loop diagram	A causal loop diagram (CLD) consists of variables connected by arrows representing causal relationships in a system, which serves to highlight feedback loops.
Dynamic complexity	Describes the prevalence of feedback loops, delays, accumulations, and non-linearities in real-world systems, which makes them respond to human interventions in complex, often unanticipated, ways.
Dynamic hypothesis	A theory explaining the dynamics observed in a system in terms of its underlying feedback structure.
Elasticity	The ratio of the percentage change in a dependent variable as a result of the percentage change in the cause variable. Characterises the strength of a cause-and-effect relationship.

Endogenous variable A model variable formulated based on other variables within the model.

Exogenous variable A model variable whose behaviour is determined by external input.

Feedback loop Circular causal relationship involving two or more variables.

Flow A flow (rate) variable is a variable measured over time which drives change in a stock (level) variable.

Reference mode The pattern of historical (and potential future) behaviour of a model variable which is continually referred back to in the system dynamics modelling process.

Reinforcing (feedback) loop A feedback loop where an initial change in one variable in a certain direction propagates through one or more other variable(s) in the system and feeds back to cause a further change in the original variable in the same direction of the original change. Therefore, it is a mechanism that can cause accelerating change in one direction.

Stock A stock (or level) variable is, at any point in time, the result of the accumulation of its net flow (inflows minus outflows), plus any initial value assigned to it. Mathematically speaking, a stock is an initial value plus the integral of its net flow over time.

Stock and flow diagram A diagram of a system dynamics model outlining its stock and flow variables and their interlinkages.

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