Essays on housing supply, land use regulation and regional labour markets
This book is no. 430 of the Tinbergen Institute Research Series, established through cooperation between Thela Thesis and the Tinbergen Institute. A list of books which already appeared in the series can be found in the back.
Essays on housing supply, land use regulation and regional labour markets

ACADEMISCH PROEFSCHRIFT

ter verkrijging van de graad Doctor aan de Vrije Universiteit Amsterdam, op gezag van de rector magnificus prof.dr. L.M. Bouter, in het openbaar te verdedigen ten overstaan van de promotiecommissie van de faculteit der Economische Wetenschappen en Bedrijfskunde op donderdag 30 oktober 2008 om 10.45 uur in de aula van de universiteit, De Boelelaan 1105

door

Wouter Vermeulen

geboren te Amsterdam
promotor: prof.dr. P. Rietveld
copromotoren: dr. J.N. van Ommeren
dr. J. Rouwendal
Preface and acknowledgements

Spatial economics is not a topic that fascinated me in my youth. On the contrary, the fact that I have written a thesis in this field should probably be regarded as a major coincidence. I used to dream of designing airplanes at primary school and I imagined a future as nuclear physicist in later years. However, after finishing my masters in mathematics, and having done a good deal of theoretical physics at that, I wanted to work on something with a more direct and visible social relevance, which should be explicable to my friends and family without too much effort. Economics held that promise, and it seemed a discipline in which my mathematical skills would not be totally wasted, so I decided to apply for a position as economist.

Against all odds, CPB was willing to hire me, and to invest heavily in my virtually nonexistent economic expertise. As the spatial economics units happened to have a vacancy, I started working there in 2001, initially as a ‘government trainee’. Rather generously, I also got the opportunity to take courses at the Tinbergen Institute. The academic environment in which these courses took place pleased me. Naturally, I got in touch with the spatial economics department of VU University, which pleased me as well. Hence, when in 2003 a PhD position became available there, on the dynamics of commuting if I remember correctly, I applied. In a strict 50-50 arrangement, I have been employed at both CPB and VU University since.

Starting with an empirical analysis of the interdependency between regional population and employment growth, I soon learned about the strong mark that housing supply and planning have left on regional development in the Netherlands. Another paper on the relationship between house prices and regional unemployment pointed to the prominent role of housing markets as well. So in recent years, I have specialized more and more on the topic of housing markets and land use regulation, and the thesis that is now in your hands is the result. Looking back, I must admit that this topic has really grown on me, and I am grateful for the strokes of coincidence, luck and help that brought me here. But is this thesis directly and visibly relevant for society? Is it explicable to my friends and family without too much effort? Let me know after you have read it!
I am indebted to many people that have put or kept me on the way. Respecting the chronological order, I should start by thanking CPB for taking a long-term perspective in the relationship they entered with me. Not only did I receive the necessary resources and sufficient time to complete my courses at the Tinbergen Institute, but I could also make numerous trips abroad, including a three-month stay at the London School of Economics, with their help. A pivotal person in many of the deals I struck was Taco van Hoek, and Ruud Okker and Carel Eijgenraam have been more than supportive as well. It is difficult to understate the importance of the opportunities that they have created for me.

If one person were to be held responsible for dragging me into academia, though, it should probably be Jos van Ommeren, who was enthusiastic and encouraging about my work from the outset. Jos is not only a true optimist but also a creative thinker, and I have enjoyed the many discussions that we had. In recent years, I have collaborated increasingly with Jan Rouwendal, who has become my second supervisor. In the background, though more prominently so in the last phase of writing my dissertation, Piet Rietveld was a reliable and knowledgeable promotor. Together, this team of supervisors has given me excellent guidance and feedback, and I am grateful for the time and energy they have been willing to invest in me.

A visit to the LSE in the fall of 2006 was another important step in my development as an economist. I have learned a lot from people I encountered there and I relished the numerous top-level seminars that were on offer. I thank LSE and Paul Cheshire in particular for enabling me to make this visit. One of its fruits was a joint survey paper with him that appears as chapter 2 of this thesis, and I enjoyed this collaboration as well.

For this long and the many short trips abroad that I made, I benefited not only from financial support of CPB, but also from grants of Tinbergen Institute, the PhD fund of VU University and a travel grant from the Netherlands Organization of Scientific Research (NWO). Furthermore, I would like to acknowledge that my PhD position has been partly financed by Habiforum within its research program on multifunctional land use.

And then there is this long, long list of people who commented on draft papers or chapters, acted as discussant in one of the seminar or conference presentations that I have given, or who were simply there in the audience making smart remarks. I have omitted an exhaustive enumeration for the sake of brevity but feedback is the fuel on which my research runs, so let me just extend this big thanks to all of you. In particular, I thank my colleagues at CPB, who were always and anytime available for discussion.
Of course, writing a thesis is about more than doing research, and life is about more than writing a thesis. Therefore, I want to thank my colleagues also for the pleasant time that I have had with them. My roommates at CPB, Eugene Verkade and Jelte Haagsma deserve special mention. ‘Room 129’ has been a haven to me in which all the ups and downs of the life of a young researcher could be shared and put into perspective.

Finally, I would like to express my love and gratitude for my wife Karen, who has been at my side throughout, and for my beautiful daughter Sarah.

Wouter Vermeulen
Den Haag, 2008
# Table of contents

Chapter 1: Purpose and organization of this thesis

Chapter 2: Land markets and their regulation: the welfare economics of planning  
2.1 Why is intervention in urban land markets needed?  
2.2 Optimal land use policies in economic theory and in practice  
    2.2.1 A simple economic framework for land use policy analysis  
    2.2.2 From welfare economic theory to practice  
2.3 Evidence on the effects of land use regulation  
    2.3.1 The valuation of planning induced amenities  
    2.3.2 The costs of land use restrictions: housing supply and prices  
    2.3.3 The evidence on net welfare effects  
    2.3.4 Regulation of non-residential land use  
2.4 Conclusions

Chapter 3: Housing supply and land use regulation in the Netherlands  
3.1 A review of the housing supply literature  
3.2 Institutional setting  
3.3 Analysis of residential investment and new construction  
    3.3.1 Data  
    3.3.2 Analysis of stock variables  
    3.3.3 Models for investment and new construction  
3.4 Adjustments in the quality of structures and locations  
3.5 Conclusions

Chapter 4: Does land use planning shape regional economies? A simultaneous analysis of housing supply, internal migration and local employment growth in the Netherlands  
4.1 Trends in the spatial distribution of houses, people and jobs  
4.2 Data and model variables  
4.3 Econometric analysis  
    4.3.1 Housing supply  
    4.3.2 Net internal migration  
    4.3.3 Employment growth  
4.4 Labour supply or local consumer demand?  
4.5 Conclusions and discussion

Appendix: Accounting for interregional commuting
Chapter 5: Compensation of regional unemployment in housing markets 115

5.1 Theoretical framework 118

5.2 Analysis of the Urban Audit 122

5.3 Analysis of a housing demand survey 130

5.4 Conclusions 134

Chapter 6: Urban expansion or clustered deconcentration? An applied welfare economic analysis of growth controls and the foundation of satellites 137

6.1 Theoretical framework 141

6.2 Application to Amsterdam and Almere 150

6.3 Comparative statics and policy analysis 156

6.4 Extension with multiple satellites 161

6.5 Conclusions 163

Appendix: Data used for the model calibration 165

Chapter 7: Conclusions 169

Bibliography 177

Samentvatting (Summary in Dutch) 189
Chapter 1

Purpose and organization of this thesis

In recent years, soaring house prices in various parts of the world have raised attention for the issue of land use regulation and its potential consequences for the functioning of housing markets. For instance, the price of an average apartment in Manhattan exceeds its construction costs by more than a factor two, and Glaeser et al. (2005) relate this finding to restrictions on building height. An extensive inquiry into the British ‘Town and country planning system’ concluded that its upward effect on the level and volatility of house prices might hinder accession to the European Monetary Union (Barker, 2003, 2004). In South-East Asia, restrictive land use policies such as the greenbelt that surrounds Seoul have also come under increased pressure in the face of rising house prices (cf. Lee and Linneman, 1998).

In spite of a growing number of studies that analyse the impact of land use regulation, the modest size of the literature on this issue contrasts sharply with its potential significance for aggregate economic outcomes and welfare. For instance, Cheshire and Sheppard (2004) observed that expenditure on housing in the US amounts to about three times the expenditure on all fuels, utilities and public services combined, but that telephone regulation alone is the subject of about three times as many papers in economics journals as land market regulation, even if telecommunication services comprise about 2% of household expenditures (p. 619-620). Presumably, governments intervene in land markets with the purpose of generating benefits to their residents, which have to be weighed against the costs in order to obtain a well-founded policy evaluation. Unfortunately, however, the literature is particularly incomplete with respect to the welfare economics of land use regulation.

This thesis aims to contribute to our understanding of the consequences of land use regulation by considering the case of the Netherlands, where governments intervene strongly in land and housing markets. Land use regulation is defined broadly, encompassing not only restrictions on the quantity and location of developable land, but also restrictions on the type of housing that is built on it, as well as implicit taxes levied by local governments. The two questions on which we focus are: how do these types of policy affect market outcomes, and how should their impact be normatively evaluated? Furthermore, since land use and location are bundled, so that land use policies are inherently spatial policies, we pay particular attention to the spatial repercussions of land use planning.
The remainder of this introductory chapter provides some background information on the Dutch housing market and the way in which land use is regulated in this country. We then provide an overview of the essays in this thesis, and of how they relate to our main research questions.

**Dutch housing market policy and land use regulation**

In 2006, Dutch households allocated about 30% of their net household income to housing, and the owner-occupied housing stock was worth almost 1 trillion €, or roughly twice the gross domestic product. As in many other countries, owning a house is subsidised in the Netherlands because interest payments on mortgage loans are deductible from the income tax and there is a relief from capital gains on housing. Van Ewijk *et al.* (2006) estimate the net annual subsidy to amount to 12 billion €. However, renters of housing are also subsidised through various channels, and the total annual subsidy is in the same order of magnitude (Romijn and Besseling, 2008). In particular, the Dutch social housing sector is large from an international perspective, containing a third of the total stock on average, and much more in the larger cities. In this segment of the market, rents are restricted and supply is regulated by so-called housing associations whose incentives are not necessarily compatible with market signals. Furthermore, demand in the rental sector is supported through housing allowances.

While housing market policies in the Netherlands thus support demand in both the owner-occupier and the rental sector, supply is hampered through various institutions and policies as well. Defined broadly, land use regulation is probably an important channel through which this occurs. Land is an indispensable input for the production of new housing, but through zoning, land use plans limit the amount of land that is available for residential construction. Such plans are initiated by the national government and, after being elaborated on by provincial governments, are implemented by municipalities. Changing the use of land requires permission of these municipalities, so the supply of land for new development is ultimately a government decision.

---

1 In 2006, owner-occupiers and renters spent 25% and 36.3% of their net household income on housing respectively. These figures are available from Statistics Netherlands (www.statline.nl) and they are based on a housing demand survey (WoON 2006). In the same year, the total housing stock consisted of 6.9 million dwellings, of which 56% were owner-occupied. The Dutch Association of Realtors (www.nvm.nl) reports a median sales price of 235,000 €. Multiplication of these figures yields a rough estimate of the value of the housing stock in 2006. Since prices in the rental sector are heavily regulated, it is less straightforward to value the stock of rental housing.

2 Van Leuvensteijn and Shestalova (2006) discuss the incentives for investment by housing associations. Next to a wedge between annualized housing prices and regulated rents, they point to vague and shifting directions from the government.
Although over the past decades, alleged policy aims have shifted in the national planning documents, Koomen et al. (2008) point to a remarkable consistency with the vision that was proposed in the first of these documents in 1958. Rather than consisting of one large metropolitan area, the Randstad area may be described as a ‘cluster of towns and open space’, and land use planning has consistently strived to maintain this character. Key ingredients of the planning strategy are preservation of the Green Heart area between the main cities of the country (Amsterdam, Rotterdam, The Hague and Utrecht) and of so-called Buffer zones, which prevent these cities from melting together. Other important policy concepts are ‘compact cities’ and ‘clustered deconcentration’. The first of these policies aims to foster high urban densities, so that open space outside of cities is preserved, and the second aims to concentrate suburbanisation at specific locations for similar reasons.

A nice illustration of spatial planning in the west of the Netherlands is given in Figure 1.1, which is obtained from Koomen et al. (2008). This map shows the contours of the present Green Heart, as well as of its original conception half a century ago. Given the facts that the Dutch population has grown by almost 50%, and that the number of households has more than doubled since, the consistency between original and present contours is no less than stunning. Another striking feature of Figure 1.1 is the overwhelming presence of agricultural land and nature in one of the most densely populated areas of the OECD. About 75% percent of all land in the Randstad may be characterised as open space. Hence, there is a strong suggestion that land use regulation has succeeded in curtailing urban sprawl in this area.

Considering changes in land use between 1995 and 2004, Koomen et al. (2008) show that indeed, the propensity of transformation from open space to urban use was significantly lower in the Green Heart and the Buffer zones than in other parts of the Randstad. Moreover, Figure 1.1 indicates that such changes occurred predominantly in relatively large contiguous areas that are attached to urban areas, thus adhering to the principles of compact development and clustered deconcentration.

The extent of restrictiveness of land use planning may also be inferred from the difference in value between land in agricultural use and land that is zoned for residential development. This difference may equivalently be interpreted as a scarcity rent on residential land (CPB, 1999), as the shadow price of land use restrictions, or as a regulatory tax (Glaeser et al., 2005). In a spatial regression analysis of agricultural land transactions in the province

---

3 See Statistics Netherlands at www.statline.nl.
4 As a consequence of land use regulation, the land market is segmented. Hence, the price of a piece of land depends on the segment to which it is allocated. More specifically it depends on demand and supply within this particular segment. Expectations about a future change of segment may also capitalize into the price.
Figure 1.1: Land use in the western part of the Netherlands in 2003

Source: Koomen et al. (2008).
of North-Holland, Dekkers et al. (2004) show that *ceteris paribus*, agricultural land is sold at a much higher price if it is bought by municipalities or speculators, presumably with the objective of residential development, and that the price more than doubles if the land is located within so-called Red contours, in which permission for such development in national land use plans was announced. These spatial discontinuities in prices could not have emerged in unsegmented land markets, so the restrictions that planning imposes on land use must be binding. Moreover, these results underestimate the true price differential, because all agricultural land in this province will command some premium, reflecting expectations about future planning decisions. Segeren (2007) reports that in the western part of the Netherlands, the price of developable land is about 60 to 75 higher than the price of agricultural land on average, while the difference may be much higher at certain attractive locations.

Land use regulation in the Netherlands does not stop at restricting the supply of residential land, but it also determines the specific type of housing that is built on it. An illustrative example are the so-called VINEX locations, where the government planned residential development in the early 1990s. Reflecting the compact development principle, the high density of dwellings that was imposed contrasted strongly with consumer preferences for large houses and gardens (cf. Priemus, 1998). At the municipal level, land development projects are also subject to regulations with respect to the share of social housing, which may require cross-subsidization by the private sector, since rents are restricted below the market level. To the extent that local infrastructure and public goods are financed from land revenues, residential development in the owner-occupier sector is subject to another implicit tax that may hamper supply. Throughout this thesis, we consider such policies as another form of land use regulation, since they derive from conditions that (local) governments impose on land use. Hence, land use regulation in a broad sense has a strong grip on the location, quantity and quality of housing supply, which is likely to leave substantial marks on aggregate market outcomes.

Internationally comparable measures for the restrictiveness of land use regulation are difficult to find. Nevertheless, it seems fair to say that the Dutch planning system is

---

5 These plans were in the end not accepted by the national government, and the Red contours were never officially implemented, but their announcement was apparently sufficient to induce the capitalization effects reported in this study.

6 Note the contrast with land use regulations such as minimum lotsize or ‘exclusionary’ zoning, which are common in the US (cf. Fischel, 2004).

7 Moreover, as owners of land have the right to develop it and the number of locations that are considered for new development is usually limited, developers that own land have a strong bargaining position and negotiations with municipalities may be lengthy. Indeed, new construction projects at VINEX locations have experienced major delays, as reported in Jókövi et al. (2006).
remarkably restrictive from an international perspective. One indication is that the Dutch policy framework for the preservation of open space is internationally regarded as successful in the world of planners (cf. Koomen et al., 2008). For instance, in a six-nation comparison of farmland preservation, Alterman (1997) finds that the Netherlands and the UK are particularly effective in this respect. Also telling is a survey of the literature on the impact of land use regulation on housing supply and prices in the US by Quigley and Rosenthal (2005). These authors suggest that part of the difficulty in establishing an upward effect of land use regulation on prices is that in practice, they may not be binding: “The net effect of adopting development restrictions may ultimately be symbolic only, meant to appease ‘not-in-my-backyard (NIMBY)’ and other constituencies, but generally lacking the will or ability to implement true growth management in the face of population pressures.” (p. 84). Clearly, land use regulation in the Netherlands is beyond such qualifications.

Housing market policy and land use regulation in the Netherlands may thus be characterised as supporting demand and, at the same time, restricting supply. Presumably as a consequence of this combination, house prices have risen substantially over the past decades.8 OECD (2004a) indicates that real house prices in the Netherlands have tripled between 1970 and 2002, whereas real house prices in countries such as Germany, Switzerland and Sweden are presently at about the same level as they were three decades ago.

Introduction to the essays in this thesis

The observation that land use regulation imposes binding restrictions is valuable in itself, but it does not inform us about the consequences of this policy for aggregate housing market outcomes. However, given the importance of land for housing production, one would expect these consequences to be significant. In order to explore this issue, we investigate the extent to which housing supply at the national level is responsive to market signals. This is done in a time-series analysis of the volume of investment in residential structures and new housing construction in units. In order to shed light on adjustments through the quality of new housing supply, we also consider developments in the quality of structures and locations, as estimated in a hedonic analysis. Although this approach does not use direct information on land use

---

8 It is sometimes claimed that land use regulation cannot push up house prices, since it is the price of housing that determines the price of land rather than reversely. This statement is usually motivated with a reference to Ricardian theory, which held that corn prices determine land prices rather than reversely. The crucial difference, however, is that Ricardo assumed a competitive land market, whereas land use regulation restricts market forces. The mechanisms through which restrictions on the supply of residential land may push up house prices are detailed in chapters 2 and 6 of this thesis.
PURPOSE AND ORGANIZATION OF THIS THESIS

regulation, it may provide significant indirect evidence of its effects. In particular, we would expect to find a high sensitivity of supply to price signals if restrictions on land use and construction are not binding, while a lack of such sensitivity to market conditions would suggest the opposite.

Land use and location are bundled so that land use policies are inherently spatial policies. Therefore, the spatial repercussions of land use planning are a second thread in our research. As we have seen, the Dutch government has imposed highly restrictive land use plans in the Randstad area by protecting the Green Heart and various Buffer zones. If these regulations have restricted housing supply, one may wonder whether they have also marked population and employment growth in this region. Indeed, over the past decades, population and employment growth in the Randstad area have been significantly smaller on average than in surrounding regions. In order to shed light on this question, we perform a simultaneous analysis of housing supply, internal migration and regional employment growth at the level of COROP regions (European NUTS3).

The relationship between regional housing and labour markets is investigated further by considering the relationship between house prices and local unemployment. In most European countries, regional unemployment rates are highly persistent over time, which suggests that people in high-unemployment regions are somehow compensated for the loss of income. We conjecture that workers in these regions are compensated by cheaper housing, and test this hypothesis on data for European cities as well as Dutch regions. By highlighting the relationship between local housing and labour markets, this analysis provides further support for the notion that land use regulation may affect regional labour market outcomes through housing supply.

The third and perhaps most important issue that we investigate in this thesis is the welfare analysis of land use regulation. Although restrictions on land use may have a strong

9 The direct use of land use regulation measures in this type of analysis is problematic for at least two reasons. In the first place, it is difficult to find a proper measure for its restrictiveness, as this type of regulation generally comes in many different forms. Secondly, as is fairly standard in the econometrics of policy evaluation, there may be a simultaneity in housing market developments and the imposition of land use policies, and it is difficult to control for factors that affect both. Quigley and Rosenthal (2005) point to similar issues in their survey of the US literature on land use regulation and housing market outcomes.

10 Land use regulation may also affect local employment growth through restrictions on the provision of land for production. However, municipalities tend to be rather generous with this type of land and its usage is also subsidized at the national level. Hence, it is rather unlikely that binding restrictions on the supply of land for production have hampered employment growth at the regional level, so we ignore this type of land use regulation in the remainder of this thesis.

11 In 1973, the Randstad contained 46.0% of the population and 49.2% of employment in the Netherlands. In 2002, these relative shares have dropped slightly to 44.6% and 48.3% respectively. In the Intermediate zone, the population share has risen from 26.2% to 29.1% and the employment share has risen from 26.1% to 27.9% over the same period. See chapter 4 for details on data and definitions.
impact on outcomes in aggregate and regional housing markets, this does not imply that they are costly to society. For instance, Cheshire and Sheppard (2002) estimate that the gross benefits from planning-induced amenities such as local open space and a separation of land in residential and industrial use are substantial. In this thesis, we consider the welfare effects of compact development and clustered deconcentration, which is a typical feature of land use planning in the Netherlands (see also Figure 1.1 and our discussion of it). Specific assumptions are made about the type of benefits that arise from restrictions on urban growth, which are incorporated in a general equilibrium model that allows for growth in a nearby satellite. This model is calibrated on data for Amsterdam, as expansion of the capital is highly restricted, while the nearby town of Almere is planned almost double in size in the coming decades.\footnote{While planning is relatively restrictive around Amsterdam, development at many other places in the west of the Netherlands commands a significant scarcity premium as well. See for instance Ecorys-NEI (2004).}

\begin{center}
\textit{Figure 1.2: Structure of this thesis}
\end{center}

\begin{center}
\begin{tikzpicture}
\node[draw,rounded corners] (a) {Chapter 2: Survey of the literature};
\node[draw,rounded corners] (b) at ([yshift=-2em]a.south west) {What is the impact of land use regulation...};
\node[draw,rounded corners] (c) at ([yshift=-4em]b.south west) {...on aggregate housing supply and prices?};
\node[draw,rounded corners] (d) at ([yshift=-4em]b.south east) {...on regional labour market outcomes?};
\node[draw,rounded corners] (e) at ([yshift=-6em]c.south) {=> Chapter 3};
\node[draw,rounded corners] (f) at ([yshift=-6em]d.south) {=> Chapter 4 and 5};
\node[draw,rounded corners] (g) at ([yshift=-8em]f.south) {And how should this impact be normatively evaluated?};
\node[draw,rounded corners] (h) at ([yshift=-10em]g.south) {=> Chapter 6};
\end{tikzpicture}
\end{center}

The structure of this thesis is indicated in Figure 1.2. Essays on the consequences of land use regulation are contained in the chapters 3 to 5. Chapter 3 considers the price elasticity of housing supply at the aggregate level, while the next two chapters focus on regional repercussions of land use planning. Chapter 6 presents a welfare analysis of clustered deconcentration applied to Amsterdam and Almere. These chapters are preceded by a survey of the literature on land use regulation, which puts our research findings into a wider
purpose. A synthesis of our findings, as well as policy implications and a future research agenda are contained in a concluding chapter.
CHAPTER 1
Chapter 2

Land markets and their regulation: the welfare economics of planning\(^1\)

The great majority of the world’s population, and all those living in developed economies, live in societies in which the goods and services they consume are by and large provided through markets and – subject to their incomes – they are free to choose what, where, and how much to consume. But to varying degrees governments intervene and regulate all markets. So the regulation of land markets is not exceptional in itself: but it is exceptional in its form and severity. What economists call ‘land market regulation’ however, most people – including those who practice it – call land use ‘zoning’ or ‘planning’. This is definitely a form of regulation, however, since it determines the use of an economic resource according to rules and norms: prices and land markets are still influential, as we will see below, but their influence is constrained and regulated by planning decisions.

Underlying and guiding the form of most systems of market regulation there are general analytical principles derived from welfare economics, which build essentially on two ‘fundamental theorems’.\(^2\) The first of these theorems is that under certain conditions, the outcomes generated by markets are ‘efficient’ or ‘socially optimal’. The economic concept of efficiency has a very particular meaning; an outcome is socially optimal if no redistribution of ‘goods’ or re-allocation of resources is possible which would not make at least one person worse off in welfare terms than they were previously. In other words, taking the real income distribution and legal property rights as given, it is impossible to improve total welfare without damaging the welfare of at least one individual. The validity of this theorem rests on four principle conditions holding, however: the first is that people are the best judges of their own welfare; the second is that the actions of no person or firm influence the welfare of others without that influence being reflected in prices; the third is that no agent in the system has any degree of monopoly; and finally it must be the case that all goods have prices. A violation of any one of these conditions is usually referred to as a ‘market failure’.

---

\(^1\) This chapter is based on Cheshire and Vermeulen (2008).

\(^2\) See Varian (1996) for an accessible introduction to the microeconomic theory on which we build this chapter, while a more thorough treatment may be found in Myles (1995) or Mas-Colell \textit{et al.} (1995).
The point and power of this result may seem paradoxical to a non-economist. It is that the conditions that would have to hold for markets to deliver a socially optimal outcome almost never hold in practice. But they can be identified with complete precision. The beauty of this first fundamental theorem of welfare economics is that it provides clear guidelines for regulating markets. The best sort of regulation intervenes in ways to ensure that so far as possible the conditions leading to market failure are eliminated or, more realistically, their influence is minimised. In nearly all countries there are government bodies charged with ensuring fair competition, regulating monopolistic practices, advising and intervening on health aspects of industrial processes, or devising policies to restrict pollution or combat global climate change. Some goods – the most obvious being national defence – do not have prices and are provided directly by the government. All these examples of government intervention or regulation reflect clearly identified sources of market failure.

Economists make a sharp distinction between efficiency – the best society can do on the basis of the current distribution of incomes and wealth – and what is ‘equitable’, that is, what society might collectively choose as a fairer distribution of income and wealth. The advantage of the notion of efficiency is that outcomes can be analysed without resorting to ethical judgements beyond those identified above. It is the content of the second fundamental theorem of welfare economics that whatever its distributional properties, every outcome that is efficient can be attained in a market economy by transferring money between agents in a lump sum fashion. So if society, for example, really prefers an outcome in which every agent is equally well off, irrespective of their endowments in terms of human capital, it can attain this outcome by transferring money to agents with little human capital and leave the allocation of commodities to markets. Nevertheless, this result takes the distribution of real incomes again as given, treating the ‘ideal’ distribution as a matter of individual conscience and judgement. Economists are of course interested in distribution but they are less confident in their analysis. For instance, economics has important things to say about the often unexpected distributional outcomes of planning interventions (see section 2.3 for some examples) but it has little to say about what those distributional outcomes should be. Economics contributes a great deal to the analysis of issues such as the affordability of housing, exclusionary zoning or social housing but it has little to say about the necessity or desirability of the distributional purposes of such policies.

To most planners, welfare economics is an alien way of thinking, as they tend to come from a completely different intellectual tradition. Economists are rational, calculating and – aspirationally at least – the closest in approach to natural science of any social science.
Planning’s roots are in design and engineering and its aspirations are utopian. Hall (1974) in his wonderful overview of the historical origins of planning, devotes a whole chapter to ‘The Seers’. The founder of the Council for the Preservation of Rural England (in 1925) was Abercrombie, the author of the seminal 1944 plan for Greater London. Another influential figure in the early days of planning was the eccentric architect of Portmeirion, Clough William-Ellis (1928). In the Netherlands, one of the most important architect-planners in this era was H. P. Berlage, whose design of a neighbourhood in the south of Amsterdam is still highly celebrated today. Planning has added a good deal of social science over the past generation and is now an established, legalised and legalistic system, but its intellectual roots are in design and what draws eager students into the subject is an aspiration to improve the lot of human kind by means of a better built environment. Ultimately, for planners, ‘urban containment’ or ‘mixed development’ are worthwhile because they are right: or at least that is how it seems to be to an economist looking in to the world of planning.

Another essential distinction is that while planners treat aesthetics and amenities as having intrinsic value, economists attempt to value these attributes in terms of how they influence human welfare, reflected in what people are willing to pay for them. For instance, environmentalists appear to economists to set some absolute value on environmental outcomes, independently of human preferences. Economists try to estimate the willingness to pay for environmental outcomes. Most planners favour mixed land uses and mixed communities. Economists ask awkward questions, like what is the value of such attributes? Who gains from them? Who loses? And how much do they cost to secure? All these issues can be treated within the framework of welfare economics, which puts sustainability and environmental outcomes, including those of the built environment and its relationship to rural preservation or conservation, to the same fundamental tests: costs and benefits. They are not outcomes given value in their own right, but their value depends on the preferences and willingness of people to pay for them and what we have collectively to forego in order to obtain them.

Though not an approach that is widespread in the planning community, this chapter offers a welfare economic perspective on land use regulation. In the next section, we will discuss the reasons for land use regulation in terms of various types of market failure. Section 2.2 illustrates how economic theory may be employed to derive optimal land use policies that take account of externalities and the public nature of certain types of land use, while offering some thoughts on the applicability of these theoretical results in the real world. The empirical evidence on costs and benefits of land use regulation is considered in section 2.3. As land use
regulation is relevant for other sectors too, and as there may be indirect effects of these policies, our concluding section puts this discussion into a wider perspective.

2.1 Why is intervention in urban land markets needed?

How exactly does the rather general framework of welfare economics apply to land markets and cities? Land markets are riddled with problems of market failure, particularly those associated with actions of land owners that are not priced and the provision of specialised public ‘goods’, such as open space, which it is difficult or impossible to price. An obvious feature of land is that any parcel has a specific and fixed location. The value of any parcel of land is, moreover, largely determined by the characteristics and uses of other parcels of land bordering it and to which it gives access. A plot of land in central London may be worth £100 million a hectare, not because of its fertility but because it gives easy access to one of the largest, most highly skilled and highest paying labour markets in the world and large numbers of high spending customers. If it is close to a parcel of land being used as a major intersection of the Tube system its value will be substantially greater because access will be even easier. If a firm were to set up on the adjoining plot, smelting lead or incinerating toxic waste, the value of the site would be greatly reduced. Houses under a flight path at Heathrow airport will be worth less than similar houses not affected by aircraft noise. A house in a National Park and with a view out over its unspoilt beauty or with frontage to a good fishing or boating river will equally have a substantially higher price than a similar house looking out to a railway line or a power station. There is an extensive literature documenting the extent, complexity and sophistication of the ways in which land and housing markets capitalise the impact of amenities, neighbourhood characteristics and disamenities to which their location exposes them. As far as it concerns the valuation of open space and other planning-induced amenities, a brief review of this literature is offered in section 2.3.

But while the value of any given site depends on the uses of sites bordering it and to which it gives access, the actions of the owners of those other related sites which generate (or reduce) that value would, in unregulated markets, be neither rewarded not penalised; or at least only incompletely. The firm that decides to set up a lead smelting plant may lose value in its own site but does not (at least without regulation) have to compensate the owners of the other surrounding sites for the losses they incur. A farmer who pollutes a river would lose the value of his own fishing rights but not the value of all those down river who also suffered
loss. These are all examples of externalities, and because land values are so strongly influenced by the actions of owners of adjoining and nearby plots, land markets if left unregulated would exhibit serious problems of market failure. The pattern of land uses would consequently be far from the optimum. It should be added, though, that land use externalities do not need to be negative. Households that live in close proximity to each other may find it easier to maintain their social networks and firms may want to locate in close proximity to other firms in order to reap the benefits of agglomeration economies, such as the easy transfer of knowledge.

The provision of public goods is another significant source of market failure in land markets. In economics the term ‘public goods’ is used in a very specific way to describe goods (or services) which i) are non-rival in consumption and ii) are non-excludable. What ‘non-rival’ in consumption means is that if one person benefits from the provision or consumption of a good, this does not affect the welfare of its other consumers or the costs of the producer. I might share a packet of cashew nuts with my friends but the more I eat the less there are for my friends, and replacing the packet would cost resources. But this is not true of all goods – national defence is an example which is often used, but the same is true of National Parks or, indeed, any park, museum, open space, cityscape or architecturally attractive neighbourhood. If I enjoy a walk in Amsterdam’s Vondelpark, this in no way restricts the enjoyment of others and any additional costs of park maintenance are so trivial we can forget about them. The exception might come when a park or open space begins to get congested. Then an additional user would impose costs. The enjoyment of existing users (as well as that of the additional user) would be reduced by the congestion effect. ‘Non-excludable’ means that it is impossible to stop people consuming the good, if it is provided. For practical purposes I can only eat my cashew nuts if I buy them. If I do not pay for them it is easy to exclude me from enjoying them. With some goods this is not possible: for example, if a view is beautiful, it is impossible to exclude people from enjoying it. Cityscapes or areas of architectural interest are equally impossible to exclude people from and it is difficult to exclude them from parks.

This class of public goods is relevant because markets will not provide any incentive, or sufficient incentive, to provide optimal quantities of them. It is also difficult to know what the optimal quantity to provide is, since markets do not provide the necessary signals.³

³ The polar opposite are ‘private goods’. For these there is a price reflecting the willingness of consumers to pay for the goods and so signal their preferences, given the distribution of incomes; and a cost reflecting the value of the resource used to produce the goods. The reality is that many goods are neither purely private not ‘pure’
Tiebout (1956) demonstrated that this was not necessarily the case for local public goods where the ability to consume was determined by where someone lived. So long as such local public goods were provided and paid for by local governments and their residents and people were free to move, then people could vote with their feet and choose rates of local taxes and supplies of local public goods which best suited their pockets and preferences. But this conclusion rests on particular fiscal and political institutional arrangements and minimal costs of mobility, so it may not be generally applicable as a solution to the real world problem. In fact, a significant element of land use regulation is to provide such goods directly by preserving open space within and around cities, supplying parks, recreational facilities as well as conserving architecturally significant areas, environmentally important sites and helping to provide and maintain cityscapes.

The locational specificity of land, housing and real estate is central to both these reasons for market failure. It also underlies yet another reason for market failure, related to market power. Many development projects, most obviously large infrastructure projects such as roads or railways but also large restructuring projects in developed urban areas, require the merging of several or many parcels of land under different ownership to make a viable development. A railway line that is incomplete because a particular landowner refused to sell the essential final parcel of land would be useless. This gives increasing market power to hold-out sellers. For private developers, trying to assemble larger sites from several separately owned plots, this is a nuisance and may lead to non-development, loss of private profits and a suboptimal outcome in terms of social welfare. For major infrastructure projects, the potential for suboptimal social welfare outcomes is very substantial. This led nearly all countries to introduce some form of compulsory powers of purchase either for government on behalf of the developers, or the granting of such powers directly to the companies themselves with (usually) significant regulation attached. This cause of market failure in land markets is, however, not endemic in the way that externalities and problems of public good provision are, and it generates a more specialised and particular type of regulation.

For completeness, we should include the possibility that another assumption underlying the first fundamental theorem of welfare economics, namely that people are the
best judges of their own welfare, may also be violated. In this case, the government may want
to revert to ‘paternalism’ and decide for the individual how much to consume of certain
goods. The goods that would call for such interventions are usually referred to as merit goods,
and they may be defined as “goods that society deems to be especially important and that
those in power feel individuals should be required or encouraged to consume” (Lipsey and
Chrstal, 1995). There are also the inverse of merit goods: goods such as hard drugs or, in
some times or cultures, alcohol, that are judged too bad for individuals to be allowed to make
their own choices. This type of argument could possibly be invoked to cover, for example,
affordable housing policies, as certain groups in society – such as the very young or very old
– may not have the effective power to make their own informed housing consumption
choices.

2.2 Optimal land use policies in economic theory and in practice

Since outcomes in unregulated land markets can often for a number of reasons be socially
suboptimal, government interventions in these markets may be welfare enhancing. This
section introduces a highly simplified economic framework, which enables us to identify
costs and benefits of land use regulation in the context of two particular market failures: a
negative externality of residential land use and the public good nature of some open space,
such as city parks. We show how this framework may – at least in principle – be used to
derive an optimal policy. The next subsection then proceeds to discuss the range of
assumptions and simplifications that needed to be made, and what this means for applying the
stylised economic framework to land use regulation in the real world. Next to externalities
and public goods, redistribution is often another motive for government intervention in land
and housing markets, but since economic theory offers no clear reason for large-scale
redistribution specifically by interventions in housing and land markets, we ignore this issue
here.\(^4\)

---

\(^4\) As already discussed in the introduction to this chapter, the second fundamental theorem of welfare economics
holds that under certain conditions, every efficient outcome can be attained in a competitive economy by
transferring money between agents in a lump sum fashion. So if society prefers an outcome in which every agent
is equally well off, irrespective of their endowments in terms of human capital, it can attain this outcome by
transferring money to agents with little human capital and leave the allocation of commodities to free markets.
This means that, in the stylised world in which this result is derived, redistribution does not require any market
intervention. In practice, it is usually not possible for governments to transfer money in a lump sum fashion, so it
has to restore to other means of redistribution. The two main options are progressive income taxation and the
taxation or subsidisation of commodities, of which the extensive social or affordable housing programs in some
countries are an example. However, it has also been shown that under certain conditions, progressive income
In order to illustrate how a welfare economic framework may be used to analyse optimal policy in the presence of land use externalities, we consider a city-region within which all residents live and work. The city-region has an urban core but is surrounded by a rural (or as the French might have it a ‘peri-urban’) hinterland. This hinterland is interpreted as a multifunctional park that provides citizens with recreational areas, environmental amenities and scenic views – as in the greenbelt that was originally envisioned by Ebenezer Howard.\textsuperscript{5}

Urban expansion would imply that open space in this greenbelt was reduced, or that it is moved outwards and so becomes less accessible to residents of the inner city. However, in unregulated markets the size of the urban area is the outcome of land use decisions of individual households and in determining the size of their own houses and gardens, these households will generally ignore the loss of access to open space at the urban fringe that their choices impose on the wider community. Hence, they do not take full account of the burden that their behaviour imposes on society, and a government intervention in the land market may be appropriate. Our analysis of compact city and clustered deconcentration policies in chapter 6 will consider an externality of this type. Nevertheless, although we may thus conveniently introduce the welfare economics of urban containment policies, it should be noted that the existence and significance of negative externalities related to the total amount of urban land in residential use are not in practice as clear-cut as the conventional wisdom on greenbelt-type policy implies.\textsuperscript{6}

\textsuperscript{5} Note, however, that these assumptions require that the land in the greenbelts is open to public access. That was certainly the rationale for greenbelts in the original vision of Ebenezer Howard and it arguably applies in some countries. Lee and Fujita (1999) consider the case of the greenbelt around Seoul, South Korea, for which Lee and Linneman (1998) had shown that a premium of about 5\% of the land value per kilometre is paid for proximity to the greenbelt. Equally in the Netherlands, areas such as the Green Heart and the Buffer zones between cities are accessible through a myriad of walking and bicycle routes. However, in other countries such as the UK and the USA, access is limited or manifestly absent.

\textsuperscript{6} In particular, evidence to be discussed in section 2.3 suggests that residents put much more value on parks within an urban area than on open space at the city fringe (see for instance Table 2.1). To the extent that large chunks of parkland interior to the city – like the Vondelpark in Amsterdam or Hampstead Heath in London – provide a similar experience to recreation in greenbelt land, they may be good substitutes at closer proximity for most urban residents. The economic framework for analysing the public provision of parks will be considered later in this section.
We consider the market for residential land in a partial equilibrium setting. It is assumed that people derive utility from the consumption of residential land, from recreational activities in open space at the urban fringe, and from all other goods and services that are aggregated into a single *numeraire* good. This composite or numeraire good may be normalised in such a way, that one unit of it is equivalent to one currency unit. This allows us to express utility and social welfare in pounds sterling, Euros or any other currency unit. Furthermore, we assume that the demand for residential land is not affected by income, and that no relationships exist between the outcome in this market and prices in other markets. These are all simplifying assumptions to help us reveal more clearly important underlying relationships and policy choices.

Figure 2.1: Equilibrium in an unregulated market for residential land

It is helpful to represent this welfare analysis of land use regulation diagrammatically as in Figure 2.1. This figure features aggregate residential land on the horizontal axis, and the price of a unit of residential land at the vertical axis. The downward sloping line $D$ indicates the aggregate demand for residential land, which is the sum of all the demands of individual households in society – in this case all those living and working in our ‘city-region’. This demand curve is downward sloping, because as the price of residential land falls households

---

7 See Mas-Colell *et al.* (1995) for a thorough treatment of the partial equilibrium model.
may increase the size of their houses and gardens, choose to live in detached houses rather
than town housing or apartments and new households will form as housing is cheaper.\textsuperscript{8}
Formally, it shows the particular level of consumption for every price if all consumers chose
their demand for residential land optimally. This price may be interpreted as the social benefit
of increasing the aggregate supply by one unit at the specified level of consumption, as it
measures the total amount of numeraire goods that residents are willing to forego in order to
obtain it. Hence, the area under the demand curve may be interpreted as the total social
benefit from residential land consumption, or its contribution to aggregate utility, exclusive of
the costs that are associated with it.

Figure 2.1 also contains two supply curves. The first curve $MPC^i$, for marginal private
costs, indicates the costs of a unit of land that are internalised in markets, consisting mainly of
opportunity costs (the price of agricultural land) and conversion costs. We assume that the
curve $MPC^i$ is flat, that is, the costs that are internalised in unregulated markets do not vary
with the total supply of residential land. More agricultural land could always be converted to
urban use at an approximately constant cost in real terms.\textsuperscript{9} The second supply curve $MSC$, for
marginal social costs, adds to these private costs the burden imposed on society that is not
reflected in market prices. This is the reduced accessibility of greenbelt land at the urban
fringe which people value, but by assumption in our model, do not pay for. It can be measured
in terms of the loss of the numeraire consumption good that would be associated with an
equal reduction in their welfare. As numeraire goods are normalised to currency units, this
loss may also be converted into a money value – the payment people would have to make to
have exactly the same impact on their wellbeing as the loss of open space. Formally, $MPC^i$
indicates the private costs of producing an additional unit of residential land for each level of
supply, and $MSC$ adds the penalty that is equivalent to the loss of access to open space
associated with it. The areas under these supply curves therefore indicate the total private and
the total social costs from the supply of residential land. We assume that the two curves
intersect when the total supply of residential land is zero, and that the marginal social costs

---

\textsuperscript{8} In Britain Peterson \textit{et al.} (1997) estimate an elasticity of response of - 0.1 percent: that is a 10 percent reduction
in housing prices is associated with a 1 percent increase in the rate of household formation as additional people
can afford to set up on their own account. See Börsch-Supan (1986) for estimates of this elasticity for the US.

\textsuperscript{9} Formally, in a monocentric city, the supply curve of residential land is upward sloping, because as the urban
area grows, the quality of agricultural land at the fringe falls in terms of access to jobs in the centre. Hence, the
price of land within the city and the intensity of its usage must rise before it becomes profitable to expand –
leading to differential rents on inframarginal land. However, the amount of land that becomes available with
each kilometre of city expansion increases quadratically, so for medium to large urban areas, the effect may be
negligible for practical purposes. A more elaborate discussion of the role of differential land rents in pushing up
aggregate house prices in the Netherlands will be provided in the next chapter.
increase with the total supply of residential land. In a very small community in which every person can see and walk into the surrounding green open countryside the externality problem would not arise. It only sets in when the city becomes so big that people within it begin to place a value on access to unbuilt land external to the city – access to true green space. This is predicated, though, on there being public access to that green space and one must accept the possibility that large ‘country parks’ internal to the urban area could be substitutes, even superior substitutes (see also footnotes 5 and 6).

Households will choose to buy residential land up to the point at which the cost to them is equal to the value or welfare they derive from it. In the absence of any government intervention their consumption of residential land will be at the point at which the demand curve \( D \) and the supply curve \( MPC^l \) intersect, with a supply of \( S^l \) at a price \( P^l \) for each unit of residential land. How should this equilibrium be evaluated from a welfare economic point of view? The area \( \text{alpm} \) under the demand curve measures the gross social benefit that is derived from the consumption \( S^l \) units of residential land. The total internalised production costs are measured by the area \( \text{ilpm} \) under the supply curve \( MPC^l \). The triangle \( \text{ali} \) that results when all internalised costs are subtracted from the gross social benefit is the consumers’ surplus in the residential land market. Intuitively, it derives from the fact that all except the marginal consumer would have been willing to pay more than they actually had to for the land they consume. The consumers’ surplus may also be interpreted as the value of the numeraire good people would have to be given in order to make them equally well off if the consumption of residential land was zero. However, it does not take account of the loss of access to open space at the urban fringe their consumption choices entail which is not internalised in the cost function. This additional ‘social cost’ is measured by the triangle \( \text{idl} \). This can be interpreted as the amount of the numeraire good or money that would have to be taken away from society to have the exact same negative impact on welfare as the loss of access to open space.

Because in making their own individual decisions consumers ignore the external costs of land consumption in the free market equilibrium this outcome cannot be optimal. This is readily seen in Figure 2.1. Consider a fall in the consumption of residential land by one unit, relative to the free market outcome \( (S^l, P^l) \). This reduces the gross social benefit by an amount equal to \( OP^l \), while the reduction of social costs (both internal and external) amounts to \( OC^l \). Equivalently, we can say that a marginal reduction of the consumption of residential land does not affect the consumers’ surplus in this market, but that it reduces the external costs by an amount \( C^l - P^l \). Hence, on balance, it makes society better off. Indeed, the
condition for optimality in this framework is that a marginal change in residential land use would create changes in social benefits and costs that exactly offset each other.

Figure 2.2: An optimal tax on residential land development

We can now use this analysis to show how government could intervene in land markets to produce this socially optimal outcome, first by imposing a tax on land consumption and then by direct regulation. Figure 2.2 illustrates a tax on the conversion of open space to residential land, \( \tau^1 \), which raises the marginal private costs of supplying residential land to the curve \( MPC^2 \). Again, households will choose their consumption of residential land such that the social benefit of increasing aggregate consumption by one unit equals the actual costs to suppliers of providing it. Since these costs now include the development tax, this leads to an equilibrium with a lower supply of residential land \( S^2 \) at a higher price \( P^2 \). The gross social benefit derived from the consumption of residential land is now indicated by the area \( agom \), and the total private costs are given by the area \( egom \), including tax expenditures \( egki \). The consumers’ surplus is the triangle \( age \). It is much smaller than in the free market equilibrium, both because less residential land is now consumed (incurred a reduction of \( glk \)), and because people pay a higher price for it (incurred a

10 In a stylised model, this development tax is equivalent to a tax on the consumption of residential land, because developers will pass it on to consumers in a competitive setting. Although direct regulation of land use is much more common than this type of fiscal incentive, there is some analogy with the Impact Fees that are gaining popularity in the USA. We will get back to the topic of Impact Fees in section 2.3.
reduction of $egki$), although since this latter rectangle represents the increase in tax revenues, consumers could be fully compensated if these were entirely redistributed to them.\footnote{This assumes that tax revenues are converted entirely into welfare – so there is no deadweight loss associated with collection and spending.} Therefore, the costs of this policy, interpreted as the loss of consumers’ surplus in the residential land market that cannot be compensated by tax revenues, amounts only to the dark grey triangle $glk$. This cost reflects the shift in residential land consumption caused by the tax, which might be reflected in slightly smaller houses and gardens or in other adjustments reducing personal consumption of space. However, as the aggregate consumption of residential land was – before the tax was imposed – too large because of the unpriced reduction in access to open space at the urban fringe it caused, the tax also generates benefits. The total external costs are now given by the triangle $igk$, so the tax leads to a reduction of external costs of $gdlk$. This trapezoid may be interpreted as the social value of the open space protected from development by the tax. The net welfare gain of imposing the tax, $\tau^1$, is the difference between the costs, $glk$, and the benefits, $gdlk$; that is the light grey triangle $gdl$.

There can be government failure as well as market failure, however, and in Figure 2.3, we illustrate the case in which the government sets the development tax at a level $\tau^2$ that is too high. The marginal private cost curve is now raised to the level $PC^3$, resulting in a supply of $S^3$ at a price of $P^3$. The trapezoid $acnm$ is the value of the gross benefit society derives from the consumption of residential land. After subtracting the total private costs $bcnm$, (of which $beji$ represents the tax) the consumers’ surplus of $acb$ is left over. The loss of consumers’ surplus relative to the free market equilibrium that cannot be compensated through tax revenues amounts to the triangle $clj$ – which exceeds the value of the benefits generated by the lower external costs imposed by loss of open space that is represented by the area of the trapezoid $hdlj$. The net welfare effect relative to the free market outcome is the difference between the light grey area $gdl$ and the dark grey area $cgh$. Hence, it is seen that this particular level of the development tax not only exceeds the social optimum, but it also leaves society worse off than in the equilibrium without any government intervention at all.

As illustrated in Figure 2.3, the government could also secure the equilibrium ($S^3$, $P^3$) by imposing a direct restriction on the supply of residential land, for instance through an urban growth boundary or the designation of greenbelt land. In practice, this type of direct land use regulation is much more common than the imposition of development taxes. If the government were to impose a growth boundary and prohibit any residential land development in excess of the quantity $S^i$, then the supply curve would in effect be the vertical line at $S^i$. In
our simplified framework, the welfare implications of directly limiting the supply of residential land to $S^3$ are the same as when the government levies a development tax $\tau^2$. Moreover, for any level of development tax, the government could impose an equivalent quantity restriction, and vice versa. However, although this does not affect net welfare in principle, it should be noted that in the case of the quantity restriction, the area $bcji$ cannot be interpreted as a tax revenue. Instead, while pushing residential land prices above their marginal production costs, direct supply restrictions give rise to *scarcity rents*, which accrue to owners of land with permission for residential development. Hence, there are important distributional consequences, as we will see in the next section. Furthermore, the scarcity rent on a unit of land with permission for development may be interpreted as the shadow price of direct land use restrictions, and being equal to $\tau^2$ – the tax that would lead to the same outcome, it is sometimes referred to as a *regulatory tax* (cf. Glaeser *et al.*, 2005, and Cheshire and Hilber, 2008).

---

12 Besides transfers from consumers to landowners, these scarcity rents may also dissipate in rent seeking behaviour. Furthermore, in a spatial setting, they may be partly offset by foregone gains to landowners of land the development where is restricted. These issues are further discussed in section 2.3, but they are ignored in this stylised framework.
Whereas we have focused so far on a negative externality of residential land use, the public good nature of certain land uses such as open space may be a much more important rationale for government intervention, particularly within urban areas. As explained in section 2.1, public goods are characterised by non-rivalry and non-excludability in consumption, and these conditions substantially hold for certain types of land use such as public parks, beautiful landscapes or coastlines and rare habitats; and features of cities, such cityscapes and historic districts or architecturally interesting neighbourhoods. The free market would not provide enough of these goods, because their social benefit could not be fully converted into a private flow of revenues to compensate the provider. In other words, the private provision of public goods like city parks would generate a particular type of positive externality; the urban community would benefit from them without fully paying either for the social value they generated or the costs of provision. Hence, the reason for government intervention here is conceptually related to the negative externality of residential land use that was discussed earlier in this section, and subsidies (rather than taxes) or direct provision of these public goods could equally generate optimal outcomes. Again, in the practice of land use planning, public goods are usually provided directly, rather than through pecuniary incentives to private developers.

Figure 2.4: The optimal provision of a public good

![Figure 2.4: The optimal provision of a public good](image-url)
We illustrate the optimal provision of land in parks in Figure 2.4, which has a similar general setup as Figures 2.1 to 2.3. On the horizontal axis, we now measure the total area in parks rather than the amount of land in residential use. A market for land in parks does not exist, so that demand and supply curves do not reflect market prices. Nevertheless, it may still be assumed that land in parks generates benefits to the urban community, and that if land in parks was not available in order to have an equivalent level of welfare, residents would have to be compensated with more numeraire goods – measured in currency units. This implies people, collectively, would be willing to pay a certain sum of money in return for the provision of these parks. The ‘demand curve’ MSWTP should be interpreted in this way – as the marginal social willingness to pay for land in parks. This curve is downward sloping because the people derive less utility from an additional piece of park land if the total supply of parks in the area is already substantial – as is aptly illustrated in the Cheshire and Sheppard (1995) paper that we will discuss in the next section. On the other hand, if society provides these parks, it pays a price in terms of forgone alternative land use and maintenance costs. Here, we assume this marginal social cost curve MSC is upward sloping, though the argument would run in the same way for a horizontal supply curve. As for optimal development taxes and land use restrictions dealing with a negative externality of residential land use, the optimal supply of land in parks has the property that the marginal social benefit it generates equals the marginal costs of production, so at the optimum, the net welfare effect of providing an additional unit of park land is zero. This point is simply the intersection of the MSWTP and MSC curves, where an amount $S$ of park land is provided. The gross total benefit derived from this policy is measured by the trapezoid $agom$ and by subtracting the total social costs $igom$ we obtain the net social benefit of $agi$.

### 2.2.2 From welfare economic theory to practice

What value do the optimal policy rules that we derived in the previous subsection have for land use planning in the real world? Clearly, numerous simplifications have been made, that could drive a wedge between optimal policy in theory and practice. This subsection discusses a number of these simplifications, and how relaxing them might alter policy prescriptions.

One major simplification of the approach in the previous subsection is that for both residential land and open space, it aggregates demand and supply to the level of ‘society’ –

---

13 Note that if the park is publicly provided, the distinction between private and social costs becomes meaningless.
composed of all the residents of a city-region. However, in section 2.1 we have stressed that many land market failures arise from the fact that each parcel of land has a specific and fixed location. The bundling of land use with accessibility implies that social welfare depends not just on the quantity of open space but on its distribution relative to that of residential land. For instance, if all open space is supplied in the north of the city, and residents live in the south, then the social value of this open space will be less than if it was supplied in a more accessible way. On the other hand, a certain quantity of open space may be appreciated more when it is provided in one large area, than when it is divided into many small pieces. Moreover, patterns of residential land use determine landscapes and cityscapes, and some patterns may be more pleasing than others. If we allow for hills and valleys, then houses on the high ground will command views which are valued. But having houses on hills may deprive other residents of views of open hill tops. The implication is that for a more complete policy prescription, we should disaggregate our framework to many different local residential land markets, and derive an optimal regulation of land use for each of them. Nevertheless, the bundling of land use and accessibility implies that the local supply of open space is capitalised into land prices. Land and so the houses on it located near a nice park is more expensive, all other things equal. So in contrast to the assumptions made in the previous section, the social value of open space may be largely reflected in market prices. This may have important consequences for the provision of certain types of open space by local governments or private developers not considered here.¹⁴

A second complication that arises when implementing the policy prescriptions of the previous subsection is that their optimality is conditional on the absence of market failures in other markets. However, as we have extensively discussed in section 2.1, urban land use is associated with a myriad of externalities, which are not always easy to disentangle. In principle, externalities should be addressed in the most direct way possible, because such policies are likely to be the most effective, while generating the least undesirable side effects. For instance, if the use of carbon-based fuel is excessive from a social point of view contributing to global warming, the answer is to address this market failure directly. The closest we are likely to get to an optimal solution is by imposing a fuel tax. This gives households a direct incentive to reduce fuel usage. It would push up the demand for higher

---

¹⁴ Consider for example a developer who owns all the land in a neighbourhood. The developer may give up some land and create parks instead. These parks push up the price of surrounding houses, compensating for the opportunity costs of assigning land to parks. Under certain conditions it may be shown that, if all benefits of the parks capitalise fully within the neighbourhood, the developer will provide an optimal amount of them while maximizing profits. So in this case, no government intervention is required to arrive at the social optimum.
density living only to the extent that there is a link between housing density and the demand for transport. Similarly, a link between urban form and traffic congestion may exist but congestion externalities will likely be addressed more efficiently by taxing them directly, rather than regulating land use in such a way that the urban form becomes less congestion prone.

Yet in practice, land use regulation is often treated as a solution to a wide range of externalities. To illustrate the disadvantages that this may have, let us consider again the example of a negative externality of fuel use. If the government seeks to reduce these external costs by restricting the supply of residential land through urban containment policies the only effect on fuel use will come from a more compact urban form reducing car mileage. There are two issues to consider here. The first is that a restraint on urban land take will only affect new development – perhaps as little as 1% of all development. The result would be that even if there is any causal relationship between density and less fuel use, the impact via land use controls will be painfully slow. The second point is that reactions may be altogether more complex. A more compact urban form might intensify social contacts so that, while trips are shorter on average, the total number of trips increases. Because houses and shops would be smaller, shopping and restocking trips may be more frequent and more subject to congestion. So overall the land use policy is likely to be at best marginally effective, and it may even increase the external costs of fuel use.\footnote{Conversely, it has been argued that fuel taxes should be increased because this would lead to more compact urban form. However, fuel taxes have been shown to be less efficient instruments for this purpose than development taxes or growth boundaries (cf. Bento \textit{et al.}, 2006, Cheshire and Sheppard, 2002). One of the undesirable side effects of raising fuel taxes, relative to these direct instruments, is that it increases the density gradient in cities.}

A third major assumption underlying the derivation of optimal taxes or direct regulation in the case of externalities and public goods is that the government has sufficient information. For instance, in order to find the optimal development tax in Figure 2.2, the government needs information about the private and social costs of residential land use. Moreover, if it chooses to restrict land use directly, it also has to know the shape of the demand curve, and because of the spatial fixity of land, in principle it has to know the shape of these curves at each location. Implementation of the optimal supply of parks in Figure 2.4 presumes knowledge about the value that an urban community attaches to the marginal unit of land in parks, which is even more complicated since there is no market for parks and residents have an incentive to overstate their valuation in surveys (‘free-riding’). Although the informational requirement for optimal land use regulation may seem prohibitive the bundling
of land and accessibility also offers the opportunity for measuring the social costs and benefits of particular types of land use providing amenities, such as open space, or disamenities, such as noise or pollution. In so far as these are capitalised in land prices we can estimate their social value through the impact they have on house prices. As we will see later, this is one of the main techniques for empirical welfare analysis of land use regulation.

In summary, we might say that policy implications of the simple framework set out in subsection 2.2.1 should be hedged about with many provisos – some relating to the nature of the particular externalities and sources of market failure and others relating to more technical issues including failures in other markets which may have a bearing on the particular market – here the land market – we are interested in, and a substantial informational burden exists on top of this. Policies in the real world may end up attempting to achieve something close to a second best and the best policy mix will need to be based on both the unachievable ideal and on judgement about how significant particular market failures are and how failures in one set of markets may interact with failures in others. Nevertheless, the intuition obtained here provides a useful and in fact practical benchmark. In particular, government interventions in land and housing markets always generate costs and benefits for society, and policy makers should aim to strike a balance between them.

2.3 Evidence on the effects of land use regulation

This section reviews some of the evidence that has been built up over the past 20 years or so about the welfare effects of land use planning. In principle the net effects could be positive or negative. On the one hand by correcting market failure and ensuring a supply of amenities that would otherwise be undersupplied, land use regulation in the form of planning or zoning, creates benefits. At the same time, however, it may restrict the supply of valued goods – notably the supply of specific kinds of space – in housing, offices, shops, factories or, of course, in the form of private open space: in gardens. Any planning policy that curbs urban expansion, increases densities or restricts building heights necessarily restricts the supply of a particular type of space. If supply is restricted it is not just that the price is driven up, so the good in question becomes more expensive, there may be knock on effects on household mobility, travel behaviour and productivity and there will certainly be distributional effects. Those landowners who own land on which it is allowed to build (or build higher) get an increase in their asset values; those who are unable to develop their assets in the most
profitable way get a corresponding reduction in asset values. Those who own houses gain in asset values, especially if their houses are endowed with more of the attribute the planning system is restricting the supply of (they have bigger gardens or their houses are constructed in the greenbelt); those who rent or are would-be house buyers suffer a reduction in asset values or incomes. We review the evidence of each of these effects in turn, including the rather sparse evidence on the net welfare effects: that is the net impact on welfare allowing for both the value of benefits generated and higher costs imposed on the use of space.

2.3.1 The valuation of planning induced amenities

The two main methods for empirical valuation of open space are via the estimation of ‘hedonic’ models and stated preference analysis. The use of hedonic models is theoretically preferable since it is based on clear theoretical foundations and observes the actual behaviour of people. As pointed out in section 2.1, each house consists of a complex bundle of attributes and because each parcel of land has a unique location its occupation determines access to a wide range of local public goods. This implies that their value is reflected (or capitalised) in house prices. The price of any house is in a sense the aggregate price of all its attributes, including the access it gives to local amenities and public goods. In fact these non-structural attributes typically account for the great majority of the total value of a house. Although as an empirical technique the estimation of hedonic models goes way back to the 1920s (see Sheppard, 1999), it was Rosen (1974) who provided the theoretical framework and showed how the valuation of such goods may be estimated in hedonic models. A sizeable and ever growing literature has followed his idea.

In their survey of hedonic studies on the benefits of open space, McConnell and Walls (2005) report a wide variation between estimates, and they highlight the importance of distinguishing between different types of open space. The value of preserving a piece of land in a certain use is bound to depend strongly on whether it is a park in an urbanised area, a piece of exurban agricultural land or a wetland. The careful study of house prices in the Minneapolis – St. Paul metropolitan area in the USA by Anderson and West (2006) shows more than this. Not only does the capitalised value of proximity to open space depend on the type of open space and how far away it is from the house but it also varies according to the characteristics of the neighbourhood. For an average home, they find that benefits from

16 ‘Hedonic’ from the ancient Greek for ‘pleasure’.
proximity to open space range from a low of 0.0035% of sales price for every one percent decrease in the distance to the nearest neighbourhood park, to a high of 0.034% for every one percent decrease in the distance to the nearest lake. Importantly, they find that the value of proximity to open space rises with average income and density in the neighbourhood, while it falls with distance to the central business district. Given that access to open space is a ‘normal’ good – people consume more of it as they get richer – it is not surprising to find that it has a higher value in richer neighbourhoods. Equally the finding that its value is higher in higher density neighbourhoods suggests that at least to an extent public open space is a substitute for private open space. The reason why the value of open space falls with distance from the city centre could be that the total supply of (private and public) open space in suburban areas is higher, so that its marginal benefit is lower, or that residents in suburbs have easier access to open space outside of city boundaries as a substitute for parks.

A potential drawback of estimating the value of proximity to open space by means of its hedonic price is that while this yields the slope of the valuation of open space with respect to distance, its level – its total value – is not inferred. The valuation of a large special park might decline less with distance, simply because it is appreciated over a wider area, so that its value to the whole metropolitan community might be considerably larger than the total value of a local park of which the valuation declines more steeply with distance. This problem is circumvented by estimating the value of the amount of open space surrounding a house, at the expense of imposing more restrictive assumptions on the relationship between valuation and distance. This latter approach has been applied for instance by Cheshire and Sheppard (1995, 1998), who estimated a hedonic model for house prices in two British towns, subject to land use restrictions that varied significantly in severity. In order to measure the benefits of planning induced amenities, these authors considered the share of land in a square kilometre around each house that was used for either ‘accessible’ or ‘inaccessible’ open space, as well as the share of land that was not in industrial use. Accessible open space meant accessible to the public – parks, recreation grounds, churchyards or common land; this was mainly internal to the urban area. Inaccessible open space was land not built on and not accessible to the public. This was mainly greenbelt land used for farming at the urban fringe but included private woodland. Increasing the shares of both types of open space was found to yield significant gross benefits, with the benefits associated with accessible open space

17 The total value would obtain by integrating the derivative of valuation with respect to distance over the total area in which people value proximity to the open space.

18 The authors did note, however, that there were no significant impacts on house prices of open space (or less industrial land) in locations further than the surrounding spare kilometre.
considerably exceeding those from inaccessible open space, but accessible open space was valued less at the margin in the town where land use planning was more restrictive. In a similar hedonic analysis of house prices in three Dutch cities, Rouwendal and Van der Straaten (2008) find a significant effect of the share of land in parks and public gardens within 500 metres, while proximity to industrial land decreases house values.

While the main focus of these studies was on the value of open space within urban areas, the preservation of open space outside cities may generate significant benefits as well. As we saw, Cheshire and Sheppard (1995) found some value for agricultural land in the greenbelt for houses within the kilometre square. Irwin (2002) however concentrates on this issue, analysing residential transactions in an exurban region in central Maryland, USA. She found that within 400 metres of a house, the conversion of one acre of developable pastureland to conservation land raised the average house price by 1.9%; converting it to public land yielded a premium of 0.6%. That is the more certainly the agricultural land was protected from development the greater the ‘value’. Interestingly, conversion to low-density residential land had a negative impact on surrounding house prices, underlining the fact that one of the important attractions of open space is simply that it is not developed. This negative impact is also likely to be one reason for NIMBYism. As Fischel (2001) has argued, since houses form a substantial element in peoples’ asset portfolios and they are immobile, there is a significant incentive to protect their value by using local zoning or planning policies to prevent land in one’s neighbourhood from being developed.

Although the hedonic approach has the advantage that it rests on revealed preferences – actual behaviour – it also has potential limitations. It is only truly applicable if the value of the amenity in question is localised within the housing market area covered by the study. This may be reasonable in the case of a neighbourhood park or a local school but would be questionable in the case of an amenity for which demand extended over a wide area. This is very likely to be the case with, for example, National Parks, and might possibly be the case with a Greenbelt provided that it acts as an accessible recreational area, such as the Green Heart in the west of the Netherlands. It is also almost certainly the case with world famous attractions, such as Hyde Park, in London, or a famous cityscape, such as Venice. There is an alternative approach to valuing such amenities and that is stated preferences, sometimes known as ‘contingent valuation’. In this approach people are asked to put a value – how much they would be willing to pay and in what circumstances – to have access to or just to know that particular amenities exist so they could access them if they felt inclined. This approach has significant disadvantages since people may make different choices or suggest different
values when they are actually confronted with decisions for which they have to pay. There is
also a potential for the ‘free rider’ problem. That is people overstate their valuations in order
to increase the supply of an amenity that will largely be paid for by others. Although research
using the contingent valuation method has become substantially more sophisticated over time
still these methodological concerns remain (cf. Arrow et al., 1993, McConnell and Walls,
2005). Nevertheless, it may yield valuable insights that complement findings relying on
revealed preferences, and sometimes there is simply no alternative method available.

Table 2.1

<table>
<thead>
<tr>
<th>Land type</th>
<th>Present benefit (per hectare per year, in 2001 £)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban core public space (city park)</td>
<td>54,000</td>
</tr>
<tr>
<td>Urban fringe greenbelt</td>
<td>889</td>
</tr>
<tr>
<td>Urban fringe forested land</td>
<td>2,700</td>
</tr>
<tr>
<td>Rural forested land</td>
<td>6,626</td>
</tr>
<tr>
<td>Agricultural extensive</td>
<td>3,150</td>
</tr>
<tr>
<td>Agricultural intensive</td>
<td>103</td>
</tr>
<tr>
<td>Natural and semi-natural wetlands</td>
<td>6,616</td>
</tr>
</tbody>
</table>

Source: Barker (2003)

As in their survey of hedonic studies, the McConnell and Walls (2005) survey of
stated preference research finds substantial heterogeneity in the estimated stated value of open
space, and again its type and location appear to matter a lot. Nevertheless, for agricultural
land, the stated value is in the same order of magnitude as in the Irwin (2002) study of
exurban house prices discussed previously, suggesting that fears about missing wider benefits
of agricultural land using hedonic methods may be misplaced. Also consistent with Irwin’s
results, stated preference studies suggest that negative externalities of residential development
are an important motivation for the preservation of open space. Based on a survey of stated
preference research in the UK, Barker (2003) also reports a strong dependency of the value of
open space on its location and use (see Table 2.1, copied from Barker (2003), page 36). For
instance, publicly accessible open space in the urban core is valued much more than greenbelt
land, and the landscape value of intensively farmed land is particularly low. These values are
broadly consistent with those in Cheshire and Sheppard (1995). Open space at the urban
fringe not accessible to the public has a relatively low value although its value is significant.
Interestingly, the values reported in Barker are significantly higher than in most US studies
that are surveyed by McConnell and Walls. Perhaps, this is a parallel finding to that of
Anderson and West (2006): open space is more valuable in more densely developed contexts and densities are greater in the UK than in the USA. In addition of course, in the UK there are some limited access rights even to agricultural land by means of ‘public footpaths’ or ancient rights of way. So the amenity value of agricultural land in the UK – even in Europe generally – may be higher than in the USA or other countries which have no rights of public access to private land at all.

While our discussion of the benefits of land use regulation has so far focussed on the provision of open space, it is important to keep in mind that urban planning is about much more. Other aspects, which have received considerable attention in so-called ‘New Urbanism’ and ‘smart growth’ initiatives in the USA, are dense development, the mixture of land uses, access by public transit and the provision of infrastructure for pedestrians and bicycles. The valuation of such planning-induced features of neighbourhoods may be estimated using similar hedonic or stated preference methods. An interesting example is Song and Knaap (2003; 2004), who find significant effects for several new urbanism design features in a hedonic model of the Portland, USA housing market. For instance, they find that the connectivity of local street networks, pedestrian accessibility to commercial uses and proximity to light rail stations raise house values. On the other hand they find that higher densities of neighbourhoods and mixed land uses within a neighbourhood have a negative impact on house prices. This may be comparable to the finding that there is a positive income elasticity of demand for (private) space and that more industrial land in a neighbourhood generates a negative price effect. Nevertheless, Song and Knaap show that these effects are more than compensated by the many positive contributions of new urbanism design features to house prices, so that neighbourhoods that by and large adhere to these principles command a significant premium.

2.3.2 The costs of land use restrictions: housing supply and prices

In generating these benefits, land use regulation imposes limits on supply, although the question has to be asked, what exactly does the regulation restrict the supply of? Different systems and instruments of land use planning may restrict the supply of different attributes of the built environment. For example planning in the UK and in some South-East Asian countries explicitly restricts the supply of land for urban development by imposing containment boundaries and greenbelts. But they do not impose much restriction on the
subdivision of existing developed sites. In the USA, in contrast, there are strong restrictions on converting existing houses to multiple occupation or to subdividing built lots. Many communities also impose minimum lot sizes which, to European eyes, can be oppressively large.\textsuperscript{19} As we have discussed in the previous chapter, spatial planning in the Netherlands combines restrictions on urban expansion through greenbelts with regulation on the type and size of houses to be built, but it tends to foster higher density development rather than minimum lot sizes. Furthermore, restrictions on building height are a form of land use regulation that is observed all over the world.

Notwithstanding the heterogeneous form in which supply restrictions come, their effect is to push up house prices. Indeed, various countries and cities have experienced soaring house prices in recent years, and in some cases, the role of planning as a mechanism restricting supply has been well established. Glaeser \textit{et al.} (2005) in their study of the Manhattan housing market, where prices increased by more than a half between 1980 and 2000, concluded that supply restrictions imposed by the New York zoning laws particularly on height, were the likely cause.

Since the Manhattan market consists mainly of condominiums, the marginal construction costs of new housing amount to the costs of increasing building height, which can be estimated fairly accurately. The authors calculated that average condominium prices exceeded $600 per square foot in the early 2000s, while construction costs for space on an additional floor – even for the typical high-quality, luxury-type condominium unit – were no higher than $300 per square foot. Given these costs and prices in an unrestricted competitive market, the construction of condominiums would have been a lucrative business so high construction rates should have been observed. However, only 21,000 new units were permitted throughout the entire decade of the 1990s, whereas there were 13,000 new units permitted in 1960 alone. They argue that since the construction industry in New York is highly competitive, the difference between prices and construction costs must be interpreted as a shadow price of planning restrictions, or as a regulatory tax (see our discussion in subsection 2.2.1). In other words, restrictions on building heights have pushed up house prices in this city. Left without the height restrictions developers would have built higher – because it was profitable to do so. Similarly, Quigley and Raphael (2005) show that in Californian

\textsuperscript{19} Some communities in the mid West have 10 acre minimum lot sizes. Glaeser and Gyourko (2003) conclude that in many communities in New England the willingness to pay for an increase in lot size beyond the mean is negative! That is people are being constrained to buy and consume more land than they would ideally like to. But they still found that house prices were increased as a result of this restriction on supply. What was being restricted was the supply of house+land bundles.
cities where land use regulation is more restrictive, new construction is less sensitive to prices and housing is more expensive.

In some European countries, a rise in aggregate house prices has also been related to land use regulation. This has been a particular issue in the UK for instance, where there has not only been a long-run upward trend in real house prices (increasing in real terms by a factor of 3.5 between 1955 and 2002 – see Cheshire and Sheppard (2004)), but an increasing volatility in the housing market. The argument here is that if the supply becomes less responsive to price changes because of regulatory restrictions, any short run changes in demand translate more directly into price changes. In a series of reports to the Treasury and the Office of the Deputy Prime Minister, Barker (2003, 2004) identified both a falling affordability of housing and a reduced responsiveness of supply to demand. She argued that the British planning system was the main cause of these problems. Furthermore, the Barker reports contain a thorough discussion of the consequences of such housing and land market institutions for the wider economy and for aggregate welfare. Real house prices have also risen substantially over the past decades in the Netherlands (increasing by a factor of 3 in real terms since the early 1970s). The extent to which housing supply in this country is responsive to demand and the role of land use regulation will be the topic of the next chapter.

Long-term trends in real house prices in the UK and the Netherlands contrast starkly with, for instance, the German experience, where the real price of houses fell in both the decades of the 1980s and 1990s and was completely stable over the whole period 1971 to 2002. Over the same 30-year period German real household disposable incomes increased at 2.6 percent a year compared to 2.3 percent in the Netherlands and 2.9 percent in the UK (OECD, 2004a), so variation in this typical determinant of housing demand across these countries has been modest compared to the observed variation in real house price growth. However, similar shifts in demand may lead to strongly divergent price developments under different supply conditions, and in line with this argument, the estimated price elasticity of housing supply in Germany of 6 is of a completely different order of magnitude than in the other two countries (Swank et al., 2002).

It should be recognised, however, that many studies relating aggregate housing supply and prices to land use regulation fail specifically to identify the causal effect of particular regulatory measures. For instance, in their study of the Manhattan condominium market, Glaeser et al. (2005) admit that:
while it is difficult to think of a plausible alternative explanation of why buildings are not taller, we recognise that our analysis essentially is naming a residual (p. 351).

In a critical assessment of the empirical literature on the effect of land use regulation on house prices, Quigley and Rosenthal (2005) find that the evidence is mixed and inconclusive. Some of the challenges to proper estimation of this effect are fairly standard in the econometrics of policy evaluation. In particular, there may be simultaneity in housing market developments and the imposition of land use policies, and it is difficult to control for factors that affect both. For instance, wealthier communities where housing is more luxurious might have a taste for certain zoning regulations (and the incomes, of course, to indulge such tastes). In addition to these issues, the measurement of land use regulation is problematic, because the heterogeneity in shapes it may take is vast, ranging from caps on population or construction to urban growth boundaries and from minimum lot size zoning to Impact Fees20 (Quigley and Rosenthal provide a taxonomy in their survey). There is no reason to expect that these different policy options have similar effects on housing market outcomes, so the estimated effect of an aggregate index of land use regulation is difficult to interpret.

Nevertheless, recent studies that deal with one or more of these issues do suggest that land use regulation restricts housing supply while pushing up prices. For instance, in an analysis of new residential construction in US cities, Mayer and Somerville (2000a) distinguish separately the average delay in obtaining permission for subdivisions, the number of growth management techniques and the imposition of impact fees. They report that metropolitan areas with more extensive regulation can have up to 45 percent fewer starts and price elasticities that are more than 20 percent lower than those in less-regulated markets, even if the effect of Impact Fees is not statistically significant. Ihlanfeldt (2007) analyses the impact of an aggregate measure of land use regulations on jurisdictional house prices in Florida, US. Dealing carefully with the issue of endogeneity, he also finds a significant positive impact. However, in another study with Burge (Burge and Ihlanfeldt, 2006) he had already shown that communities which used Impact Fees and therefore had a greater fiscal incentive to permit development were indeed less restrictive.

Besides methodological issues, Quigley and Rosenthal (2005) suggest that part of the difficulty in establishing an upward effect of land use regulation on prices is that in practice, they may not be binding:

20 Though Impact Fees, in principle, cannot legally be used in the USA as a mechanism of land use regulations since they have to satisfy a ‘rational nexus’ test: that is for them to be legally valid government has to be able to show a clear connection between the development and the need for additional infrastructure etc. and the level of fees has to be a function of these costs (see Ihlanfeldt and Shaughnessy, 2004).
The net effect of adopting development restrictions may ultimately be symbolic only, meant to appease ‘not-in-my-backyard (NIMBY)’ and other constituencies, but generally lacking the will or ability to implement true growth management in the face of population pressures (p. 84).

This statement is telling for the differences that exist between planning in the US and in many European countries, where governments tend to have a much stronger grip on land use and be far more restrictive in terms of land supply. In South-East England or the west of the Netherlands, for instance, ‘grotesque’ (Muellbauer, 2005) discontinuities exist between the price of land in agricultural use and adjacent land that is zoned for residential development. Cheshire and Sheppard (2005) report an increase of price from £7,500 to £3,000,000 per hectare at the urban boundary in Reading and data for 2007 – see Figure 2.5 – shows several locations where the value of agricultural land that is rezoned to permit residential development is well over £6,000,000 per hectare: so getting permission to change use from agricultural to residential increase the price of land some 700-fold. Against the background of such direct evidence on the planning-induced segmentation of land markets, the question of whether land use regulation raises prices seems somewhat pedantic.

Nevertheless, in spite of a sizeable literature on the impact of land use regulation on supply and prices, evidence on its costs in terms of welfare and their distribution over different groups in society is scarce. Quigley and Swoboda (2007) consider restrictions on the amount of developable land through critical habitat designation under the US Endangered Species Act. Their analysis is only of costs – they ignore any benefits – and their prime focus is the distinction between partial equilibrium effects in the preserved area and general equilibrium effects in the wider urban area, assuming that the total regional population is given. The authors show theoretically that reductions in the amount of developable land increase the population density in existing urban areas and induce urban expansion into other areas. The owners of both types of land benefit, while consumers of housing and owners of the protected land lose. The model is calibrated on data for a typical US city to show that general equilibrium effects of critical habitat designation are substantially larger than partial equilibrium effects, and that this policy induces major transfers, predominantly from consumers to owners of developed land. These findings extend to the case of an urban growth boundary.

As we have discussed in chapter 1, in the western part of the Netherlands, the price of developable land is about 60 to 75 times as high as the price of agricultural land on average, while the difference may be much higher at certain attractive locations (Segeren, 2007). Direct evidence of the impact of spatial planning on land use patterns is provided by Koomen et al. (2008).
Bertaud and Brueckner (2005) consider the social costs of restrictions on building height also in the framework of a monocentric city. They apply this analysis to the city of Bangalore, India, where a cap exists on the ratio of a building’s total floor area to the area of the land parcel on which it sits. Again the authors look only at costs and ignore any potential benefits. They show that in general, height restrictions increase a city’s ‘footprint’ – the total area of land it occupies – and that for each household in the city, the welfare loss is equal to the extra commuting costs that a household at the urban fringe incurs. Their model indicates that lifting the height restrictions in Bangalore would reduce city size by about 17%, and that the cost saving would range from 1.5% to 4.5% of household income, depending on the specific assumptions about urban form. The same framework could be applied to the minimum lot size zoning policies that enjoy significant popularity in the US.
2.3.3 The evidence on net welfare effects

To the best of our knowledge, Cheshire and Sheppard (2002) were the first to provide a comprehensive account of the welfare effects of land use regulation that is empirically founded on revealed preferences in land prices. They use estimates from earlier work on the Reading housing market, discussed in subsection 2.3.1, coupled with data on the incomes and demographic composition of the households to estimate the structure of demand for both private residential land and planning produced amenities such as open space, as a function of prices and household income. More specifically, the planning induced amenities that contribute to household utility in their model are the share of land in a square kilometre around the house that is used for either accessible or inaccessible open space and the share of land that is not in industrial use. This demand system is integrated in a monocentric urban economic model, which is calibrated to various data sources for the Reading housing market.

Since both costs and benefits of changing the planning system operate through the residential land market, the authors can then use this model to estimate the trade-offs involved in producing a little more or less of the ‘planning amenities’ and a little more or less of private space for residential occupation. From this it is possible to estimate the net welfare effects of relaxing the planning system’s constraints on land supply in various ways. They find that increasing the amount of residential land within the city boundary and shifting this boundary outwards both have positive net social gains, although gains of the latter policy option are substantially larger. If Reading would be allowed to expand by 70% of its total surface, the estimated net welfare gain would amount to almost 4% of household income even allowing for the loss of inaccessible greenbelt land and accessible open space such a relaxation would entail. Nevertheless, these findings do not support the abolition of land use regulation altogether since the system did produce benefits. The problem is that it produced those benefits in its then current degree of restrictiveness on supply at considerably greater cost to the community than the value of the benefits generated.

In the same study, Cheshire and Sheppard consider the distributional effects of land use regulation. This was possible because their sample included the precise location of the houses (and so the ‘value’ of their consumption of planning produced amenities) and the income of the households. With respect to the gross benefits, they report that the provision of inaccessible open space – greenbelt land - tended to increase inequality; benefits were even more inequitably distributed than were the incomes of owner occupiers. The separation of
industrial from residential land was broadly neutral in distributional terms compared to the incomes of owner occupiers, while the provision of accessible open space tended to reduce inequality. However, overall, adding all three amenities together the net welfare effect was almost distributionally neutral – again relative to the distribution of the incomes of owner occupiers. This suggests that richer households do not only benefit more from planning-induced amenities, but that they also, through the housing market, pay a higher price. The distributional effects through land ownership, which were the focus of Quigley and Swoboda (2007), were not considered explicitly here.

The study by Rouwendal and Van der Straaten (2008), also mentioned in subsection 2.3.1, closely follows the work by Cheshire and Sheppard in various respects, although their prime focus was on open space within cities. In a stylised theoretical model, the authors show that the amount of open space in a neighbourhood is optimal when the total benefits of increasing it by one unit are equal to the local price of residential land. Applying this cost-benefit rule to three Dutch cities, they find that the share of land in open space is too high in Amsterdam, too low in The Hague and approximately optimal in Rotterdam. The similarity in the specification of land use externalities suggests that the same first-best policy rule would apply equally in the Cheshire and Sheppard model. Since the local provision of open space renders urban growth boundaries superfluous in such an ideal setting, it is not surprising that relaxing growth restrictions in Reading was found to be so beneficial.

Walsh (2007) assumes that not only the share of open space in a neighbourhood enters household utility, but also the distance to the nearest parcel of publicly held open space, as in Anderson and West (2006). This specification of demand is incorporated into a general equilibrium model of land use, which is calibrated to data from Wake County in North Carolina, USA. As in Quigley and Swoboda (2007), an important message of this paper is the likely existence of a gap between partial and general equilibrium evaluations of land use regulation, because the preservation of land use in one location may induce urban expansion and loss of open space at other places. The author even finds that through endogenous adjustments in privately held open space, for example land in agricultural use, increases in the quantity of land in public preserves may lead to a decrease in the total amount of open space in the metropolitan area. Amongst the policy scenarios that are considered, the public acquisition of land or development rights in the more densely populated parts of the county appears to be the most beneficial, while the imposition of an urban growth boundary is found to be particularly costly.
A small number of studies analyse the costs and benefits of greenbelts or urban growth boundaries within urban equilibrium models that rely more heavily on theory, with a sensible choice of key parameters constituting their main empirical foundation. Lee and Fujita (1999) provide a useful theoretical framework for the welfare analysis of greenbelts, considered as a multifunctional park that provides citizens with recreational areas, environmental amenities and scenic views. The authors show that if the enjoyment of at least some of these public goods declines with distance, the imposition of a greenbelt that imposes binding restrictions on residential development is socially desirable, although leapfrogging development at its outer fringe should be allowed under certain conditions. Similarly, Brueckner (1990) and Engle et al. (1992) propose a theoretical framework in which urban growth boundaries may be socially desirable, as negative externalities increase with the number of people in a city because of congestion, pollution or crime. It is this type of city size externalities that we will also consider in chapter 6. It should be realised that the externalities or public goods in these latter models affect all residents in the same way, so their impact would not identifiable via variations in local house prices.

Both Bento et al. (2006) and Cheshire and Sheppard (2003) have analysed the efficiency and distributional impacts of alternative anti-sprawl policies, coming to rather different conclusions. Bento et al. assumed that households value the amount of open space that is preserved through such policies and set parameters so that their numerical model resembled a typical US city, although the parameter for the valuation of open space was chosen arbitrarily. In terms of efficiency, both an urban growth boundary and a tax on land conversion turned out to be optimal policy responses to the externality, and should reduce the equilibrium city size by about 12%. Taxes on fuel or property appeared to be rather poor second-best policy alternatives, reducing city size by about 8% and 4% respectively in the constrained optima. Cheshire and Sheppard (2003) used the valuation of open and private space as estimated in their 2002 model (rather than assuming values) and then modelled the welfare effects of a) growth boundaries; b) fuel taxes; and c) a tax on the consumption of land with each tax rate selected to achieve the same total urban take of land as the observed urban growth boundaries in a). The result was that by a significant margin the most welfare effective mechanism was a tax on land consumption with a fuel tax being no more efficient in welfare terms than an urban growth boundary. This assumed, however, that tax revenues were converted entirely into welfare – there was no deadweight loss associated with collection and

---

22 On the realism of these assumptions, see our discussion at the outset of section 2.2.1.
spending. It also did not evaluate the welfare impact of the growth boundary itself. It simply asked the question if this is the total urban area that society wants what is the least costly way in welfare terms of achieving it. They also took no account of other possible benefits associated with fuel taxes.

Bento et al. (2006) also considered the distributional effects for land owners. As in Quigley and Swoboda (2007), these depended strongly on the location of the land. For instance, the fuel tax harmed owners of land close to the city fringe and the property tax harmed owners of land near the CBD. To owners of land that was not developed, the development tax was preferable to an urban growth boundary, because they benefit from the redistribution of tax revenues.

2.3.4 Regulation of non-residential land use

All the above evidence has related to the impacts of land use planning on prices and welfare through the residential sector. By far the largest proportion of a cities occupied land is in residential use but planning restrictions can in principle have impacts on prices and welfare in other land uses. There is very little evidence here, however. Again in principle there are likely to be benefits and costs and to observe price increases is not necessarily to infer a welfare loss. If the supply of say commercial space is restricted, then there will be both distributional effects – owners of property allowed to (fully) develop will gain while owners of property unable to develop will lose. The costs of space will be increased and since space is an input into production output prices will increase and total output will fall somewhat. But there may also be benefits in the form of historic cityscapes preserved and the amenity values of cities.

Glaeser et al. (2005) in their study of the New York housing market note in passing that the impacts of height (development) restrictions on office costs are slight. Indeed at the low point in the real estate price cycle, in 1996, they estimated the effect of development restrictions on the cost of office space to be zero although by the high point of the cycle, in 2002, there appeared to be some small effect – equivalent to a tax of perhaps 50%. This, however, may have simply reflected a short run adjustment problem since expansion of the stock of office space in the face of a rapid increase in demand is difficult.

However, as has already been noted, some European governments are less wary of regulating markets than is the case in the USA and the local fiscal system in the USA provides a very strong incentive to local communities to encourage commercial development.
Table 2.2
Estimated regulatory tax for UK office markets and selected European cities

<table>
<thead>
<tr>
<th>City</th>
<th>Estimated Regulatory Tax Rate (RT)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1999</td>
</tr>
<tr>
<td><strong>UK Markets</strong></td>
<td></td>
</tr>
<tr>
<td>London West End</td>
<td>9.18</td>
</tr>
<tr>
<td>City of London</td>
<td>6.41</td>
</tr>
<tr>
<td>Canary Wharf</td>
<td>3.43</td>
</tr>
<tr>
<td>London Hammersmith</td>
<td>2.77</td>
</tr>
<tr>
<td>Manchester</td>
<td>2.71</td>
</tr>
<tr>
<td>Newcastle upon Tyne</td>
<td>1.06</td>
</tr>
<tr>
<td>Croydon</td>
<td>1.18</td>
</tr>
<tr>
<td>Edinburgh</td>
<td>3.11</td>
</tr>
<tr>
<td>Glasgow</td>
<td>2.33</td>
</tr>
<tr>
<td>Maidenhead</td>
<td>3.72</td>
</tr>
<tr>
<td>Reading</td>
<td>2.71</td>
</tr>
<tr>
<td>Bristol</td>
<td>1.53</td>
</tr>
<tr>
<td>Birmingham</td>
<td>2.59</td>
</tr>
<tr>
<td>Leeds</td>
<td>2.15</td>
</tr>
<tr>
<td><strong>Selected European Cities</strong></td>
<td></td>
</tr>
<tr>
<td>London West End</td>
<td>7.62</td>
</tr>
<tr>
<td>City of London</td>
<td>4.68</td>
</tr>
<tr>
<td>Frankfurt</td>
<td>5.44</td>
</tr>
<tr>
<td>Stockholm</td>
<td>4.28</td>
</tr>
<tr>
<td>Milan</td>
<td>2.07</td>
</tr>
<tr>
<td>Paris: City</td>
<td>2.35</td>
</tr>
<tr>
<td>Barcelona</td>
<td>2.23</td>
</tr>
<tr>
<td>Amsterdam</td>
<td>2.12</td>
</tr>
<tr>
<td>Paris: La Défense</td>
<td>1.41</td>
</tr>
<tr>
<td>Brussels</td>
<td>0.52</td>
</tr>
<tr>
<td><strong>United States</strong></td>
<td></td>
</tr>
<tr>
<td>(based on Glaeser et al., 2005)</td>
<td>1996</td>
</tr>
<tr>
<td>Manhattan (New York City)</td>
<td></td>
</tr>
<tr>
<td>(cycle bottom)</td>
<td></td>
</tr>
<tr>
<td>(cycle peak)</td>
<td></td>
</tr>
<tr>
<td>Manhattan (New York City)</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes: The table shows the regulatory tax as a rate relative to marginal construction costs.
Source: Cheshire and Hilber (2008).

Business property taxes are an important source of net revenues to local governments – business property creates more tax revenues than it costs local communities to service. Again these conditions are not uniformly found in Europe where in some countries such as the UK business property taxes are entirely a national tax providing no direct revenues to local communities at all despite the legal obligation local communities have to provide services for businesses. Thus in effect the fiscal incentive is entirely reversed. Local communities are fined for allowing any development at all. In the Netherlands, on the other hand, municipalities have discretion over the height of a tax on residential and commercial real estate, and this is one of the few sources of revenue over which they have direct control.
It is against that background that the figures in Table 2.2 should be interpreted. These derive from Cheshire and Hilber (2008) – the first study to have planning impacts on commercial property as its main focus. They used the same measure of the gross costs as Glaeser et al. (2005) – the so-called ‘regulatory tax’: that is the difference between the costs of building an additional unit of space by increasing building height and the price of that space (see also our discussion in subsection 2.2.1). In the Cheshire and Hilber study however, this is expressed as a ‘tax rate’ on costs. Thus the value reported for London West End offices as the average 1999-2005 means that the excess of the price of space over its costs of construction was estimated as being equivalent to a 809% tax on constructions costs.

It is obvious that the gross costs of regulation in European centres is far higher than in the US and far higher in Britain than in nearly all Continental European cities. It is not surprising to find a higher cost in London’s West End or the City of Paris than in the City of London, London’s Docklands or La Défense. Amenity values are higher in such locations. Nevertheless it is not clear why Amsterdam or Brussels (Belgium is well know for having by European standards very flexible planning controls) deserve much lower levels of restriction than London Docklands or even Birmingham. The gross costs for many of these cities suggest that there is a least a case to answer. Are the costs being imposed on office users generating even remotely matching benefits for society?

2.4 Conclusions

The wide range in terms of institutional arrangements, form and restrictiveness in which land use regulations are applied all over the world make it impossible to summarise their effects on housing markets and welfare in a few key facts and figures. In some cases, regulations on land use appear to exist merely pro forma and no impact whatsoever can be empirically identified, while planning-induced discontinuities in land prices have been described as ‘grotesque’ in cases at the other extreme. Clearly, land use regulation that does not impose binding restrictions neither generates benefits to society nor imposes costs, but in places where planning holds a strong grip on housing supply and urban form, adverse welfare effects have been found to be substantial, sometimes even amounting to several percentage points of household income. Less is known about the impacts of planning on costs of space for economic activities although again, what evidence there is, suggests these can be substantial.
As we have emphasised throughout this chapter, there is still a lot of research to be done, and the evidence on net welfare effects of land use regulation is particularly scarce. Illustrating the discrepancy between the importance of the topic and the extent to which it was ignored by most economists, Cheshire and Sheppard (2004) observed that:

In the US 32.4% of consumer expenditures are on housing generally, with 18.7% (virtually the same as the 18.5% in the UK) of expenditures specifically for shelter. This is about three times the expenditure on all fuels, utilities and public services combined. Telecommunication services comprise only 2.3% of household expenditures, yet regulation of such services receives much more attention from economists; in economics journals telephone regulation alone is the subject of about three times as many papers as land market regulation (p. 619-620).

It is therefore not surprising that the literature has hardly come to grips yet with the fact that over and above the welfare effects that operate via urban land and housing markets, binding land use regulation is likely have additional indirect effects. While we have provided a rather extensive survey of the existing evidence on the former type of welfare effects in this chapter, we conclude by sketching a number of these wider consequences, as some of them are likely to be important for aggregate welfare and policy.

To begin with, the paper work that comes with residential development in a regulated urban land market imposes a ‘fixed cost’. Whoever bears that cost, and it is likely to be mainly negatively capitalised into land prices, it does cost real resources. It is reported in Shanghai that getting from a cleared site to a saleable building requires a total of more than 130 permits, licences and permissions. 23 It is easier to carry such costs in large development projects and large developers that have more experience with the bureaucratic processes. Hence, a barrier to the entry of new and small firms in the industry may be imposed, so that competition is restricted. Furthermore, as illustrated in Figures 2.3 and 2.5, development in urban land markets that are directly regulated may generate substantial ‘scarcity rents’ which become available once development is permitted. Would-be developers and others attempting to capture a share of these scarcity rents spend resources. At one extreme this may just lead to wasteful expenditures on advocates, glossy brochures, and luxurious trips with people who make planning decisions; at the other it can lead to large scale corruption damaging the capacity of public administration. The Italian research institute CENSIS (CENSIS, 1985) estimated that more than 2.7 million illegal homes were built in Italy between 1971 and 1984.

23 Private communication from a Chinese developer.
That was more than 50 percent of all homes built over that period and constituted in 1985 12.3 percent of the total stock of homes in Italy.

Anticompetitive effects may extend indirectly to other sectors by restricting entry. In this respect the retail sector has been much discussed because restrictions on the supply of land for shops may lead to market power for the existing retailers in a local area (Competition Commission, 2008). Just the same happens to the price of beer if the planners restrict the number of pubs in a neighbourhood. In Oxford, England, the local planning system determined that the community ‘did not need any more Estate Agents’. The established local Estate Agents were the sole beneficiaries of this restriction.

Furthermore, planning may inhibit the development of ‘big box’ retail shops at the urban fringe, in which the exploitation of economies of scale may lead to significantly higher productivity levels. Gordon (2004) argues that this type of regulation explains a significant part of the observed difference in aggregate productivity growth between the USA and Europe over the past decade. This measure obviously does not reflect any benefits that people may derive from having more small local shops in their residential area and less development on land at the edge of cities. But this benefit comes at the unrecognised and unquantified expense of higher prices in the shops and more frequent, smaller, shopping trips.

Other important indirect effects of land use regulation may derive from its potential repercussions on regional labour markets. As shown for the USA by Glaeser et al. (2006), regulation that restricts housing supply in an urban area may also restrict the number of workers and hence job growth, while it pushes up house prices and wages. In turn, the full benefit of economies of agglomeration may not be reaped, so that labour productivity growth is hampered throughout the economy. This also appears to be relevant in the Randstad area in the west of the Netherlands – one of the most densely populated metropolitan areas of the OECD – where job growth in the past decades has been lower than in surrounding regions. In line with the argument of foregone economies of agglomeration, the OECD (2007) pointed to lagging labour productivity growth in this area relative to other metropolitan areas, partly as a consequence of rigidities in housing markets. In chapter 4, we will investigate the role of housing supply and land use restrictions in hampering job growth in this area. Nevertheless, with the notable exception of Rossi-Hansberg (2004), hardly any theoretical or empirical work on the relationship between land use regulation and economies of agglomeration exists.

24 The same mechanism holds equally for cities that compete on international labour markets, who may find it more difficult to attract highly skilled workers as housing gets more expensive.
As housing dominates the budget of most households, land use regulation that raises prices is likely to affect more macroeconomic outcomes than just the productivity of labour. For instance, high house prices make each dollar earned less valuable, so that restrictive planning reduces the incentives to supply labour. Furthermore, housing being the dominant asset in most households’ portfolios, there are also repercussions on saving, investment and consumption choices. Most households are not able to adequately diversify the uncertainty about asset returns of housing, and land use regulation may not only push up the share of housing in their portfolios, but also the degree of uncertainty about its returns. Since these returns may be spent in turn on consumption, this enhances macroeconomic volatility and risk, as has been extensively discussed in Barker (2003, 2004) at the time that the UK considered entry into the Euro area (see also OECD, 2004a).

Finally, the fact that housing features so prominently in the portfolio of owner-occupiers, and that the risk associated with this is hard to diversify, opens up a range of issues within the field of political economy. For instance, it implies that older generations who already own a house have an incentive to limit new construction, as this will raise their asset gains. For similar reasons – reduced local housing supply raises asset returns, it implies that homeowners have an incentive to limit new construction in their local neighbourhoods, the NIMBY behaviour that we have briefly discussed in the previous section. This may be particularly problematic if voting for land use regulation occurs at the local level, where its costs are most strongly experienced and bear particularly heavily on small numbers of voters, while the benefits of new development accrue to people in a wider area (who have no votes in the decision making process). Such considerations may lead to policies that deviate from optimal planning, and as we have amply discussed throughout this chapter, the costs this imposes on society may be large. Hence, next to its welfare economic aspects, the political economy of land use regulation is another field in which progress should be made, in order to understand not only the consequences but also the causes of the restrictive planning of land use that is presently gaining popularity in various parts of the world.

Moreover, even if voting occurs at a higher regional level, this type of behaviour may still be influential through local lobby groups. If the costs of residential development fall on a small group of people, it is worthwhile for them to lobby and the transactions costs of forming lobbying groups are lower than for the large group of people each receiving only small benefits. This is likely to be true even when the combined value of the many small benefits substantially exceeds that of the relatively few large costs.
Housing supply and land use regulation in the Netherlands

Long-run developments in house prices vary dramatically over countries. The average annual increase in real house prices over the period 1971 - 2002 has varied from essentially zero in Germany, Switzerland and Sweden to almost 4% in the UK (OECD, 2004a). In view of the prominent role of housing in consumer budgets and investment portfolio’s, a thorough understanding of what drives such differences is needed. Variation in typical determinants of housing demand, such as trends in the real disposable household income and the real interest rate, has been modest compared to the observed variation in real house price growth. However, similar shifts in demand may lead to strongly divergent price developments under different supply schedules. These simple statistics therefore naturally lead one to wonder about the role of housing supply conditions in these countries.

Supply conditions also matter for house price volatility and aggregate economic stability. Restrictive land use policies may increase the steepness of the housing supply curve, so that the sensitivity of prices to demand shocks is enhanced. In their analysis of the contribution of housing markets to cyclical resilience, OECD (2004a) highlights the impact of the asset price of housing on consumption decisions. It is implied that restrictive supply conditions affect the responsiveness of consumption to housing demand shocks, such as (expectations about) fluctuations in real interest rates. Obviously, volatility in consumption feeds into many other macroeconomic variables. Such considerations have led the UK Treasury to demand for a thorough evaluation of the functioning of the British system of land use controls, at the time that adoption of the Euro was discussed (Barker, 2004, see also Muellbauer, 2005).

Despite its relevance for housing market and aggregate economic outcomes, the body of empirical work on housing supply seems small and fairly inconclusive (DiPasquale, 1999). Estimates of the price elasticity of supply in the US range from 1 to 4, with outliers from almost zero to infinity, while this literature generally does not deal explicitly with investments in the existing stock. Research on housing supply outside the US is scarce. This is

---

1 This chapter is based on Vermeulen and Rouwendal (2007).
unfortunate, because one would expect to find large international differences in supply elasticities. Institutions in land and housing markets vary substantially between countries, and recent studies point to a strong relationship between the restrictiveness of land use regulation and the price elasticity of housing supply (cf. Green et al., 2005, Quigley and Raphael, 2005). In turn, as we have argued earlier, an enhanced understanding of housing supply conditions may shed light on the large international heterogeneity in trends and volatility of real house prices.

Against this background, the analysis of housing supply in the Netherlands in the present chapter seems well motivated. Since the early 1970s, real house prices have roughly tripled in this country, and their volatility is well above the OECD average (OECD, 2004a). National and local governments intervene in various ways in land and housing markets. Perhaps most fundamentally, a zoning system implies a segmentation of land markets, which essentially turns the supply of residential land into a policy outcome. It is widely known that substantial rents are associated with the transformation of agricultural land to land with a permission for residential use, which implies that restrictions on residential land use are significantly binding (see chapters 1 and 6). It is an open issue, however, to what extent such interventions in land and housing markets affect prices and the responsiveness of supply at the aggregate level. Hence, an analysis of the Dutch case may provide an interesting contribution to the growing body of literature on relationships between land use regulation, housing supply and the level and volatility of prices.

Our empirical work focuses on estimating the price elasticity of housing supply. In order to enhance the robustness of this estimate, we consider a range of supply measures. Annual time-series of the volume of investment in residential structures and of new construction in units, for the owner-occupier and the rental sector, are observed from 1970 onwards. Both variables have been studied in the literature, but it should be noted that they measure different aspects of housing supply. Distinguishing between owner-occupied and rental housing seems particularly relevant in our case, as the Dutch rental sector is large and heavily regulated. In addition, we develop several indices of housing quality in the owner-

---

2 This pattern is confirmed in a few comparative studies (Mayo and Sheppard, 1996, Malpezzi and MacLennan, 2001).

3 As a second motivation, we note that the tax deductibility of mortgage interest payments has recently become a topic of fierce debate in the Netherlands, as it is or has been in many other European countries and the US. Welfare effects of this policy depend crucially on the price responsiveness of supply. Van Ewijk et al. (2006) estimate the net social costs of mortgage interest deductibility in the Netherlands to be 0.8 billion Euros (0.15 percent of GDP) under a fully elastic housing supply schedule, and to be 2 billion Euros (0.4 percent of GDP) under a fully inelastic supply schedule. Hence, our chapter constitutes a meaningful contribution to this discussion as well.
occupier sector in a hedonic analysis, using micro data on sales in 1999 and 2000. This allows us to estimate the extent to which housing construction in the preceding decades has responded to price changes through the quality of structures and of locations.

Our evidence consistently indicates that housing supply is almost fully inelastic, at least in the short to medium run. However, a less than fully elastic long-run housing supply curve does not necessarily point to the distorting impact of land use regulation, as it also obtains in a fully competitive Ricardian framework, in which land at attractive locations is scarce. The distinction between these explanations is important, because it implies that the wedge between house prices and marginal construction costs should either be interpreted as the shadow price of restrictions on the supply of residential land, or as a differential land rent (cf. Glaeser and Gyourko, 2002, Glaeser et al., 2005). The Ricardian explanation has two implications that can be tested using our index of the location quality of new construction. In the first place, more attractive locations are developed first in this framework, so location quality should decrease as the total housing stock expands. Secondly, if differential land rents were to account for the observed long-run trend in real house prices, one would expect the difference in location quality between construction in the 1990s and construction in the 1970s to be considerable. Both predictions turn out to be at odds with the data, so that government interventions in land and housing markets appear to be the more likely of the two explanations for the absence of any significant supply response to prices.

While our survey in chapter 2 has focussed on land use regulation, the remainder of this chapter starts with a review of the literature on housing supply in general. In section 3.2, we provide an overview of government interventions in land and housing markets over the past decades, which may account for the behaviour of housing supply to a considerable extent. The analyses of residential investment and new construction are presented in section 3.3. We proceed by an analysis of adjustments through housing quality, while offering some conclusions in the final section.

### 3.1 A review of the housing supply literature

As housing is a durable good, the market on which it is traded is generally modelled in a stock adjustment framework. Although many variants may be found in the literature, a baseline version of such a model would constitute of two equations. First, the demand for housing must equal supply in the present stock. This determines prices in the short run. Second, the
housing stock evolves through construction and depreciation, presumably in response to these prices.

Typically, in these models, the stock does not jump to its long-run level at once, but adjustment takes time. This assumption may be justified on several grounds. In the macroeconomic literature on investment, such lagged adjustment processes are generally understood as a consequence of adjustment costs (cf. Chirinko, 1993). For instance, Topel and Rosen (1988) relate their model of housing investment to this literature, while considering both internal and external adjustment costs. They show that, as a consequence of such costs, it is optimal for the construction industry to smooth output over time. A more mechanical reason for lags in the construction response to price developments is the time it takes to build a house. This explanation is reinforced when housing supply and land use are strongly regulated, as negotiations with local governments or planning boards may cause additional delays (Mayer and Somerville, 2000a). Finally, the durability of housing implies a downward rigidity in adjustment of the stock.

Building on this economic framework, structural analyses of housing supply consider either residential investment or new construction in units. For instance, Poterba (1984) estimates a model for real investment in structures in the US, reporting a supply elasticity in the range from 0.5 to 2.3. Blackley (1999) analyses the real value of US private residential construction put in place, and reports elasticities ranging from 0.8 to 3.7, depending on the dynamic specification of her model. These two studies obtain the volume of housing produced by deflating residential investment by a consumer price index, while ignoring the role of land. Topel and Rosen (1988) analyse the price elasticity of new single family housing starts (new one-unit structures on which construction was started during the reference period), reporting a short-run elasticity of 1.0 that is significantly lower than their long-run elasticity of 3.0.

One important aspect ignored in these earlier studies of housing supply is its relationship with land use. Let us consider for instance a Ricardian setting, in which the most preferable housing locations are turned into residential land first. At the margin, residential

4 External adjustment costs arise from economy-wide upward sloping factor supply curves. Adjustment costs that are internal to the construction industry may be associated for instance with the costs of hiring and firing workers (cf. Mussa, 1977).

5 Mayer and Somerville (2000a) note that the coefficient of variation of starts is greater than that of sales, which sits uncomfortably with the notion that the construction industry smooths out investment over time. They suggest that in the US, delays in bringing land from agricultural to urban land use and obtaining building permits may lead investors to smoothen the supply of permitted, developed sites ready for starts.

6 Both Poterba (1984) and Topel and Rosen (1988) estimate the price elasticity of housing investment, and not the price elasticity of the housing or residential capital stock. These elasticities may differ in general, but DiPasquale and Wheaton (1994) show in a stock-adjustment framework that they are equal in equilibrium.
land rents should equal the rent associated with alternative land use. It follows that in equilibrium, the relationship between the total supply of residential land and rents on infra-marginal land is upward sloping. The same result is obtained in standard urban economic theory (cf. Fujita, 1989). As land is an essential input in housing construction, the long-run supply curve of housing is upward sloping as well, even if the construction industry is perfectly competitive. Accounting explicitly for the functioning of land markets, DiPasquale and Wheaton (1994) propose a model for single family housing starts, which includes the lagged housing stock. Consistent with the presence of an upward sloping supply curve, they confirm that this variable relates negatively to new construction. The authors report a long-run price elasticity of the stock of 1.2 to 1.4. Unlike most other studies, their results suggest that it takes several decades for housing supply to converge towards its equilibrium value through new construction.

Mayer and Somerville (2000b) formally derive their housing supply equation from the urban growth model developed by Capozza and Helsley (1989). They pay more attention than most earlier work to the time-series properties of their variables, observing that while construction is a stationary variable, house prices are integrated of order one. The authors therefore specify a model that relates new construction to changes in house prices and construction costs. Quarterly starts of single family dwellings appear to be elastic in the short run, but they find a 0.08 long-run elasticity of the housing stock. Like Topel and Rosen (1988), the authors find that the larger part of the supply response takes place within a year.

Next to the structural analyses we discussed so far, a significant part of the literature on housing supply has relied on reduced form approaches. For instance, Harter-Dreiman (2004) infers the elasticity of housing supply from the long-run relationship between income and house prices at the MSA level. Underlying her analysis is a simple model of the housing market, in which plausible values are imputed for the demand parameters. Harter-Dreiman estimates a long-run elasticity of real house prices with respect to real income of 0.27, from which she infers a lower bound of 1.8 and an upper bound of 3.2 for the price elasticity of supply. Unlike structural models for residential investment or new construction in units, this supply elasticity reflects both land and housing capital, while including investments in the existing stock.

---

7 We refer to DiPasquale (1999) for a discussion of earlier work on housing supply that adopts a reduced-form framework.

8 It is shown in this framework that the price elasticity of supply must equal the price elasticity of demand plus the ratio of the income elasticity of demand and the income elasticity of the price in the long run. The author assumes that the price elasticity of demand ranges between -1.0 and -0.5, and that the income elasticity of demand ranges between 0.75 and 1.0.
Various authors have suggested that current prices are not a sufficient statistic for housing market conditions. According to Topel and Rosen (1988), the existence of adjustment costs implies that builders take expectations of future house price developments into account. Case and Shiller (1989) relate inefficiency of the housing market to its illiquid character, due to for instance high transaction costs. DiPasquale and Wheaton (1994) argue that slow clearing of the housing market is related to search frictions, as housing is highly heterogeneous and search is time consuming. The consequence of such distortions is that estimates of the price elasticity of supply may underestimate the responsiveness of new construction to market conditions. This may also explain why most structural analyses of housing supply find large effects of variables like time on the market, vacancy rates and interest and inflation rates, although their effect should be small or absent in perfectly competitive markets.

Another common feature of studies on US housing supply is the poor performance of cost variables. For instance, none of the measures for construction costs in Poterba (1984), Topel and Rosen (1988) and DiPasquale and Wheaton (1994) have a statistically significant impact on starts. Blackley (1999) reports a positive sign for wages in the construction industry in a specification in levels, but she finds a modest negative effect of wages in a specification in first differences. DiPasquale (1999) suggests that these anomalies in the literature may be due to measurement problems, as most studies use aggregate data rather than data where the builder is the unit of observation. A second reason may be the insufficiency of the price statistic. For example, a variable like the interest rate may contain additional information on housing market conditions. As in business cycle peaks, both output in the construction industry and the interest rate tend to be relatively high, the estimated coefficient for this latter variable may be biased if the state of the business cycle is not appropriately accounted for.\(^9\)

As discussed in section 2.3.2, more recent work on housing supply in the US pays attention to the role of land use regulation. For instance, Mayer and Somerville (2000a) estimate effects of delays, the use of growth management techniques and development fees on the number of single family permits in a panel of US metropolitan areas. They report that the elasticity of permit supply may be up to 20 percent lower in regulated cities, predominantly as a result of delays in obtaining approval for subdivisions (zoning) of land. Harter-Dreiman (2004) finds a long-run supply elasticity in the range between 1.0 and 2.1 for cities with tight regulation.

---

\(^9\) Another issue may be nonstationarity. Notably, Mayer and Somerville (2000b) cannot reject the presence of a unit root in real house prices, the real prime rate and the real material price index in levels, but most other studies on US housing supply make use of these variables, without reporting tests for stationarity. Regressions that include nonstationary variables are prone to spurious relationships.
spatial planning, while a range between 2.6 and 4.3 is estimated for unconstrained cities. Using the same urban economic model as Mayer and Somerville (2000b), Green et al. (2005) estimate MSA specific elasticities of the supply of building permits, which appear to vary widely between cities. They find a negative relationship between these elasticities and a regulatory index. Quigley and Raphael (2005) perform a similar analysis for cities in California, and they report a significantly negative relationship between the supply elasticity of the housing stock and their regulatory index as well. Furthermore, the authors argue that the house price boom in this region is largely attributable to regulatory stringency.

Much less work on housing supply has been done outside the US. A particularly extensive investigation into housing supply conditions has been performed under the authority of the UK Treasury (Barker, 2003, 2004). It reports a supply elasticity of almost zero, which is attributed at least partly to restrictive land use planning. Furthermore, a few international comparative studies exist, that also suggest a significant effect of land use policies. Malpezzi and Maclennan (2001) infer the price elasticity of housing supply in the US and the UK from a long-run relationship between income and house prices in these countries. For the post war period, they report a range between 0 and 0.5 for the UK, while estimated elasticities are much higher for the US. Using essentially the same method, Mayo and Sheppard (1996) estimate supply elasticities for Thailand, Korea and Malaysia. In both studies, the relationship between regulatory stringency in a country and the elasticity of supply is negative. Moreover, Mayo and Sheppard identify the negative impact of a British style land use regulation system in Malaysia on a shift in the supply elasticity after its introduction in the seventies. Finally, OECD (2004a) reports supply elasticities for a limited number of countries, reporting a strongly negative correlation of this variable with house price volatility over the period 1971 – 2002.

The few recent papers that exist on housing investment in the Netherlands diverge substantially in their estimates of the supply elasticity. A study by Hakfoort and Matysiak (1997) largely follows Topel and Rosen (1988). Given the extent of government intervention in the social rental sector, which is relatively large in the Netherlands, the authors only consider unsubsidized housing starts between 1977 and 1994. Like Topel and Rosen, they prefer the specification that takes account of adjustment costs. They find a short-run price elasticity of 2.3 and a long-run elasticity of 6, which would suggest that housing supply is...

10 Similarly, Meen (2002) finds that the elasticity of supply explains most key differences between housing markets in the US and the UK.
more elastic in the Netherlands than it is in the US. At the other extreme, Swank et al. (2002) study the supply of building permits, and they cannot reject a price elasticity of zero, while their point estimate is 0.3. In a recent study of the fiscal treatment of housing in the Netherlands, Koning et al. (2006) obtain the elasticity of the total supply of housing services from calibration of a structural model that is essentially based on Poterba (1984). The authors infer a long-run price elasticity of 0.65. Finally, some indirect evidence may be found in analyses of Dutch house prices, which generally find high long-run elasticities of income. For instance, OECD (2004b) reports a long-run elasticity of real house prices with respect to real disposable income per household of 0.84, and Verbruggen et al. (2005) estimate this elasticity to be well over unity. The long-run price elasticity of total housing supply implied by an income elasticity of unity, using the same model and demand parameters as in Harter-Dreiman (2004), would range between -0.25 and 0.5.

3.2 Institutional setting

As discussed in the previous section, analyses of housing supply are generally founded on the macroeconomic investment literature or on urban economic theory. However, it is not a priori clear to what extent either macroeconomic or urban models of housing investment are applicable to a housing market that is highly regulated, as is the case in the Netherlands. For instance, the free market assumptions underlying both types of models are violated if the supply of residential land is a policy outcome. In that case, the price elasticity of housing supply essentially reflects the extent to which policy is sensitive to price signals. Moreover, in such a setting, the relationship between housing supply and other variables, such as construction and opportunity costs, is also weakened. Therefore, in this section, we provide a brief overview of government interventions in housing and land markets in the Netherlands, which may contribute significantly to an understanding of housing supply patterns over the past decades.

While certain forms of land use regulation have existed for centuries in the Netherlands, relating for instance to protection against floods, the foundations of modern spatial planning were laid in the Housing Act (Woningwet) of 1901. In this industrial era, the

Although their paper is not concerned with the price elasticity of housing supply, lags in the construction industry are also analysed in Merkies and Steyn (1994). The authors allow for time-varying lag structures, using quarterly data. They find lags of at most three years, which is roughly consistent with findings in Topel and Rosen (1988). We remark that these lags do not necessarily reflect delays in the supply of residential land that result from regulations.
main focus was on the improvement of living conditions for the poor. The Housing Act obliged municipal governments to develop and enforce formal zoning plans, which would facilitate the provision of elementary facilities such as water and sewerage. At the same time, (non-profit) housing associations were established for the construction and management of social rental housing, predominantly in the largest cities of the Netherlands.

Government involvement in housing supply was boosted in the aftermath of the Second World War. Severe damage of the production capacity led to government planning of investments in industries and infrastructure. In view of a major housing shortage, and in order to keep wage pressure down, the government set rents substantially below the free market level. The construction of social rental housing was subsidized, and annual production quantities were planned as well. In subsequent years, this range of policies evolved into a more encompassing planning strategy, elaborated in a series of White Books (Nota’s van de Ruimtelijke Ordening).

The legal framework for land use regulation during our period of observation is the Spatial Planning Act (Wet op de Ruimtelijke Ordening) of 1965. This act constitutes a top-down process, in which the national government provides rough guidelines, which are translated to a lower scale at the provincial level, and finalized by municipalities. Municipal zoning plans designate detailed land use functions (housing, industry, offices, shops, recreation, ...). Formally, these plans have to be updated about every ten years, in a process that may take several years, but the law allows for amendments that take a relatively short period of time. Nevertheless, municipal approval is always required for changes in land use. Hence, in this system, the supply of residential land is ultimately a government affair, and market signals can have effects only to the extent that government institutions are sensitive to them. Moreover, even if these institutions are responsive to price signals, then legal procedures significantly delay such responses.

In subsequent decades, the national spatial planning strategy has balanced two conflicting purposes. On the one hand, a strong political support for involvement in housing supply has remained in place long after World War II. Besides various other policy interventions, this was manifest in spatial planning through provision of the land necessary to realize residential production targets. On the other hand, it has always put a strong emphasis on the preservation of landscape heritage and open space. For example, from the sixties

---

12 The social housing sector evolved into an important instrument for countercyclical policy. In our analysis, this is particularly visible in the early 1980s, when the construction of social rental housing was subsidized heavily by the government (see also Figure 3.4).
onwards, residential development between the four main cities of Amsterdam, Rotterdam, The Hague and Utrecht has been heavily restricted, while preserving Green Heart area (see also Figure 1.1). For similar reasons, from the seventies onwards, the ‘growth centre policy’ and ‘clustered deconcentration’ aimed to accommodate population growth in especially designated, and sometimes newly created towns, while restricting expansion of the larger cities nearby (chapters 1 and 6). Furthermore, there appears to have been a continued focus on compact development. Nowadays, it is a policy aim that 40% of new construction is infill development. Hence, it seems fair to conclude that land use regulation has always been restrictive, at least at certain locations, while showing a tendency to direct people towards other locations, deemed more desirable from a social point of view.\footnote{After World War II, spatial policies also aimed to keep the population density in peripheral regions at a level that was sufficiently high to sustain the supply of local public services. This ended during the economic crisis in the early 1980s. Empirical evidence of the directive character of Dutch land use regulation will also be presented in chapter 4, which contains a simultaneous regional analysis of housing supply, migration and employment growth.}

In the course of the 1980s, the political agenda changed, and the sense of urgency with respect to housing construction waned. This resulted in a major change in Dutch housing policy in the beginning of the 1990s, when most of the subsidies on housing construction were abandoned, and housing associations were liberalised.\footnote{Importantly, in a procedure in 1995 called ‘grossing’, all future state subsidies where paid out, whereas the housing associations paid all outstanding debts to the government (see for instance Priemus, 1998).} The responsibility for the realization of housing supply and the provision of associated local public goods, such as parks, roads and social housing, was shifted towards local governments and (quasi)market parties (commercial developers and housing associations). As expected, this policy change led to a substantial decrease in the construction of social rental housing. The rental sector, which accounted for about two thirds of the housing stock in 1970, is presently dominated quantitatively by the owner-occupier sector. However, construction in the owner-occupier sector in the 1990s was not significantly higher than it was in the second half of the seventies either. On the contrary, Dutch housing construction reached a post war trough in 2003, although the high level of real house prices was unprecedented.\footnote{During our period of observation, construction in the owner-occupier sector was only lower during the crisis of the early 1980s.}

Various explanations for the low rates of construction in the past one and a half decade have been raised. For instance, Priemus (1998) has argued that the government’s weakening interest in housing construction has been replaced by an increasing interest in environmental issues like the preservation of landscape heritage and open space. The Ministry of Housing, Spatial Planning and the Environment (VROM), while continuing to formulate ambitious
goals with respect to housing production, became responsible only for the realization of the environmental goals. Hence, it may have complicated residential construction by market parties through the restrictive supply of land. However, this cannot be the full explanation, as Jókövi et al. (2006) document that even for many locations that were designated for new housing construction, the targets were not reached, or reached only with substantial delay. Another culprit may have been the way in which planning procedures deal with the price of land. It has become conventional to compute the value of land as the residual that results when costs of construction are subtracted from the potential sales revenues. This residual is used to finance the acquisition and conversion of land, and the provision of local public goods. Furthermore, the associated costs are borne predominantly by developers in the private sector, so that social housing construction is still subsidized. This system thus levies an (implicit) development tax on residential land for private construction, which is conditioned on potential sales revenues. In negotiations with market parties, municipalities have probably varied their demands for local public good provision with the expectations of these revenues. Hence, market signals to the construction sector about the optimal size and composition of the housing stock may have been dampened, or even fully undermined (cf. Conijn, 2006).

In the planning process, the level of house prices is usually taken as given when plans are developed. Since many parties with different interests are involved, many claims on the surplus exist. Market power by land owners, which is reinforced by legal privileges (owners of land have the right to develop it), may have made negotiations particularly cumbersome and time consuming. If market conditions deteriorate, as they did in the beginning of the 2000s, plans can only be changed after renegotiations that may again take years. It should also be noted that the need for mutual agreement and planning is forced upon all parties involved by the limited availability of sites for residential location, which strongly reduces opportunities to react elsewhere to market incentives in a more appropriate way. Development of new sites is usually a sequential process and the next location will only come available when negotiations over the ones that are presently planned have been completed. Hence, through restrictive supply of developable land, land use regulation is an important factor underlying the delays.

---

16 This approach is often motivated by Ricardian analysis of land rent, where policymakers interpret this theory as claiming that the value of housing determines the value of land (cf. Evans, 1999). However, it should be observed that Ricardian analysis refers to market outcomes, and not to planning procedures. Clearly, in a segmented land market, restrictions on the supply of residential land will push up house prices.
While our account of Dutch government interventions in land and housing markets in this section is far from exhaustive, it suggests various channels through which market signals may have been hampered in the process of residential development. Of course, in the social rental sector, where rents have been restricted below competitive levels, new construction was largely dependent on explicit or implicit subsidies, and given the countercyclical nature of these subsidy flows, a price elastic supply should not be expected. In the owner-occupier sector, land use regulation, consisting of limits on the supply of residential land, restrictions on the type of housing that is built on it and implicit taxes, would appear to impose significant barriers to market-driven development. In this setting, it makes sense to interpret the price elasticity of housing supply predominantly as a measure for the price responsiveness of the body of institutions and policies that govern residential development.

Finally, we note that policy makers may be less sensitive to demand revealed through prices than market parties. For instance, the Dutch government projects housing demand on the basis of stated preferences, such as expressed in the Dutch housing demand survey (WBO), and demographic models. This approach yields an estimate of the ‘housing need’, which, confronted with the number of housing units in the existing stock, leads to a certain ‘housing shortage’. Resolving this shortage has often been an explicit policy goal, particularly in the decades after the Second World War. To the extent that the supply of residential land relies on demographic projections, shifts in demand that result from for instance rising incomes and falling interest rates are ignored. Hence, it is by no means obvious that the government fully internalizes demand when making land use decisions, even in the long run.

3.3 Analysis of residential investment and new construction

The literature reviews in sections 2.3.2 and 3.1 suggests that amongst the reasons for the ongoing controversy on the price elasticity of housing supply are problems associated with measurement (see also Quigley and Rosenthal, 2005). Housing supply arises through various channels, such as new construction or conversions in the existing stock. Furthermore, housing quality and location are potentially important aspects. However, housing quality is ignored in

17 The difference between these policy notions and demand functions in economic theory is that the former do not account for the relationship between demand and prices. Hence, policy may ignore that the ‘housing need’ is lower at the current high level of prices than it would have been at the marginal costs of producing a house. Another complicating issue is the heterogeneity of housing. It would seem preferable from a theoretical point of view to discuss the demand and supply of housing services, rather than units.
studies that focus on units, permits or housing starts, and the spatial aspect is ignored in most studies that have relied on national data. In order to obtain a robust set of estimates of the price elasticity of housing supply in the Netherlands, we perform a range of analyses on various datasets. The quality of housing structures and location, and their relationship to prices, will be the subject of the next section. In this section, we consider the volume of residential investment and new construction in units, both for the total housing market and for the owner-occupier sector.

3.3.1 Data

We consider annual data over the period 1970 – 2005. Observations for this full period are available for all variables except for the volume of residential investment and the residential capital stock, for which consistent time-series are available until 2003.

Residential investment consists of both the value of new housing structures and the value of investments in the existing stock, while ignoring the value of investments in residential land. This variable is estimated in a national accounting framework by Statistics Netherlands (CBS), using information on output in the construction industry. Hence, in practice, only the larger investments in the stock, such as renovation projects and major house improvements, are measured. In this chapter, we are interested in the extent to which the volume of residential investment responds to house prices. It is obtained by deflating the value of residential investment by a construction cost index, although we note that this price-volume split may not be fully reliable.18 We also consider the residential capital stock, which has been estimated by CBS in a vintage model (cf. Van den Bergen et al., 2005). The construction of this variable requires additional assumptions on depreciation of the housing capital stock, which are also quite difficult to verify. Hence, some caution in interpreting the analyses that use these data is warranted. Finally, it should be noted that these variables do not allow for the distinction between an owner-occupier and a rental sector.

Our second measure of housing supply is the number of newly constructed housing units. These data, as well as information on the total stock of housing, are provided by CBS. A new housing unit consists of a structure component and a residential land component. Furthermore, this measure clearly reflects the volume of investments, so separating out price effects is not an issue here. However, it does not capture the quality component (or residential

---

18 Even if the volume of residential investment is fully price inelastic, then its value still correlates to prices, so an imperfect price-volume split may lead to an overestimation of this elasticity.
capital intensity) or investments in the existing stock. The data on new construction allow for a distinction between the rental and the owner-occupier sector. This seems relevant, as the government is less involved in this latter sector, so we might find a different response to prices. Unlike new construction in units, the share of owner-occupied housing in the total housing stock is measured only every four years, using a housing demand survey (WBO). For other years, we have estimated this share using information on construction of rental and owner-occupied housing, and on conversions.

A central variable in our analysis is the price of housing. Ideally we would have used a constant quality (hedonic or repeat sales) price index, as in most studies of US housing supply. However, such an index is unavailable for the Netherlands over the period we consider here, and we have to rely on an index referring to median sales price of Dutch houses. This series is put together from an index provided by the Dutch Association of Realtors (NVM) from 1970 to 1978, and an index provided by the land register (Kadaster) from 1978 onwards.  

For a much shorter period of observation, starting in 1993, the land register has constructed a repeat sales index. Somewhat surprisingly, this index shows a substantially faster increase than median sales prices over the period until 2006. Hence it does not suggest that we overestimate the quality adjusted price increase by using median sales prices – which might have occurred because of rising housing quality.

In the housing supply equations, we use a number of controls that are similar to variables used in the US literature. Construction costs are measured as the real residential investment deflator, such as used in the national accounts. Furthermore, we include the real long interest rate as a measure for opportunity costs of foregone investment in other markets. Both variables should affect housing supply negatively. As an instrument for prices, which are at least theoretically endogenous, we use the real disposable labour income per full-time equivalent (FTE), as discussed in subsection 3.3.3.

In the previous section, we have argued that Dutch institutions may be responsive to other variables than prices. In particular, the government has traditionally used the concept of ‘housing need’, which is estimated with stated preference data and demographic models. We proxy this variable with an estimate of the total number of households, that is obtained using age specific headship rates in a base year (1985) and the evolution of the age composition of households.

---

19 We have repeated the empirical analysis using only data after 1978, but estimates of the housing supply elasticities were not statistically distinct from those reported Table 3.4.
20 Possibly, this index does not properly account for investments in existing houses between two sales.
21 We have obtained this series from the OECD, which uses the same measure for construction costs in OECD (2004b). Statistics Netherlands also has a time-series of residential construction costs based on building permits. The two series are almost fully congruent.
<table>
<thead>
<tr>
<th>Variable</th>
<th>mean</th>
<th>std. dev.</th>
<th>minimum</th>
<th>maximum</th>
<th># obs.</th>
<th>ADF</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>volume of residential capital (1,000,000 units of a 2001 Euro)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stock</td>
<td>407430</td>
<td>105458</td>
<td>228069</td>
<td>586589</td>
<td>34</td>
<td>-2.93</td>
<td>0.15</td>
</tr>
<tr>
<td>investment</td>
<td>17953</td>
<td>2463</td>
<td>14405</td>
<td>22366</td>
<td>34</td>
<td>-2.92</td>
<td>0.16</td>
</tr>
<tr>
<td>total housing units (1,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stock</td>
<td>5580</td>
<td>983</td>
<td>3763</td>
<td>6955</td>
<td>36</td>
<td>-0.19</td>
<td>0.99</td>
</tr>
<tr>
<td>new construction</td>
<td>101</td>
<td>24</td>
<td>60</td>
<td>155</td>
<td>36</td>
<td>-3.92</td>
<td>0.01</td>
</tr>
<tr>
<td>housing units owner-occupier sector (1,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stock</td>
<td>2574</td>
<td>765</td>
<td>1270</td>
<td>3815</td>
<td>36</td>
<td>-1.95</td>
<td>0.63</td>
</tr>
<tr>
<td>new construction</td>
<td>55.2</td>
<td>8.5</td>
<td>34.1</td>
<td>69.1</td>
<td>36</td>
<td>-2.83</td>
<td>0.19</td>
</tr>
<tr>
<td>housing units rental sector (1,000)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>stock</td>
<td>3006</td>
<td>256</td>
<td>2494</td>
<td>3287</td>
<td>36</td>
<td>-0.79</td>
<td>0.97</td>
</tr>
<tr>
<td>new construction</td>
<td>46</td>
<td>26</td>
<td>13</td>
<td>97</td>
<td>36</td>
<td>-4.04</td>
<td>0.01</td>
</tr>
<tr>
<td>median house price index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>level</td>
<td>174</td>
<td>66</td>
<td>100</td>
<td>318</td>
<td>36</td>
<td>-2.17</td>
<td>0.50</td>
</tr>
<tr>
<td>changes</td>
<td>6.2</td>
<td>16.3</td>
<td>-38.6</td>
<td>49.0</td>
<td>35</td>
<td>-3.68</td>
<td>0.02</td>
</tr>
<tr>
<td>real construction cost index</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>level</td>
<td>124</td>
<td>11</td>
<td>100</td>
<td>150</td>
<td>36</td>
<td>-2.56</td>
<td>0.30</td>
</tr>
<tr>
<td>changes</td>
<td>1.42</td>
<td>2.46</td>
<td>-4.61</td>
<td>5.43</td>
<td>35</td>
<td>-3.18</td>
<td>0.09</td>
</tr>
<tr>
<td>real long interest rate (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>level</td>
<td>3.3</td>
<td>2.2</td>
<td>-1.4</td>
<td>7.0</td>
<td>35</td>
<td>-1.41</td>
<td>0.86</td>
</tr>
<tr>
<td>changes</td>
<td>0.022</td>
<td>1.083</td>
<td>-2.383</td>
<td>1.971</td>
<td>34</td>
<td>-4.52</td>
<td>0.00</td>
</tr>
<tr>
<td>demographic demand</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>level</td>
<td>5749</td>
<td>733</td>
<td>4487</td>
<td>6818</td>
<td>36</td>
<td>0.81</td>
<td>1.00</td>
</tr>
<tr>
<td>changes</td>
<td>66.6</td>
<td>14.3</td>
<td>30.2</td>
<td>90.1</td>
<td>35</td>
<td>-0.39</td>
<td>0.99</td>
</tr>
<tr>
<td>real disposable labour income per FTE (in 1970 Euros)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>level</td>
<td>5887</td>
<td>750</td>
<td>4438</td>
<td>7198</td>
<td>36</td>
<td>-1.93</td>
<td>0.64</td>
</tr>
<tr>
<td>changes</td>
<td>76</td>
<td>131</td>
<td>-213</td>
<td>263</td>
<td>35</td>
<td>-2.78</td>
<td>0.20</td>
</tr>
</tbody>
</table>

Notes: Next to standard descriptives, we show an Augmented Dickey-Fuller test (ADF) statistic and the associated MacKinnon approximate p-value. The ADF test is augmented with one lag and a linear trend. For further details on the data, we refer to the main text.
the population (cf. DiPasquale and Wheaton, 1994). Including this ‘demographic demand’ variable in our analysis, we may investigate the hypothesis that as a consequence of restrictive planning, demographic projections of demand explain supply better than the demand revealed in prices.

Descriptive statistics for all variables are provided in Table 3.1. Following Mayer and Somerville (2000b), we pay particular attention to the time-series properties of our data. Hence, for each variable, we show descriptives for both levels and changes, and report an Augmented Dickey-Fuller test statistic (augmented with one lag and a linear trend) for the presence of a unit root. Mayer and Somerville find that most of their variables are nonstationary in levels, but stationary in changes, where new construction is interpreted as the change in the housing stock. Similarly, the unit root tests in Table 3.1 indicate that most of our variables in levels have a unit root. Since our time-series are relatively short (unlike Mayer and Somerville, we do not use quarterly data), and since the Dickey-Fuller test is not very powerful, it seems reasonable to adopt a low level of significance for rejection of a unit root. If we take a significance level of 20%, a unit root is rejected for all variables in changes, except for the demographic variable. For some variables, such as total new construction and price changes, a unit root is rejected at a much higher level of significance. Hence, we will treat the detrended first-differenced variables as stationary in our subsequent analyses. The statistical properties of the demographic demand variable will be discussed more extensively in the next subsections.

Using nonstationary variables in a regression analysis may have severe consequences. In particular, there is an increased risk of multi-collinearity, which may lead to spurious relationships. This may be an issue for the majority of US studies on housing supply that ignore the presence of unit roots in explanatory variables, most notably Poterba (1984) and Topel and Rosen (1988). In our analysis, we avoid these problems by adopting a two-step approach. In the next subsection, we consider the variables in levels and investigate the presence of co-integrating relationships. In particular, we consider the existence of a long-run relationship between housing supply and prices, such as predicted in a Ricardian model of the land market, and the existence of a long-run relationship between housing supply and our demographic demand variable, such as may be expected in the Dutch institutional context. In subsection 3.3.3, we will study short-run relationships in an analysis of variables in changes.
3.3.2 Analysis of stock variables

Figure 3.1 presents our three measures of the stock of housing supply, the volume of the residential capital stock, the total housing stock and the stock of owner-occupied housing, as well as the level of prices and demographic demand. For the purpose of comparability, all variables in this figure are indices, where their value for 1970 is set to 100. Over the period considered, the volume of residential capital has increased by more than 150%, whereas the housing stock increased by approximately 85%. This points to a substantial increase in the volume of residential capital per housing unit, which may have occurred both through increasing quality of new units, and through investments in the existing stock. Furthermore, we note that the stock of owner-occupied housing has roughly tripled over our period of observation, whereas the rental housing stock increased by only about 30%, so that the share of the owner-occupier sector in the total housing stock has risen from less than a third to about 55%.

*Figure 3.1: Indices of housing stock measures, real prices and demography*
The same figure also shows the development of the level of real house prices. This variable shows a much greater volatility over time than the three housing stock measures, which have increased steadily over time. The boom in the second half of the seventies stands out in particular. It has been attributed to high inflation rates, translating into low or even negative user costs of housing. The bubble busted after a major increase in the real interest rate, and real house prices halved within a few years. The boom in the second half of the nineties is generally associated with rising incomes and falling interest rates (cf. Verbruggen et al., 2005), and a significant price correction has not yet been observed. The figure does not suggest that these booms have significantly marked the development of housing supply in either of the three measures.

### Table 3.2
Long-run relationships between housing supply and prices (elasticities)

<table>
<thead>
<tr>
<th></th>
<th>capital (volume)</th>
<th>total stock (units)</th>
<th>o.o. sector (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td>real house price index</td>
<td>0.554 (0.095) ***</td>
<td>0.319 (0.058) ***</td>
<td>0.612 (0.083) ***</td>
</tr>
<tr>
<td># observations</td>
<td>34</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>R²</td>
<td>0.518</td>
<td>0.475</td>
<td>0.614</td>
</tr>
<tr>
<td>ADF statistic</td>
<td>-2.56</td>
<td>-1.82</td>
<td>-1.72</td>
</tr>
<tr>
<td>p-value</td>
<td>0.30</td>
<td>0.69</td>
<td>0.74</td>
</tr>
</tbody>
</table>

Notes: Standard errors appear in parenthesis, * indicates significance at 10 % level, ** indicates significance at 5 % level and *** indicates significance at 1 % level. In order to facilitate interpretation of the coefficients, we report the elasticity evaluated at the sample average.

As the variables shown in Figure 3.1 are nonstationary, any relationships inferred from inspection of this figure run a high risk of being spurious. We consider the existence of cointegrating relationships between prices and our three measures for the level of supply, by testing for the presence of a unit root in the residuals of bivariate regressions of these relationships. Table 3.2 shows regressions of the house price index on our supply variables, as well as Augmented Dickey-Fuller test statistics (augmented with one lag and a linear trend) on the residuals. In order to facilitate interpretation, we report the implied elasticity at the sample average, rather than regression coefficients. The table indicates that the level of house prices correlates strongly with both the volume of the residential capital stock, the total number of housing units and the size of the owner-occupier housing stock. All three variables

---

22 Furthermore, credit constraints were eased in the early 1970s, and a law was passed that made it possible to split houses into separate apartments. This pushed up the demand from lower-income households in particular.

23 In the early 1990s, credit constraints were again relaxed. In particular, it became possible to obtain a mortgage on the household income, rather than the income of the household head.
In our interpretation of these findings, we focus on the relationship between prices and the total housing stock. These two variables are plotted against each other in Figure 3.2. In a perfectly competitive setting, in which the special features of land markets would be irrelevant, house prices should be determined by construction costs in the long run. As construction costs have developed roughly in the same way as the consumer price index, real house prices should be stationary and the curve in Figure 3.2 should be flat. However, both the test for a unit root in the real house price index reported in Table 3.1 and inspection of this figure are inconsistent with these predictions. Hence, the competitive model with fully elastic supply of land seems strongly at odds with our findings.

Nonstationarity of prices may be reconciled with a perfectly competitive setting once the existence of a long-run upward sloping supply curve of land is recognized, as in a
Ricardian framework or, more specifically, in urban economic theory. In this setting, prices and the total housing stock should be co-integrated, and Figure 3.2 should trace out the long-run supply curve of housing. However, our analysis in Table 3.2 rejects the existence of such a co-integrating relationship. As a consequence, the curve in Figure 3.2 cannot be interpreted as a long-run supply schedule, and the regressions in Table 3.2 do not identify the long-run price elasticity of supply. It is implied that our findings are also at odds with a perfectly competitive Ricardian model, a claim that will be verified more extensively in the next section.

While the findings in this section cannot be reconciled with conventional models of competitive land and housing markets, they may alternatively be understood within the Dutch institutional context, in which the supply of residential land is essentially a policy outcome. We have argued in section 3.2 that policy makers may not be that sensitive to demand signals as revealed in prices, relying rather on stated preference information and demographic models. In this setting, the price elasticity of supply is likely to be reduced, and supply responses may be delayed. However, our findings are not consistent with a positive response of housing supply to prices within the medium run of less than a decade either. In that case, as in the Ricardian framework, prices and the total housing stock should be co-integrated, and Figure 3.2 should trace out the long-run supply curve of housing. Hence, the institutional framework appears to have resulted in a fully inelastic housing supply schedule, at least in the medium run.

We argue that lags in the adjustment process of more than a decade are implausible on both theoretical and empirical grounds. Clearly, adjustment costs in the construction industry, such as analysed by Topel and Rosen (1988), cannot account for lags of such length (see also Merkies and Steyn, 1994, for the Netherlands). However, there is no obvious reason for policy makers either to respond to price signals of more than a decade earlier, rather than to current price signals or even to expectations of future demand. Since spatial planning in the Netherlands has been predominantly a top-down process, it seems reasonable to assume that major adjustments in national policies that restrict the supply of residential land become effective after the publication of White Books on the national planning strategy. This would

---

24 This analysis assumes that the long-run relationship between supply and prices is linear. One might argue that our failure to find a co-integrating relationship is due to a nonlinear shape of this relationship. Hence, we have investigated the existence of a co-integrating relationship between supply and a second degree polynomial of real house prices, but the presence of a unit root in the residual of a regression of supply on prices and their square could not be rejected either.
imply that revisions have taken place more frequently than once in the ten years.\textsuperscript{25} Hence, if adjustments to market signals would indeed occur at these moments, we should have identified a positive supply elasticity in the medium run. Yet, this is not what we found in the data. Notably, after publication of the 1997 White Book on spatial planning, no adjustment of supply to the rise in house prices starting in the early 1990s was observed. On the contrary, new construction has decreased in the subsequent years (see also Figure 3.4 and the analysis in the next subsection). Finally, if institutions would respond elastically to price signals, but with substantial delay, we would still expect to find a positive short-run relationship between new construction and price changes. However, as indicated in the next section, such a relationship appears to be absent as well.

The findings in Table 3.2 do appear to be consistent with an alternative interpretation, which is that housing supply is not responsive to prices at all, but that it follows some autonomous process. One possible process would be that Dutch institutions respond to the ‘housing need’, estimated on the basis of stated preference information and demographic models. We briefly explore this option in an analysis of our demographic demand variable. Figure 3.1 contains the development of this variable over time. By the nature of demographic processes, the age composition of the population changes only slowly over time. Hence, by construction, our demand variable moves gradually over time as well. The figure suggests a particularly strong correlation with the evolvement of the total stock. This is precisely the pattern one would expect to find in a setting in which total housing supply in units were predominantly the outcome of a political process, focussed on the accommodation of ‘housing needs’.

We analyse bivariate relationships between demographic demand and our three measures of housing supply more formally in Table 3.3. The regressions shown in this table suggest strong correlations between these variables, as variation in the supply variables appears to be explained almost to full extent. A one percent increase in the estimated number of households based on the age composition of the population is associated with a two percent increase in the volume of the residential capital stock, a more than one percent increase in the total housing stock and a more than two percent increase in the owner-occupier housing stock. These estimates are not too far from the unit-elasticity that might be expected.\textsuperscript{26} However,


\textsuperscript{26} As headship rates have increased over time, it is not surprising that the estimates are above one. However, it is somewhat peculiar to find that housing supply in the owner-occupier sector responds more strongly to our
again, in the residuals of these regressions, a unit root cannot be rejected at any conventional level of significance. So there is no evidence of co-integrating relationships of supply variables with demographic demand either. One might argue that our approximation of the ‘housing need’ is crude, and that estimates that would take account of exogenous changes in headship rates and preferences, to the extent that governments take account of them, would have done a better job, but we leave this issue for future work.

![Table 3.3](image)

<table>
<thead>
<tr>
<th>demographic demand</th>
<th>capital (volume)</th>
<th>total stock (units)</th>
<th>o.o. sector (units)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2.103</td>
<td>1.378</td>
<td>2.321</td>
</tr>
<tr>
<td></td>
<td>(0.026) ***</td>
<td>(0.019) ***</td>
<td>(0.038) ***</td>
</tr>
<tr>
<td># observations</td>
<td>34</td>
<td>36</td>
<td>36</td>
</tr>
<tr>
<td>R²</td>
<td>0.995</td>
<td>0.993</td>
<td>0.991</td>
</tr>
<tr>
<td>ADF statistic</td>
<td>-0.92</td>
<td>-2.35</td>
<td>-0.71</td>
</tr>
<tr>
<td>p-value</td>
<td>0.95</td>
<td>0.41</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Notes: Standard errors appear in parenthesis, * indicates significance at 10 % level, ** indicates significance at 5 % level and *** indicates significance at 1 % level. In order to facilitate interpretation of the coefficients, we report the elasticity evaluated at the sample average.

### 3.3.3 Models for investment and new construction

As no co-integrating relationships amongst the nonstationary variables were found, we proceed with an analysis of variables in changes, similar to Mayer and Somerville (2000b). Instead of changes in the measures for the stock of supply, we consider investments and new construction. Deprecation or demolitions are ignored, which may be justified as these processes are expected to respond to prices to a much smaller extent. Figure 3.3 shows the volume of residential investment and changes in the house price index, while new construction for the total housing market and for the owner-occupier sector are shown in Figure 3.4.

Figure 3.3 suggests a positive relationship between investment and price changes, in particular in the second half of our period of observation. However, such a relationship does not appear to be present for new construction. Figure 3.4 indicates that the level of construction of owner-occupied housing is more or less constant over the period 1970-2005, with the exception of the early 1980s and the most recent years. The fall in construction in the demographic variable than the total housing stock, although this is the less regulated sector. Such anomalies could of course turn up if these relationships are indeed spurious.
Figure 3.3: The volume of residential investment and real house price changes

Figure 3.4: New construction in units and real house price changes
early eighties in this sector is likely to be a response to the collapse in house prices. However, falling construction rates towards the end of our period of observation have occurred after a major increase in house prices. The downward trend in total housing construction reflects falling construction rates in the rental sector, which have apparently not been compensated by increased production for the owner-occupier sector. Furthermore, Figure 3.4 does not suggest that the relationship between prices and construction has altered over our period of observation. The contrast with supply conditions in the US becomes particularly clear when we compare this figure to Figure 2 in Mayer and Somerville (2000b), which shows new housing starts and price changes in the US.

The responsiveness of residential investment and new construction to price changes is estimated more formally in a regression analysis. This analysis controls for changes in real construction costs and changes in the real long interest rate, which proxies the opportunity costs of investment in the residential market. In the model for construction in the owner-occupier sector, we include construction in the rental sector in order to control for crowding out effects. Furthermore, we include changes in the demographically estimated demand, as a measure for the aims that policy makers may pursue. In the specification presented, we have not included any lags of the explanatory variables. Most US studies do include lags, but many analyse quarterly rather than annual data. Nevertheless, we allow for lagged adjustment processes by including a lag of the dependent variable in our specification. A linear trend is removed from the variables, which makes all of them stationary (see Table 3.1), except changes in demographic demand. Hence, the coefficient of this variable should be interpreted with particular caution.

The identification of supply elasticities is generally obscured by a simultaneous response of prices to supply. In housing markets, though, this issue is relatively unimportant because of their stock nature. New construction usually adds only a small fraction to the existing stock, in our data this was about 2% on average for the total housing stock. This means that in the short run, house prices are determined through the interaction of demand and supply in the existing stock, and not through new construction. Exogeneity of housing supply is even more plausible in the Dutch institutional setting, in which price responses are

---

27 Given the institutional context, there will always be a delay between price changes and responses in construction. However, to some extent, price changes are likely to be anticipated, so that it still makes sense to use current price changes. We have experimented with lags of price changes as well, but this did not affect our overall findings. Furthermore, we have tested for autocorrelation in the residuals of our regressions, using a second order Breusch-Godfrey test (Table 3.4 reports the associated p-values). The null hypothesis of no autocorrelation could not be rejected at the 5% level of significance in any of the three models. This suggests that these models do not suffer from omission of important dynamic effects.
strongly delayed or even disabled through the zoning system (see section 3.2). We have tested for endogeneity of prices changes by instrumenting them with changes in the real disposable labour income per FTE. Studies of house prices generally find that these are strongly affected by income. However, there is no particular reason to believe that housing supply would be responsive to income changes, rather than to price changes, so that the validity of this instrument seems plausible. As reported in Table 3.4, a Wu-Hausman test cannot reject the null hypothesis of exogeneity of price changes at any conventional level of significance for residential investment and total new construction, while it is rejected at the 10% level for construction in the owner-occupier sector. We report the result of estimation with OLS for all three measures in Table 3.4, whereas IV results for construction in the owner-occupier sector are discussed separately in the text.

We find that investment and construction in the owner-occupier sector respond positively to price changes, while the estimated coefficient for total construction is negative. Only the response of investment is statistically significant at the 5% level. However,
quantitatively, it so low as to be almost negligible. As exogeneity of real house price changes is rejected at the 10% level of significance for the owner-occupier sector, we have estimated the same model with IV, using changes in the real disposable labour income per FTE as an instrument. This yields an estimated elasticity at the sample average of 0.037, with a standard deviation of 0.019, so the OLS results appear to underestimate the price elasticity of new construction in this sector. If we use the IV coefficient instead, the long-run effect of a 1% increase in prices is an increase in new construction of less than 0.1%, and an increase in the owner-occupier housing stock of less than 0.002%. These results may be contrasted with the reported elasticities in Mayer and Somerville (2000b), who find that a 1% price increase leads to a 3.7% increase in starts in the same year, and to a 0.08% adjustment in the stock in the long run. Moreover, the small supply response in the Dutch owner-occupier sector is apparently offset by construction in the rental sector.28

We now turn to the estimated coefficients of the other variables. Both for the volume of residential investment and for new construction, the effect of construction costs is positive, while it is statistically significant at the 5% level for investment and construction in the owner-occupier sector. Therefore, as in many other studies on housing supply, we find a perverse effect for this variable (cf. DiPasquale, 1999). Possibly, this control variable picks up a business cycle effect that is not accounted for by the other variables.29 Consistent with its interpretation as a proxy for opportunity costs, the coefficient for the real long interest rate is negative, although its effect appears to be small and statistically insignificant. Finally, we find a small negative effect of construction in the rental sector on construction in the owner-occupier sector, which is not statistically significant either.30

28 The supply of owner-occupied housing units may also occur through conversions. In order to account for this, we have estimated a model for changes in the owner-occupied housing stock, which was otherwise similar to the specifications in Table 3.4. A price elasticity of 0.046 with a standard deviation of 0.035 was found with OLS estimation, whereas instrumenting house price growth with income growth led to an elasticity of 0.17, with a standard deviation of 0.12. This suggests that conversions from rental to owner-occupied housing have been responsive to house price developments, although the economic significance of these effects remains limited.

29 As an additional control for business cycle effects, we have added the unemployment rate. The estimated coefficient was positive and statistically insignificant for all three dependent variables, and neither the estimated price elasticities nor the elasticities with respect to construction costs were statistically distinct from those reported in Table 3.4.

30 As construction in the rental sector is a policy outcome (for a substantial part of the stock, rents are set below market levels), it makes sense to treat this variable as exogenous. Instrumenting it with its first lag yielded similar results. In this respect, it should also be noted that the price considered throughout this chapter is the median sales price of owner-occupied housing. In a perfectly competitive equilibrium, this price would correspond to the present discounted value of all future rents for a similar house in the rental sector. However, as most rents are regulated, this present value is lower than prices in the owner-occupier sector for most houses. Taking account of these institutions, actors in the rental sector would probably show a higher responsiveness to prices. For instance, Figure 3.4 points to a fall in construction of rental housing around 1990, when direct subsidies on construction were abolished.
Consistent with the view that through the zoning system, housing supply is essentially a policy outcome, and that policymakers are more responsive to demographic ‘housing needs’ projections than to prices, we find relatively large effects of changes in demographic demand on investment and construction in the owner-occupier stock. Moreover, the imprecision of the coefficient estimate for total construction allows for an elasticity of similar magnitude. However, nonstationarity of this variable makes this finding rather uncertain, while the estimated standard errors should be considered with particular suspicion. Furthermore, it is not reassuring that the effect appears to be the weakest for total construction, while we would expect it to be stronger than for the other supply measures. Hence, we judge the time-series evidence in support for the demographic variable to be mixed at best.

In our discussion of the institutional setting in section 3.2, we have mentioned various changes in policies that occurred around 1990. One may wonder whether these institutional shifts have marked the relationship between price changes and new housing supply. In order to test for this, we have estimated the same model, extended with an interaction effect of price changes and a dummy that took the value 1 after 1990. The p-value of a test for statistical significance of this interaction effect is reported in Table 3.4. The absence of a shift in the effect of price changes on the volume of residential investment and total construction could not be rejected at any conventional level of significance. However, for construction in the owner-occupier sector, the absence of a shift is rejected at the 20% level of significance. Interestingly, the coefficient of the interaction effect implies that the elasticity of construction in this sector with respect to price changes was positive before 1990, and negative after. Hence, there is some indication that the institutional changes have reduced the price responsiveness of construction in the private sector, which appears to be in line with the discussion of these changes by Priemus (1998).31

### 3.4 Adjustments in the quality of structures and locations

The limited price sensitivity of investment in residential structures suggests that besides the price sensitivity of new construction in units, the price sensitivity of the quality of new

---

31 Furthermore, the positive supply elasticity before 1990 may be driven by the fall in new construction during the housing market crises in the early 1980s. It seems plausible that restrictive institutions hamper downward adjustments less than upward adjustments, such as required in the 1990s.
construction and of investments in the existing housing stock are limited as well. Nevertheless, given the difficulty of measuring the volume of residential investment, we perform a corroborative analysis in this section, using a different approach. First, we estimate the valuation of various aspects of housing quality that are observed in a large dataset of housing transactions over the period 1999 – 2000. By averaging the value of these characteristics for each year of construction between 1970 and 2000, indices are obtained for several aspects of quality. These indices are then related to the median house price index series of the previous section, in order to estimate their price responsiveness. Necessarily, this approach is restricted to the owner-occupier sector.

More formally, we estimate the following regression:

\[
\log(P_{r,\tau}) = C + D_{t=2000} + \sum_i \alpha_i M_i + \sum_j \beta_j X_j + \gamma_r I_r + \delta_\tau I_\tau + \epsilon_{r,\tau},
\]

in which the dependent variable is the logarithm of \(P_{r,\tau}\), the price of a house in region \(r\) that is constructed in year \(\tau\). Next to a constant \(C\) and \(D_{t=2000}\), a control for whether the house has been sold in 2000, the regression contains maintenance controls \(M_i\), measures for structure quality \(X_j\), a dummy \(I_r\) for the municipality in which the house is situated and a dummy \(I_\tau\) for the year of construction. Using the parameter estimates, the structure quality of new construction in year \(t\) is obtained as the average of the structure component \(Q_t^X = E(\sum_j \beta_j X_j | \tau = t)\), where \(E(\tau = t)\) denotes an expected value conditional on the year of construction. We construct a structure quality index as \(I_t^X = 100 \times (1 + Q_t^X - Q_{1970}^X)\), so that the index has a value of 100 in 1970. An index value of 110 in year \(t\) indicates that housing built in year \(t\) is worth 10% more on average in 1999 - 2000 than housing built in 1970 due to the increased average quality of structures. The indices \(I_t^L\) for location and \(I_t^M\) for maintenance quality are constructed similarly, using the components \(Q_t^L = E(\sum_r \gamma_r I_r | \tau = t)\) and \(Q_t^M = E(\sum_i \alpha_i M_i | \tau = t)\) respectively. Hence, a quality of location index value of 110 in year \(t\) indicates that housing built in year \(t\) is worth 10% more on average in 1999 - 2000 than housing built in 1970, because it is located in municipalities in which households in 1999 - 2000 were willing to pay more for their house. Finally, an index that picks up effects of the

---

Note that this finding may be reconciled with a competitive construction industry, if real house price developments are predominantly driven by changes in land prices, which seems plausible in the Dutch institutional context.
year of construction on the house value in 1999 – 2000 that are not accounted for by the other indices is constructed as $I_t^T = 100^* (1 + \delta_t - \delta_{1970})$. When estimating Equation 3.1 we choose 1970 as a reference year, so that $\delta_{1970} = 0$.

Equation 3.1 is estimated on a large sample of housing transactions in the years 1999 and 2000, obtained from the association of Dutch real estate brokers (NVM). The real estate brokers that are member of this association cover the majority of housing market transactions in the Netherlands. Throughout our analysis, we will assume that this dataset is representative for the entire Dutch housing stock. Amongst the variables reported for each transaction are the transaction price and date, the year of construction, two maintenance controls (interior and exterior of the dwelling), a range of quality characteristics and the location of the dwelling. The quality controls consist of size variables and proxies for the type of housing, such as detached, semi-detached, terraced housing or bungalow. The level of spatial aggregation of the location variables (municipalities) captures the majority of the spatial variation in house prices. Only single family dwellings are considered in order to enhance homogeneity of our sample. After dropping implausible outliers and houses built before 1970, this leaves a sample of about 80,000 observations. Because of the noisiness of the data, we estimate Equation 3.1 by a least absolute distance (LAD) estimator. Figure 3.5 shows the quality indices, which are constructed using sample characteristics and these coefficient estimates.

Figure 3.5 suggests that the quality of new structures has responded strongly to the housing crisis in the beginning of the 1980s. Houses built in the years 1982 – 1983 are worth now almost 20% less than houses built in 1970, because they are on average either smaller or of a less attractive type (terraced housing rather than free-standing), while these structure attributes seem to yield a similar value to houses built in the 1990s as in 1970. In contrast, the developments of the maintenance index and in particular of the residual time component index suggest that from the early 1980s onwards, housing quality has increased with the year of construction. Houses built in 2000 are about 15% more expensive than houses built in 1970 due to other components than observed structure quality, maintenance and location. This should not be surprising, as the quality of new housing is determined by many factors, of which we observe only a fraction in our dataset. Finally, the quality of location has remained unchanged.

33 Because of the large number of municipalities, we have computed median house prices at the municipal level in a first step, and then estimated the valuation of housing characteristics on house prices relative to this median in a second step. This procedure is analogous to demeaning in a municipal fixed effects model. The estimated coefficients for this regression are available upon request, and they generally match with findings in the hedonic pricing literature.

34 Disaggregation of the quality of construction index indicates that this adjustment has taken place mainly through size-related characteristics.
rather stable over the 1970s, while increasing significantly in the 1980s. In the early 1990s it dropped, and it increased again towards the end of our period of observation.

**Figure 3.5: Indices of housing quality**

![Graph showing indices of housing quality over time](image)

The relationships between house prices and each of the four quality indices presented in Figure 3.5 are analysed more formally in a regression analysis.\(^35\) We transform all variables into logarithms, so that the estimated coefficients can be interpreted directly as elasticities. Similar to our analysis in section 3.3.3, we estimate bivariate relationships for each variable in changes, while removing all linear trends. We do not account for the potential endogeneity of price changes, which may be justified by the assumption that price changes are predominantly determined in the existing stock.\(^36\) The results are shown in Table 3.5.

---

\(^{35}\) A number of caveats should be borne in mind when adopting this approach. In the first place, the quality of housing is not fixed after its construction. People may alter the quality characteristics of their house through maintenance activities or other investments. Obviously, this holds in particular for the maintenance index. Hence, the quality indices that are estimated on characteristics and prices in 1999 - 2000 do not necessarily reflect the quality at the moment of construction of the dwelling. So if, for instance, owners of a house built in the period 1982 - 1983 have invested more than average in their dwelling, then we have underestimated the price responsiveness of the index of structure quality. A second issue is that over the past decades, the demand for quality attributes may have changed as well. So quality adjustments that were deemed highly valuable in the 1970s may not be reflected fully in transaction prices in the period 1999 - 2000.

\(^{36}\) Table 3.5 reports test statistics for the exogeneity assumption, where the growth rate of the real disposable labour income per FTE is used as an instrument. Exogeneity of real house price growth is rejected only for the
Table 3.5
Price elasticity of various quality indices of new housing

<table>
<thead>
<tr>
<th></th>
<th>structure</th>
<th>location</th>
<th>maintenance</th>
<th>residual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alog(real house price)</td>
<td>0.136</td>
<td>0.050</td>
<td>0.005</td>
<td>0.031</td>
</tr>
<tr>
<td></td>
<td>(0.058)**</td>
<td>(0.039)</td>
<td>(0.002)**</td>
<td>(0.015)*</td>
</tr>
<tr>
<td># observations</td>
<td>30</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>R²</td>
<td>0.16</td>
<td>0.06</td>
<td>0.16</td>
<td>0.12</td>
</tr>
<tr>
<td>Breusch-Godfrey (p-value)</td>
<td>0.72</td>
<td>0.55</td>
<td>0.47</td>
<td>0.98</td>
</tr>
<tr>
<td>Exogeneity price (p-value)</td>
<td>0.62</td>
<td>0.02</td>
<td>0.52</td>
<td>0.96</td>
</tr>
</tbody>
</table>

Notes: Standard errors appear in parenthesis, * indicates significance at 10% level, ** indicates significance at 5% level and *** indicates significance at 1% level. We consider first differences of the logarithm of prices and quality indices, where linear trends have been removed from all variables. Furthermore, p-values are reported of a Breusch-Godfrey test for second order autocorrelation, and of a Wu-Hausman test for endogeneity of the change in the real house price index.

The relationship between the house price index and the index of structure quality is statistically significant. The estimated coefficient implies that a 1% increase in house prices leads to about a 0.14% increase in the index of structure quality, which means that houses built in the period in which this price increase would have occurred, would have a 0.14% higher value due to increased structure quality. Although quality adjustments may materialize through other characteristics than the ones we observe, the economic and statistical insignificance of the price sensitivity of the index of the residual time component of quality suggests that our index of structure quality captures the most important quality adjustments. The price elasticity of the maintenance index is statistically significant but negligible in size. In the previous section, we have found that a 1% price increase led to a less than 0.1% increase in new construction in the owner-occupier sector. This suggests that price adjustments of new housing supply in this sector are slightly stronger in the quality dimension than in the number of units. Obviously, these elasticities refer to adjustments in new construction, whereas adjustments of the total stock are much smaller.

We do not find any economically or statistically significant relationship between prices and the index of location quality. In an unregulated land market, one would expect that higher prices would lead to more development on attractive and expensive locations. Hence, this finding seems at odds with the assumption of perfect competition on land markets. In the previous section, we have discussed the possibility that prices have risen over the past decades as a result of an upward sloping supply curve of residential land. In perfectly competitive markets again, this would be consistent with the Ricardian model that was

location index. In all regressions in which real house price growth is instrumented with income growth, the estimated coefficient of the price growth variable is lower than for the OLS regressions, so if anything, we appear to overestimate the price elasticities.
explained in section 3.1. An implication of this setting is, that the quality of location of new housing is decreasing with the size of the total housing stock. It is this decrease in quality that causes average house prices to rise through differential land rents. Figure 3.6 shows a scatter plot of the quality of location index and the indexed total housing stock. This plot does not point to a negative relationship between these variables. Furthermore, it shows that the quality index has hardly varied, whereas the total housing stock almost doubled. Hence, it seems implausible that differential land rents have led to an upward sloping supply curve of housing that is sufficiently steep, to account for the observed increase in prices.

Figure 3.6: A scatter plot of location quality and the total housing stock

Again, developments in Dutch housing market institutions may provide a more accurate description of shifts in the quality of location than competitive models of land and housing markets. In the 1970s, spatial planning focused strongly on ‘clustered deconcentration’ of new housing construction. In this era, many ‘new towns’ were founded or assigned, in which the growth of housing demand in nearby large cities was to be accommodated. However, the quality of location index suggests that these locations are not
perceived as the most attractive ones by housing consumers. Houses built in the aftermath of the housing market crises are worth about 5% more on average than houses built in the 1970s, due to a higher quality of location. The steep shift suggests that the government has responded to the demand induced trough in new construction, not only by increasing production in the regulated rental sector, but also by making available more attractive locations. Also, efforts to stimulate a more even distribution of the population over the country were strongly reduced, as the need for people to locate near jobs was acknowledged during this severe economic crisis. Furthermore, the focus of the national planning strategy shifted towards (compact) development the larger cities in the 1980s. The fall of the quality of location index in the early 1990s and its subsequent rise appear to be somewhat more difficult to explain. They may be related to institutional reforms in the housing market, which have arguably led to an increased focus on environmental quality (Priemus, 1999). During the 1990s, locations at the fringe of the large cities (so called VINEX locations) were assigned for the accommodation of new housing demand. Production in these locations started to pick up somewhat towards the end of the 1990s. Housing production in these locations may have caused the final rise of the construction quality index in our data.

### 3.5 Conclusions

Housing supply in the Netherlands is almost fully inelastic in the short-run. Our estimates suggest that new construction in the owner-occupier sector rises with 0.04% after a 1% price increase in the same year, while for total construction, no significant response could be identified at all. In a comparable econometric analysis, Mayer and Somerville (2000b) report a one-year response for the US that is higher by about a factor 100. Furthermore, we find that the long-run effect of a 1% price increase on new construction in the owner-occupier sector is a 0.1% increase, which yields a 0.002% increase of the housing stock in this sector. These elasticities may arguably be considered as negligible for any practical purposes. Probably reflecting rent controls and (countercyclical) subsidies on the construction of social housing, the point estimate of the price elasticity of total housing supply was even negative.

Housing supply may respond to price changes not only through the number of newly constructed dwellings, but also through their quality, and through investments in the existing

---

37 This is confirmed by spatial house price differentials. For example, housing in Almere, one of the largest of the ‘new towns’, is worth about 30% less than housing in nearby Amsterdam, once differences in the quality of structures are controlled for. See chapter 6 for further analysis.
stock. We have analysed the volume of investment in residential structures, which measures the amount of capital invested in both new and existing dwellings. This variable was no more sensitive to house prices in the short run than new construction in the owner-occupier sector. Furthermore, we have estimated a time-series of the structure quality of new owner-occupied housing in a hedonic analysis. This index appears to be responsive to house prices in the short run with an elasticity of about 0.1. These results indicate that short-run supply responses through other channels than new construction in units were economically insignificant as well.

Whereas both prices and the housing stock, measured either in units or in the volume of residential capital, are nonstationary, we could not identify a co-integrating relationship between them. This finding would be consistent with a positive long-run supply elasticity only if lags in the adjustment process are in the order of a decade, or even longer. Hence, we may conclude that housing supply is inelastic in at least the medium run. Furthermore, it does not seem plausible that lags of such length can be attributed to rigidities in the construction industry, such as analysed in Topel and Rosen (1988). However, it is also difficult to reconcile them with Dutch institutions in land and housing markets, as there is no reason to believe that politicians or civil servants would respond to price developments of more than a decade earlier, rather than addressing present (or expected future) needs. Moreover, if these institutions would be responsive to prices, but with significant lags, we would still expect to find a larger short-run elasticity. Therefore, it seems reasonable to interpret our findings as evidence of a fully inelastic long-run housing supply schedule.

A less than perfectly elastic housing supply curve may be reconciled with undistorted housing and land markets in a Ricardian model, in which locations vary in desirability. If housing market developments in the Netherlands were to be explained within this competitive framework, then locations that are presently available for new construction should be inferior to available locations in the early 1970s to the extent that average house prices have tripled to make inframarginal housing equally attractive as new construction. The quality of location index that we have estimated in our hedonic analysis is not consistent with this framework at all. In the first place, this index shows that the quality of location has varied by only a few percent over the past decades, so that it cannot account for the long-run trend in house prices quantitatively. Secondly, the average quality of location of new construction has not decreased with the size of the total housing stock, so it is not the case that the most desirable locations have been developed first. From this, we conclude that our findings regarding
housing supply and prices in the Netherlands cannot be reconciled with conventional models of competitive land and housing markets.

This chapter has provided an overview of various government interventions in land and housing markets over the past decades. Essential in these interventions appears to be the regulation of land use, so that the supply of residential land is legally a government decision, rather than a market outcome. Consequently, the supply elasticities estimated in this chapter should be interpreted predominantly as a measure for the responsiveness of these institutions to price signals. Over the past decades, governments have planned construction following estimates of the housing need, which may have relied more on demographic models and stated preferences than on the demand revealed in prices. The protection of open space and the direction of residential development towards certain locations deemed socially desirable has been another consistent policy aim. Furthermore, since the early 1990s, new residential land has been implicitly taxed in order to finance local public goods. Over and above institutions in the social housing sector, which cannot directly account for a low price-elasticity of new construction in the owner-occupier sector, these policies have probably imposed a major inhibition on market-responsive housing supply in the Netherlands.

Housing demand has increased substantially over the past decades as a consequence of rising incomes, falling interest rates and demographic developments. Rising demand leads to rising prices if supply does not respond. This seems a plausible explanation for the long-run trend in real house prices in the Netherlands, which has been remarkably high from an international perspective (OECD, 2004a). Having established that Dutch housing supply is almost fully inelastic at least partly as a consequence of land use regulation, we must conclude that government interventions in land and housing markets have contributed significantly to the present high level of house prices in this country.
Chapter 4

Does land use planning shape regional economies? A simultaneous analysis of housing supply, internal migration and local employment growth in the Netherlands

The evidence presented in chapters 1 and 3 has indicated that government interventions in land and housing markets in the Netherlands have a strong impact on the quantity and location of new residential construction, while reducing the responsiveness of supply to market signals. These findings square with an emerging literature on the impact of land use regulation, as we have extensively discussed as well. However, the wider effects of land use regulation on regional economies have received significantly less attention. Restrictions on the supply of housing that limit the number of households in a region affect labour supply and employment. For instance, Glaeser et al. (2006) show that in US cities in which such restrictions are strong, shocks in labour demand push up wages and house prices, while the local employment response is small. Moreover, it has been well established that the spatial distribution of jobs relates to productivity through the presence of agglomeration economies (cf. Rosenthal and Strange, 2004), so that regional productivity growth may be inhibited by restrictions on residential development too.

An argument along these lines has recently been put forward by the OECD in its Territorial Review of Randstad Holland (OECD, 2007). Containing the four largest cities in the Netherlands on about 20% of all the land in this country, and contributing to the national income by more than 50%, this area is one of the most densely populated in the OECD. Nevertheless, the Territorial Review points to lagging labour productivity growth in the past few years, relative to other metropolitan areas. Amongst the potential culprits, it discusses the lack of high quality dwellings, as a consequence of rigidities in Dutch housing markets.

---

1 This chapter is based on Vermeulen and Van Ommeren (2006a, 2008a).
2 Similarly, Glaeser and Gyourko (2005) present evidence for the impact of housing supply on population growth in declining cities in the US. In these cities, the low supply elasticity of housing results from durability of the stock, rather than from restrictive land use regulation. They show that downward demand shocks lead to a fall in house prices, rather than in the stock, so that population decline is attenuated.
Motivated by such potentially significant implications, our present chapter investigates the extent to which housing supply has shaped the regional distribution of people and jobs in the Netherlands.

This research question relates to a classical debate in regional science that has come to be known as the issue whether ‘people follow jobs’ or ‘jobs follow people’. A variety of studies have estimated simultaneous models for the intrametropolitan distribution of people and jobs.\(^3\) Housing supply is ignored in the larger part of this literature, which may be justified only if new construction fully accommodates demand. However, at the urban level, an upward sloping housing supply curve is implied already by the limited availability of land at a certain proximity to the city centre.\(^4\) An increase in the demand for spacious dwellings, due to rising incomes or falling transport costs for instance, will therefore push city boundaries outwards, even if all jobs remain located in a Central Business District (cf. Anas et al., 1998). So in this case, the supply of spacious dwellings drives population growth in suburbs. Simultaneous analyses of the intrametropolitan location of houses, people and jobs in the US have confirmed the empirical relevance of such mechanisms (Greenwood, 1980, Greenwood and Stock, 1990). In this chapter, we take this debate to a setting where substantial restrictions on residential development near city boundaries exist.\(^5\)

We estimate three simultaneous equations for growth of the housing stock, net internal migration and employment growth on annual regional panel data that span three decades. Our econometric approach essentially follows Carlino and Mills (1987), although we extend their framework in a number of ways. First of all, we introduce an equation for growth of the housing stock as in Greenwood (1980) and Greenwood and Stock (1990). Second, as the regions in our data are not closed in terms of commuting, spatial interaction is accounted for following Boarnet (1994). Because internal migration is the main channel through which the population adjusts to regional labour and housing market conditions, we model the net internal migration rate rather than population growth (cf. Greenwood and Hunt, 1984). Moreover, the use of regional time-series allows us to distinguish short-run and equilibrium

---

\(^3\) See for instance Steinnes (1977), Carlino and Mills (1987), Boarnet (1994), Luce (1994), Thurston and Yezer (1994), Deitz (1998), or more recently Boarnet et al. (2005). An overview of this literature is provided in White (1999), who concludes that empirical studies have tended to find that jobs follow people, while people do not follow jobs.

\(^4\) Estimates of the price elasticity of national housing supply in the US are generally found to be much smaller than infinity (see our discussion in chapter 3). This suggests that the assumption of fully accommodative housing supply may not be innocuous at higher levels of spatial aggregation either.

\(^5\) The Netherlands has approximately the same surface and population size as Los Angeles. Hence, from a US perspective, the spatial level of our analysis may appear as intrametropolitan rather than regional.
adjustment effects in the interaction of our endogenous variables, while controlling fully for all national trends and time-invariant regional determinants.

The remainder of this chapter is structured as follows. Main trends in the regional distribution of houses, people and jobs over the past three decades are documented and interpreted in the next section. Section 4.2 introduces our data more formally and presents all variables used in the simultaneous equations model, which is estimated in section 4.3. The chapter continues with separate analyses of regional employment growth in sectors that produce for local consumption and export, in order to find out whether adjustments in the spatial distribution of jobs have been driven by local consumer demand or by labour supply. The final section concludes and offers some discussion.

4.1 Trends in the spatial distribution of houses, people and jobs

The three regions considered in this section are the Randstad area in the west of the country, an Intermediate zone and a Periphery, shown in Figure 4.1. This figure also indicates the regional division used in subsequent sections, which consists of so-called COROP regions, coinciding with the European NUTS3 level. The COROP division has been originally designed to minimize cross-border commuting. Hence, it provides a crude approximation of functional labour market regions.

Throughout this chapter, we consider the period from 1973 to 2002.

Figure 4.2 shows the number of houses, people in the age group 15 - 64 and employment in the Randstad area as a share of the national total. This area accommodates almost half of all houses, people and jobs. The share of jobs exceeds the share of the potential labour force, reflecting the fact that a significant part of the jobs in the Randstad area are held by people in the Intermediate zone. This region also contains a larger share of all houses than of all potential workers because of a relatively large share of singles and couples without children. However, in spite of the dominance of the Randstad area in terms of levels, the shares of houses, people and jobs in this region have all declined between 1973 and 2002. The share of houses has decreased strongest, with 2.6% in absolute terms and 5.3% in relative

---

6 In sections 4.2 to 4.4, we will exclude the region of Flevoland from our observations, as it is a clear outlier. The number of houses, people and jobs was almost negligible here in the early 1970s, and as a consequence of government policies, this region has experienced double digit growth rates.
7 The average share of workers that work outside their region of residence is about 20 percent. Another criterion was that COROP regions should consist of municipalities, and add up to provinces (European NUTS2).
8 The difference between these two shares has decreased over time, which should probably be explained by the increasing share of foreign immigrants in the Randstad area, who tend to live in larger households.
Figure 4.1: Overview of the COROP regions and country parts

<table>
<thead>
<tr>
<th>Number</th>
<th>Region</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Oost-Groningen</td>
<td>Agglomeratie Haarlem</td>
</tr>
<tr>
<td>2</td>
<td>Delfzijl en omgeving</td>
<td>Zaanstreek</td>
</tr>
<tr>
<td>3</td>
<td>Overig Groningen</td>
<td>Groot-Amsterdam</td>
</tr>
<tr>
<td>4</td>
<td>Noord-Friesland</td>
<td>Het Gooi en Vechtstreek</td>
</tr>
<tr>
<td>5</td>
<td>Zuidwest-Friesland</td>
<td>Agglomeratie 's-Gravenhage</td>
</tr>
<tr>
<td>6</td>
<td>Zuidoost-Friesland</td>
<td>Noord-Drenthe</td>
</tr>
<tr>
<td>7</td>
<td>Noord-Drenthe</td>
<td>Zuidoost-Drenthe</td>
</tr>
<tr>
<td>8</td>
<td>Zuidwest-Drenthe</td>
<td>Zuidoost-Zuid-Holland</td>
</tr>
<tr>
<td>9</td>
<td>Zuidoost-Overijssel</td>
<td>Zuidoost-Overijssel</td>
</tr>
<tr>
<td>10</td>
<td>Noord-Overijssel</td>
<td>Twente</td>
</tr>
<tr>
<td>11</td>
<td>Zuidoost-Overijssel</td>
<td>Veluwe</td>
</tr>
<tr>
<td>12</td>
<td>Zuidoost-Overijssel</td>
<td>Achterhoek</td>
</tr>
<tr>
<td>13</td>
<td>Noord-Overijssel</td>
<td>Arnhem/Nijmegen</td>
</tr>
<tr>
<td>14</td>
<td>Zuidoost-Overijssel</td>
<td>Zuidoost-Gelderland</td>
</tr>
<tr>
<td>15</td>
<td>Noord-Overijssel</td>
<td>Utrecht</td>
</tr>
<tr>
<td>16</td>
<td>Zuidoost-Overijssel</td>
<td>Kop van Noord-Holland</td>
</tr>
<tr>
<td>17</td>
<td>Noord-Overijssel</td>
<td>Alkmaar en omgeving</td>
</tr>
<tr>
<td>18</td>
<td>Zuidoost-Overijssel</td>
<td>IJmond</td>
</tr>
<tr>
<td>19</td>
<td>Zuidoost-Overijssel</td>
<td>Noord-Limburg</td>
</tr>
<tr>
<td>20</td>
<td>Zuidoost-Overijssel</td>
<td>Midden-Limburg</td>
</tr>
<tr>
<td>21</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>22</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>23</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>24</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>25</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>26</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>27</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>28</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>29</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>30</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>31</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>32</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>33</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>34</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>35</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>36</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>37</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>38</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>39</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
<tr>
<td>40</td>
<td>Zuidoost-Overijssel</td>
<td>Zuido-Limburg</td>
</tr>
</tbody>
</table>
Figure 4.2: Housing, population and employment share of the Randstad area

Figure 4.3: Housing, population and employment share of the Intermediate zone
terms. The shift in the employment share has been more modest, with an absolute decrease of 0.8% and a relative decrease of 1.7%. Furthermore, it is noteworthy that the share of people and houses decreased most steeply in the 1970s, whereas the share of jobs decreased most steeply in the 1980s and early 1990s.

The number of houses, people in the age group 15 - 64 and employment in the Intermediate zone as a share of the national total are shown in Figure 4.3. This region accounts for about a quarter of all houses, people and jobs. As a significant part of the residents work in the Randstad area, the share of people exceeds the share of jobs and households are relatively large in this region, so that the share of people exceeds the share of houses too. The shares of houses, people and jobs have all increased by more in absolute terms than the decrease of these shares in the Randstad area, so the Intermediate zone has also expanded at the expense of the Periphery. In relative terms, these shifts are quite substantial. In particular, the share of houses has increased relative to its 1973 level by almost 15%. Furthermore, the figure indicates that while the shares of houses and people have increased rather homogeneously over the past decades, the share of employment started rising significantly only in the second half of the 1980s.

*Figure 4.4: Housing, population and employment share of the Periphery*
Finally, Figure 4.4 contains the same variables as Figures 4.2 and 4.3 for the Periphery. In this area, the employment share is significantly lower than the shares of the other two variables, which is probably related to a higher unemployment rate, a lower participation rate and a higher rate of self employment. All shares have decreased over the past decades, but these developments were modest in absolute terms, when compared to developments in the other two areas. With a decrease of 5.1%, the share of people has fallen strongest in relative terms. Nevertheless, the Figures 4.2 to 4.4 suggest that most of the interesting dynamics for our purposes has occurred in the Randstad and Intermediate zone.

The trends in these figures give a clear indication with respect to the question whether employment growth has been a driver of regional development. While the housing stock and the potential labour force have risen faster in the Intermediate zone than in the Randstad throughout the 1970s, employment growth started picking up only in the second half of the 1980s. It seems unlikely, therefore, that local employment growth has driven the shift of houses and people towards the Intermediate zone. Another indication in support for the hypothesis that ‘jobs have followed people’ in this case is that the industrial composition was relatively favourable in the Randstad area, with a large share of employment in services. Moreover, the density of people and jobs was highest here, so that economies of agglomeration may have pushed up local labour demand too. If ‘people would follow jobs’ at this regional level, population growth should therefore be highest in the Randstad area. As the opposite has happened, we would infer that the regional distribution of employment has adjusted to shifts in local population growth instead, although the figures suggest that this adjustment has taken some time.

If it was not a shift in regional labour demand, what else could have driven growth in the Intermediate zone? A standard explanation from urban economic theory would be that rising incomes and falling transport costs have made it attractive for people to live in larger houses at a greater distance from their jobs. In unregulated land markets, these houses would typically be provided at the city fringe. The resulting process of urban sprawl or suburbanization has been observed almost everywhere in the developed world (cf. Anas et al., 1998). However, policy has restricted urban expansion in the Randstad area through preservation of the Green Heart area as well as Buffer zones between the larger cities (see

---

9 These is a competing explanation for urban sprawl, generally referred to as the ‘flight from blight’ hypothesis, which asserts that rich households have left city centres because of a lack of public goods like high-quality schools and protection against crime (cf. Nechyba and Walsh, 2004). As the provision of such local public goods is generally more evenly spread over locations in the Netherlands than in the US, and perhaps also at a higher level, this explanation seems less relevant in the context of our analysis.
chapter 1), while growth at specific towns, of which some are located in the Intermediate zone, has been stimulated by the national government in variants of a clustered deconcentration policy. Hence, increased demand for spacious dwellings may have been satisfied at locations further away from the main cities, in the Intermediate zone.

The trends in Figures 4.2, 4.3 and 4.4 do not offer clear insights into the validity of this account, but some support for it may be found in land use statistics. In the year 2000, 16% of all land in the Randstad area was built-up and 62% was used for agriculture, against 9% built-up land and 64% agricultural land in the Intermediate zone. This observation is difficult to reconcile with accommodative supply responses to increased demand for spacious dwellings at city fringes, because we would then expect to find a much smaller share of agricultural land in the Randstad area. Hence, land use information appears to be consistent with the hypothesis that sufficient space for residential development would have been available in this area, but that policies have prevented its usage.

4.2 Data and model variables

Annual information on the regional housing stock and population stems from administrative data in the Netherlands. Statistics Netherlands keeps track of all changes in the housing stock, either through new construction, demolitions or conversions, at the municipal level. These data have been put together in consistent regional time-series by the consultancy ABF Research. Municipalities are obliged by law to administer all births, deaths and migrations in their territory. Statistics Netherlands gathers this information, and transforms it into regional demographic time-series. This source also contains information on the age and

---

10 This information is provided by Statistics Netherlands in the Bodemstatistiek 2000. See also the paper by Koomen et al. (2008) that we discussed in chapter 1, which measures and maps the local provision of open space.

11 In particular, these land use statistics make it difficult to understand why the region of Flevoland has grown so dramatically over the past decades, if it were not for the reason of spatial planning. Founded on land reclaimed from the sea, the new town of Almere had very little to offer in terms of job opportunities or cultural amenities in its early years. Even in 2002, houses were about 40 percent more expensive in Amsterdam than in Almere, controlled for a broad range of quality characteristics, suggesting that people still consider the city of Amsterdam as a more attractive residential location nowadays. Sufficient agricultural land was available at locations closer to the main employment centres near Amsterdam. However, the shares of houses and people in Flevoland have steadily increased from essentially zero to almost 2% of the national total. The only plausible explanation appears to be a sustained policy effort to boost the population in Almere, in combination with strong restrictions on growth at many other locations near Amsterdam. Chapter 6 provides a welfare economic analysis of this type of policy that is applied to the case of Amsterdam and Almere.

12 Note in particular that we do not have to rely on estimates based on decennial censuses, such as in the US. This should allow us to infer short-run dynamics in a more accurate way.

13 We kindly thank ABF Research for providing us with these data.
Table 4.1
Sample properties for all model variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Number of obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
<td>Between</td>
<td>Within</td>
<td></td>
<td>Periods Total</td>
</tr>
<tr>
<td>$HOU_{it}$ (1000)</td>
<td>139.8</td>
<td>114.7</td>
<td>113.4</td>
<td>25.0</td>
<td>17.3</td>
</tr>
<tr>
<td>$\Delta hou_{it}$ (%)</td>
<td>1.688</td>
<td>0.840</td>
<td>0.379</td>
<td>0.752</td>
<td>-0.720</td>
</tr>
<tr>
<td>$POP_{it}$ (1000)</td>
<td>252.7</td>
<td>191.5</td>
<td>192.4</td>
<td>23.8</td>
<td>31.5</td>
</tr>
<tr>
<td>$\Delta pop_{it}$ (%)</td>
<td>0.779</td>
<td>1.026</td>
<td>0.381</td>
<td>0.955</td>
<td>-7.119</td>
</tr>
<tr>
<td>$NIM_{it}/POP_{it-1}$ (%)</td>
<td>-0.053</td>
<td>0.500</td>
<td>0.260</td>
<td>0.429</td>
<td>-1.785</td>
</tr>
<tr>
<td>$NPI_{it}/POP_{it-1}$ (%)</td>
<td>0.593</td>
<td>1.189</td>
<td>0.284</td>
<td>1.156</td>
<td>-14.555</td>
</tr>
<tr>
<td>$EMP_{it}$ (1000)</td>
<td>118.9</td>
<td>108.4</td>
<td>108.2</td>
<td>18.2</td>
<td>11.3</td>
</tr>
<tr>
<td>$\Delta emp_{it}$ (%)</td>
<td>0.941</td>
<td>2.593</td>
<td>0.502</td>
<td>2.545</td>
<td>-13.236</td>
</tr>
<tr>
<td>$EHR_{it}$ (%)</td>
<td>36.93</td>
<td>3.87</td>
<td>1.13</td>
<td>3.71</td>
<td>27.55</td>
</tr>
<tr>
<td>$GEHR_{it}$ (%)</td>
<td>1.238</td>
<td>0.697</td>
<td>0.210</td>
<td>0.665</td>
<td>-0.194</td>
</tr>
<tr>
<td>$EPR_{it}$ (%)</td>
<td>61.89</td>
<td>3.00</td>
<td>0.62</td>
<td>2.93</td>
<td>57.14</td>
</tr>
<tr>
<td>$GEPR_{it}$ (%)</td>
<td>0.266</td>
<td>0.906</td>
<td>0.129</td>
<td>0.897</td>
<td>-1.485</td>
</tr>
<tr>
<td>$SHA_{it}$ (%)</td>
<td>0.962</td>
<td>1.608</td>
<td>0.253</td>
<td>1.588</td>
<td>-3.886</td>
</tr>
<tr>
<td>$PRO_{it}$ (1000)</td>
<td>44.21</td>
<td>16.56</td>
<td>7.73</td>
<td>14.69</td>
<td>14.19</td>
</tr>
<tr>
<td>$EMP_{it}$ (1000)</td>
<td>52.00</td>
<td>44.73</td>
<td>44.93</td>
<td>5.67</td>
<td>6.53</td>
</tr>
<tr>
<td>$EMP_{it}$ (1000)</td>
<td>67.30</td>
<td>67.04</td>
<td>65.42</td>
<td>17.91</td>
<td>4.03</td>
</tr>
</tbody>
</table>

Notes: Variables in lower case are in logarithms. The housing stock is measured in 1000 units. All demographic variables are measured in 1000 persons and refer to the age group 15 - 64. All employment variables refer to employees, measured in 1000 full time equivalents. Productivity is measured in 1000 Euros in current prices per full time equivalent. The region of Flevoland was excluded when computing these descriptives, as the empirical analysis treats this observation as an outlier.
gender composition of the regional population. In our analyses, we will focus on developments in the regional population aged between 15 and 64, as this group constitutes the potential labour force.\textsuperscript{14} Finally, regional employment is derived from regional accounts. These data stem from Statistics Netherlands as well, which collects them as a part of the national accounting process.\textsuperscript{15} A limited number of industries are distinguished, and the data also contain an estimate of the regional value added. However, only employment of employees is observed, measured in the number of person-years. This means that regional variation in self employment and hours per worker are ignored in our analysis.

The housing stock $HOU_{r,t}$ in region $r$ and year $t$ is measured as the number of housing units. Note that we do not distinguish a (regulated) rental sector and an owner-occupier sector, nor are new construction and demolitions treated separately in our analysis. As Table 4.1 indicates, the variation in the regional housing stock is substantial, ranging from 17,000 to 600,000 dwellings. Clearly, the larger part of this variation exists between regions, but the average variation in the time-series within regions appears to be substantial too. The regional housing stock has been growing with less than 2% annually on average. The larger part of the variation in this growth rate occurs in the time-series dimension.

Our demographic information consists of regional population and migration, disaggregated to age and gender. The empirical analysis focuses on $POP_{r,t}$, the population in the age group 15 - 64, which approximately covers the potential labour force. The average regional population in this age group is about 250,000 persons and its average growth rate is about 0.8% per year. The municipal records include information on internal and foreign migration. Hence, we can decompose population growth into the rate of net incoming internal migration $NIM_{r,t}/POP_{r,t-1}$, the rate of natural population increase $NPI_{r,t}/POP_{r,t-1}$, and in foreign migration, which is further ignored in this chapter.\textsuperscript{16} One major advantage of this decomposition is that the population growth that results from natural population increase is likely to be exogenous to changes in housing supply and labour demand, so that it is a useful

\textsuperscript{14} The reason is that the interactions between population and employment appear to be driven primarily by the labour market, as will be verified in section 4.4.

\textsuperscript{15} Consistent regional time-series for eight industries have been derived from these data by CPB Netherlands Bureau for Economic Policy Analysis.

\textsuperscript{16} Foreign migration rates are small relative to internal migration rates. Furthermore, we would expect this latter variable to be more responsive to local housing and labour market conditions. For foreign migrants, other aspects such as proximity to relatives or people of the same cultural background may be more important.
The number of net internal migrants is smaller than 1% of the regional population in 95% of all observations. The average regional population growth through natural population increase, which results solely from births, deaths and ageing, is about 0.6% per year.

Regional employment $EMP_{r,t}$ is measured as the number of person-years of employees. Its average is about 120,000 full time equivalents, and the average regional growth rate is about 1% per year. As for the regional number of houses and people, the largest part of the variation in levels for this variable occurs at the regional level, while most variation in growth rates is found at the time-series level. Note also that the temporal variation in employment growth is much larger than the variation in growth rates of the housing stock and the population, presumably reflecting a larger sensitivity to the business cycle.

As a consequence of our choice to analyse annual time-series spanning three decades at the regional level, we have only a limited number of explanatory variables at our disposal. In particular, regional house prices and wages are not available for our period of observation. However, we may exploit fairly detailed demographic information to construct determinants of housing demand and labour supply. It is common in the housing markets literature to predict shifts in housing demand that result from demographic changes by multiplying shifts in the age composition of the population with age-specific headship rates in a given base year (cf. DiPasquale and Wheaton, 1996). We adapt this approach in order to obtain estimates of the regional demand for housing units on the basis of the age composition of the regional population. We observe $h^k_t$, the share of people in age group $k$ and period $t$ that are household head, at the national level. The expected number of households is obtained by multiplying these headship rates by the regional age-specific population size, and summing over age groups. We scale this variable to the total regional population $TPOP_{r,t}$, including the age groups (0 - 14) and (75 and older), to obtain the expected regional headship rate $EHR_{r,t} = \sum_k h^k_t \cdot POP^k_{r,t}/TPOP_{r,t}$. As each household will generally demand one house, this variable is likely to be an important determinant of regional housing demand. Table 4.1

---

17 It may be argued that natural population increase is endogenous because the size and composition of the current population is the result of past migration decisions, but net migration is small relative to the size of the average regional population, so this is unlikely to be relevant empirically.

18 There are a few kinks in the demographic time-series because of shifts in municipal boundaries, which explain the outliers in the rate of population growth and natural population increase. In the empirical analysis, we control for these kinks through dummies.

19 This information, provided by Statistics Netherlands, is based on a survey that is held about every four years. We thank Carel Harmsen of Statistics Netherlands for providing us with these data. Age-specific headship rates were interpolated for years in which no survey was held.
indicates that on average, 37% of the regional population is household head, so that the average regional household size in our sample is 2.7 persons.

Changes in the regional population are partly driven by internal migration. Since migrants are on average younger than the indigenous population, changes in the age composition of the population in a region may be endogenous in our model. This issue is avoided by considering only the changes in the age composition that are driven by natural population increase. The variable \( GEHR_{r,t} \), referred to as the growth rate of the expected regional headship rate based on natural population increase, is obtained by evaluating the growth rate of \( EHR_{r,t} \), while substituting \( POP_{r,t-1}^k + NPI_{r,t}^k \) for \( POP_{r,t}^k \). After some rewriting, this yields:

\[
GEHR_{r,t} = \frac{\sum_k h_k^k \left( POP_{r,t-1}^k + NPI_{r,t}^k \right)}{\sum_k h_k^k POP_{r,t-1}^k + TPOP_{r,t-1} + TNPI_{r,t}} - 1.
\] (4.1)

The average growth rate of the expected regional headship rate thus computed equals about 1.2%. This reflects a substantial decrease in the average household size, from a regional average of 3.4 persons in 1973 to 2.4 persons in 2002. The variation in this variable is somewhat smaller than the variation in the housing stock and population, both in the regional and the temporal dimension.

In a similar way, we compute the expected regional participation rate \( ERP_{r,t} \) based on the demographic composition, using national age and gender-specific participation rates. This variable may be an important determinant of regional labour supply. Let \( p_{i,g}^{k,t} \) denote the national participation rate in age group \( k \), gender \( g \) and year \( t \), which is measured by Statistics Netherlands. We then define \( ERP_{r,t} = \sum_{k,g} p_{i,g}^{k,t} POP_{r,t}^{k,g} / POP_{r,t} \), where we sum over age groups between 15 and 64 and scale to the regional potential labour force. The average expected regional participation rate in our sample is 62%. Like changes in the expected headship rate, changes in this variable may be endogenous in our model. Hence, we define \( GEPR_{r,t} \), the growth rate of the expected regional participation rate based on natural population increase, as:
The average growth rate of the expected regional participation rate thus computed equals about 0.3%, which predominantly reflects a rise in female labour participation over the past decades.

Changes in the regional demand for labour are identified by two variables. Information on the industrial composition of regional employment and on industry-specific national employment growth rates $g_i$ is combined to predict regional employment growth with the so-called share $SHA_{r,t} = \sum g_i EMP_{r,t-1} / EMP_{r,t-1}$ (cf. Bartik, 1991).\(^{20}\) Table 4.1 indicates that its variation is significantly smaller than the variation in regional employment growth. Furthermore, the regional accounting data include value added for the same industrial breakdown as for employment. This information is used to construct productivity $PRO_{r,t}$ as the ratio of value added to employment. This variable is a crude proxy for labour productivity, although it reflects the average regional human capital and returns to other factors as well. Under ceteris paribus conditions, labour demand should be higher in regions where labour productivity is higher. The average productivity is 44,000 Euros in current prices per full-time equivalent, and it varies predominantly in the longitudinal dimension.

Unfortunately, we have no obvious exogenous determinants of housing supply, because housing supply in the Netherlands appears to be predominantly a policy outcome, rather than a market outcome (chapter 3). One would ideally like to use proxies for policies that affect regional housing supply, but we have not been able to obtain such variables.\(^{21}\) However, lags in growth of the housing stock may arguably capture some of these supply side considerations. In the first place, certain features of land use regulation in the Netherlands, such as the preservation of the Green Heart area and clustered deconcentration policies, have been highly persistent over the past decades (witness in particular Figure 1.1). Secondly, the procedures for changing land use plans and obtaining permission for new construction are quite lengthy, which may translate into high autocorrelation in a time-series of regional growth of the housing stock as well.

\(^{20}\) The share variable is based on a slightly finer industrial division than the 8 industries observed throughout our period observation, but different divisions were used for the period until 1987 and the period after.

\(^{21}\) As discussed by Quigley and Rosenthal (2005), measurement problems are endemic in the empirical literature on land use regulation, and our study is therefore no exception in this respect.
4.3 Econometric analysis

In empirical work on the interdependency of local population and employment growth in the spirit of Carlino and Mills (1987), it is generally assumed that population and employment in a region converge to their equilibrium values according to a lagged adjustment process. This restricts the dynamics of the interdependency, implying in particular that such specifications cannot distinguish between short-run and equilibrium adjustment effects. While this assumption may be appropriate when changes in regional population and employment over a decade are considered, it is less innocuous in analyses of annual regional time-series. In earlier work on regional population and employment growth in the Netherlands (Vermeulen and Van Ommeren, 2004), we have tested the lagged adjustment specification against a more general econometric model and it was strongly rejected. The Figures 4.2 to 4.4 in our present chapter are also suggestive of interesting differences in the dynamics of adjustment processes. Notably, while the regional share of houses and people develop more or less in line, employment appears to adjust to these variables with a certain lag. Therefore, we do not impose lagged adjustment dynamics on our model, but more general dynamic specifications are estimated instead. As a consequence, we cannot identify our model on exclusion restrictions that follow from lagged adjustment and in each equation, we have to pay careful attention to identification with the use of other instruments. In the remainder of this section, we will present results for each equation separately.

4.3.1 Housing supply

Next to fixed effects for each region and period, our econometric model for the growth rate of the regional housing stock contains mainly demand shifters. Both population and employment growth push up local housing demand, whereas the expected regional headship rate accounts for composition effects with respect to age (see section 4.2). These variables appear in first differences and lagged levels in order to allow for the identification of short and long-run effects respectively. Employment growth $\Delta emp_{r,t}$ is weighted with a spatial weight matrix because labour demand in neighbouring regions may affect the regional demand for housing.

---

22 While the validity of identification on the assumption of lagged adjustment dynamics is seldom tested, Boarnet (1994) reports an overidentifying restrictions test that rejects his exclusion restrictions. This suggests that identification of simultaneous models of local population and employment growth may be a more troublesome issue than is generally acknowledged in the literature.
This approach essentially follows Boarnet (1994). The weight matrix is estimated on interregional commuting flows, as explained in more details in the Appendix. Furthermore, the lagged level of the housing stock is included, because a large regional housing stock relative to the population is likely to reduce new supply. It may also reduce supply because of a long-run upward sloping supply curve of residential land, as predicted by urban economic theory (cf. Fujita, 1989). This yields the following equation, where lower case variables are in logarithms:

\[
\Delta \text{hous}_{r,t} = a_1 + b_1 + \alpha_1 \Delta \text{pop}_{r,t} + \alpha_2 \Delta \text{emp}_{r,t} + \alpha_3 \text{GEHR}_{r,t} + \alpha_4 \text{ehr}_{r,t-1} \\
+ \alpha_5 \text{hous}_{r,t-1} + \alpha_6 \text{pop}_{r,t-1} + \alpha_7 \text{emp}_{r,t-1} + u_{r,t}
\]

(4.3)

The growth rates of population and employment are endogenous in this equation if regions with a high supply of housing attract people and jobs. The variable \( \Delta \text{pop}_{r,t} \) is therefore instrumented with \( NPI_{r,t}/\text{POP}_{r,t-1} \), the population growth rate due to natural increase, which is plausibly exogenous to local housing market conditions. The variable \( \Delta \text{emp}_{r,t} \) is instrumented with the spatially weighted shifters of regional labour demand, \( \text{SHA}_{r,t} \), and \( \text{pro}_{r,t-1} \), and supply, \( \text{GEP}_{r,t} \). We estimate Equation 4.3 under various exogeneity assumptions, while weighting all observations with the average regional size of the housing stock. Results are shown in Table 4.2, where the reported standard errors are robust to heteroskedasticity and autocorrelation up to the second order.

The first specification in this table contains estimation results of Equation 4.3 by Ordinary Least Squares (OLS), hence ignoring potential endogeneity issues. However, using \( NPI_{r,t}/\text{POP}_{r,t-1}, \text{GEP}_{r,t}, \text{SHA}_{r,t}, \) and \( \text{pro}_{r,t-1} \) as instruments, a C statistic wildly rejects orthogonality of \( \Delta \text{pop}_{r,t} \) and \( \Delta \text{emp}_{r,t} \) to the error term, so these estimates reflect conditional correlations rather than causal effects. The second specification instruments both population growth and employment growth using a two-stage least square (TSLS) estimator. The F tests

---

23 We treat all variables in lagged levels as exogenous. This assumption may be challenged when using fixed effects estimation, because it requires the explanatory variables to be strictly exogenous. However, the bias that results from estimating a dynamic panel data model with fixed effects is inversely proportional to the number of periods observed, approximately 30 in our case. We assume that this number is large, so that the bias is ignored.

24 All estimation and testing in this section has been carried out with the IVREG2 command in STATA. See Baum et al. (2003) for a thorough explanation of these procedures.

25 Throughout the analyses in this section, we exclude Flevoland from our observations (see footnote 6), and a number of dummies are included in the model to account for administrative shifts in boundaries of the COROP regions.
of joint significance of the instruments in the first stage equations indicate that they predict these variables reasonably well and an overidentifying restrictions test suggests that they are valid. Regional employment growth is assumed to be exogenous in Specification 3, but the $p$ value associated with a $C$ test of orthogonality of $\Delta emp_{r,t}$ to the error term is 0.06. In section 4.2, we have argued that although our housing supply equation does not include clear exogenous supply shifters, lags of the dependent variable are likely to pick up supply side considerations to some extent. Therefore, Specification 4 includes $\Delta hou_{r,t-1}$ as an explanatory variable, while $\Delta pop_{r,t}$ is instrumented as in Specification 3. The $p$ value associated with a $C$ test of orthogonality of employment growth on the error term is now 0.19, so that treating it as exogenous seems justified.

Consistent with the low price elasticity of housing supply that was reported in chapter 3, the estimation results suggest that growth of the regional housing stock accommodates demand-side variables at most to a limited extent. While the first specification points to a strong conditional correlation between $\Delta pop_{r,t}$ and $\Delta hou_{r,t}$, a 10% increase in the regional population being associated with a 3.5% increase in the housing stock, this effect disappears once we account for the endogeneity of population growth. Notably, no economically or statistically significant impact of this variable exists in the final specification. Since in the next subsection, internal migration will appear to be highly sensitive to regional housing supply, the bias in the OLS estimates is likely to be due to simultaneity. Furthermore, the effect of $\Delta emp_{r,t}$ appears to be negligible, except perhaps in the second specification, although there it is only significant at the 10% level. While the estimated effect of $\bar{GEPR}_{r,t}$ and $ehr_{r,t-1}$ is positive in the first specification, these variables appear mostly with a negative sign in the other specifications. This runs counter to what one would expect if housing supply were demand driven as well.

In the long run, housing supply is negatively affected by the regional density of housing. A 10% increase in $hou_{r,t-1}$ reduces the dependent variable by about 0.4% annually in all specifications. This effect appears to be counterbalanced by a small positive effect of $\bar{emp}_{r,t-1}$ and, in the fourth specification, $pop_{r,t-1}$. Hence, there may be a limited demand-induced effect in the long run. Furthermore, the results point to substantial autocorrelation in growth of the regional housing stock. The large coefficient for the first lag of this variable in
Specification 4 is consistent with the view of housing supply as being determined by long-running planning processes rather than by short-run variations in demand.

Table 4.2
Estimation of the housing supply equation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Spec. 1</th>
<th>Spec. 2</th>
<th>Spec. 3</th>
<th>Spec. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta \text{pop}_{r,t}$</td>
<td>0.350</td>
<td>-0.151</td>
<td>-0.127</td>
<td>0.006</td>
</tr>
<tr>
<td>(0.066)**</td>
<td>(0.082)*</td>
<td>(0.069)*</td>
<td>(0.036)</td>
<td></td>
</tr>
<tr>
<td>$\Delta \text{emp}_{r,t}$</td>
<td>0.008</td>
<td>0.160</td>
<td>0.007</td>
<td>0.013</td>
</tr>
<tr>
<td>(0.008)</td>
<td>(0.084)*</td>
<td>(0.009)</td>
<td>(0.006)**</td>
<td></td>
</tr>
<tr>
<td>$\text{GEHR}_{r,t}$</td>
<td>0.138</td>
<td>-0.302</td>
<td>-0.243</td>
<td>-0.135</td>
</tr>
<tr>
<td>(0.092)</td>
<td>(0.146)**</td>
<td>(0.123)**</td>
<td>(0.081)*</td>
<td></td>
</tr>
<tr>
<td>$\text{ehr}_{r,t-1}$</td>
<td>0.003</td>
<td>-0.079</td>
<td>-0.069</td>
<td>0.015</td>
</tr>
<tr>
<td>(0.017)</td>
<td>(0.022)***</td>
<td>(0.020)***</td>
<td>(0.011)</td>
<td></td>
</tr>
<tr>
<td>$\text{hou}_{r,t-1}$</td>
<td>-0.041</td>
<td>-0.047</td>
<td>-0.045</td>
<td>-0.038</td>
</tr>
<tr>
<td>(0.008)**</td>
<td>(0.011)***</td>
<td>(0.010)***</td>
<td>(0.005)***</td>
<td></td>
</tr>
<tr>
<td>$\text{pop}_{r,t-1}$</td>
<td>-0.003</td>
<td>-0.028</td>
<td>-0.012</td>
<td>0.010</td>
</tr>
<tr>
<td>(0.005)</td>
<td>(0.011)***</td>
<td>(0.007)*</td>
<td>(0.004)***</td>
<td></td>
</tr>
<tr>
<td>$\overline{\text{emp}}_{r,t-1}$</td>
<td>0.015</td>
<td>0.033</td>
<td>0.011</td>
<td>0.009</td>
</tr>
<tr>
<td>(0.005)**</td>
<td>(0.013)***</td>
<td>(0.007)*</td>
<td>(0.004)**</td>
<td></td>
</tr>
<tr>
<td>$\Delta \text{hou}_{r,t-1}$</td>
<td>0.676</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.032)***</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

region dummies (39) incl. incl. incl. incl.  
time dummies (29) incl. incl. incl. incl.  
Observations 1131 1131 1131 1092  
R-squared 0.84  
F(instruments for $\Delta \text{pop}_{r,t}$) 5.71 5.69 6.37  
$p = 0.00$ $p = 0.00$ $p = 0.00$  
F(instruments for $\Delta \text{emp}_{r,t}$) 7.48  
$p = 0.00$  
Hansen J statistic 0.37 3.84 2.14  
$p = 0.83$ $p = 0.28$ $p = 0.54$  

Notes: Reported standard errors are robust to arbitrary heteroskedasticity and autocorrelation up to the second order, * indicates significance at 10% level, ** indicates significance at 5% level and *** indicates significance at 1% level. Observations are weighted to the regional housing stock, averaged over time. The outlier region of Flevoland is left out of our sample. The equation further includes a number of dummies that control for administrative shifts in regional borders, which are not reported in the table.

4.3.2 Net internal migration

Next to the inherent attractiveness of regions, for which we control through fixed effects, net internal migration is assumed to be driven by conditions on local labour and housing markets. Both housing supply and spatially weighted employment enter in levels and first differences in the migration equation, where the latter variable proxies labour demand in regions on an acceptable commuting distance. Furthermore, we include the lagged level of the regional
population in this equation. A large regional population relative to the housing stock and the level of employment is likely to put pressure on local labour and housing markets, and hence reduce net incoming migration. Furthermore, a large population density may make residing in a region more or less attractive, depending on (dis)economies of scale such as social interactions or congestion externalities. This yields the following econometric model for net internal migration in the age group 15 - 64:

\[
NIM_{r,t} / POP_{r,t-1} = c_r + d_t + \beta_1 \Delta hou_{r,t} + \beta_2 \Delta emp_{r,t} \\
+ \beta_3 hou_{r,t-1} + \beta_4 pop_{r,t-1} + \beta_5 emp_{r,t-1} + v_{r,t}.
\] (4.4)

Growth of the regional housing stock is endogenous in this equation to the extent that housing supply is responsive to demand. We instrument \( \Delta hou_{r,t} \) with \( NPI_{r,t} / POP_{r,t-1} \) and \( GEHR_{r,t} \), although the analysis of housing supply has pointed out that this variable is not so responsive to these demand shifters. Hence, we also use \( \Delta hou_{r,t-2} \) as an instrument. Taking the second lag should reduce concerns about endogeneity of this variable, while evidence of the autocorrelation in regional housing supply suggests that it is still a sufficiently strong instrument. Regional employment growth is endogenous in Equation 4.4 to the extent that labour demand responds elastically in the short run to regional shifts in supply. We instrument this variable with the same labour demand and supply shifters as in the housing supply equation. Estimation results for various specifications are shown in Table 4.3, where all observations have been weighted with the regional average of the population.

The first specification of this table shows estimates of Equation 4.4 by OLS, but as a C statistic strongly rejects orthogonality of \( hou_{r,t} \) and \( emp_{r,t} \) on the error term, these results do not allow for a causal interpretation. The variable \( hou_{r,t} \) is instrumented with \( NPI_{r,t} / POP_{r,t-1} \) and \( GEHR_{r,t} \) in Specification 2, and with \( hou_{r,t-2} \) in Specification 3, while \( emp_{r,t} \) is instrumented with \( SHA_{r,t} \), \( pro_{r,t-1} \), and \( GEPR_{r,t} \) in both specifications. As expected, the instruments for \( hou_{r,t} \) in Specification 2 appear to be rather weak, witness the \( F \) statistic on joint significance in a first stage regression. Overidentifying restrictions tests do not reject the exclusion restrictions in either specification. In Specification 4 we instrument
\( \Delta hou_{r,t} \) with \( \Delta hou_{r,t-2} \), while treating \( \Delta emp_{r,t} \) as exogenous. A \( C \) test of orthogonality of \( \Delta emp_{r,t} \) on the error term does not reject this assumption (\( p = 0.26 \)).

Table 4.3

<table>
<thead>
<tr>
<th>Variable</th>
<th>Spec. 1</th>
<th>Spec. 2</th>
<th>Spec. 3</th>
<th>Spec. 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta hou_{r,t} )</td>
<td>0.654</td>
<td>2.652</td>
<td>1.165</td>
<td>1.167</td>
</tr>
<tr>
<td></td>
<td>(0.033)**</td>
<td>(0.843)**</td>
<td>(0.121)**</td>
<td>(0.110)**</td>
</tr>
<tr>
<td>( \Delta emp_{r,t} )</td>
<td>0.009</td>
<td>-0.154</td>
<td>0.139</td>
<td>0.006</td>
</tr>
<tr>
<td></td>
<td>(0.007)</td>
<td>(0.205)</td>
<td>(0.088)</td>
<td>(0.009)</td>
</tr>
<tr>
<td>( hou_{r,t-1} )</td>
<td>0.023</td>
<td>0.151</td>
<td>0.048</td>
<td>0.052</td>
</tr>
<tr>
<td></td>
<td>(0.006)**</td>
<td>(0.056)**</td>
<td>(0.011)**</td>
<td>(0.009)**</td>
</tr>
<tr>
<td>( pop_{r,t-1} )</td>
<td>-0.030</td>
<td>-0.006</td>
<td>-0.041</td>
<td>-0.028</td>
</tr>
<tr>
<td></td>
<td>(0.004)**</td>
<td>(0.024)</td>
<td>(0.009)**</td>
<td>(0.006)**</td>
</tr>
<tr>
<td>( \Delta emp_{r,t} )</td>
<td>-0.003</td>
<td>-0.052</td>
<td>0.013</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td>(0.004)</td>
<td>(0.039)</td>
<td>(0.014)</td>
<td>(0.005)</td>
</tr>
<tr>
<td>Region dummies (39)</td>
<td>incl.</td>
<td>incl.</td>
<td>incl.</td>
<td>incl.</td>
</tr>
<tr>
<td>Time dummies (29)</td>
<td>incl.</td>
<td>incl.</td>
<td>incl.</td>
<td>incl.</td>
</tr>
<tr>
<td>Observations</td>
<td>1131</td>
<td>1131</td>
<td>1053</td>
<td>1053</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.69</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F(instruments for ( \Delta hou_{r,t} ))</td>
<td>2.28</td>
<td>18.06</td>
<td>18.18</td>
<td></td>
</tr>
<tr>
<td>( p = 0.05 )</td>
<td>( p = 0.00 )</td>
<td>( p = 0.00 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F(instruments for ( \Delta emp_{r,t} ))</td>
<td>5.35</td>
<td>6.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( p = 0.00 )</td>
<td>( p = 0.00 )</td>
<td>( p = 0.17 )</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hansen J statistic</td>
<td>3.61</td>
<td>3.53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: Reported standard errors are robust to arbitrary heteroskedasticity and autocorrelation up to the second order, * indicates significance at 10% level, ** indicates significance at 5% level and *** indicates significance at 1% level. Observations are weighted to the regional population, averaged over time. The outlier region of Flevoland is left out of our sample. The equation further includes a number of dummies that control for administrative shifts in regional borders, which are not reported in the table.

Irrespective of the way in which we treat \( \Delta hou_{r,t} \), the results point to a particularly strong short-run relationship between housing supply and internal migration. In the first specification, a 10% increase of the housing stock is associated with a 6.5% increase of the regional population in the age group 15 - 64 through internal migration, conditional on the other explanatory variables. Although a lack of clear supply shifters makes identification of this effect somewhat troublesome, the other specifications suggest that if anything, the OLS estimates have underestimated the impact of \( \Delta hou_{r,t} \).\(^{26}\) In particular, the estimates in Specifications 3 and 4 indicate a unit short-run elasticity of the regional migration rate with

\(^{26}\) The sign of this bias does not point to simultaneity, suggesting that omitted variables play a role.
respect to housing supply. Furthermore, there is evidence of a modest long-run effect through \( hou_{r,t-1} \), as well as a negative impact of population density of about the same magnitude. This suggests that a long-run relationship between these two variables may exist, which is characterised by a unit elasticity, and that internal migration responds to deviations from this relationship. In contrast, the short-run effect of employment is estimated to be small and statistically insignificant in all specifications, while it is even negative in the long-run.

### 4.3.3 Employment growth

The model for regional employment growth contains both demand and supply shifters. Labour demand is expected to be higher in regions with a more favourable industry mix and in regions in which the value added per employee is higher. Supply is incorporated through levels and first difference of the regional population aged between 15 and 64, which constitutes the potential labour force, and of the expected regional participation rate based on demographic composition (see section 4.2). These supply variables are spatially weighted because the availability of labour in regions on an acceptable commuting distance may affect regional employment too. We use a slightly different spatial weight matrix than in the housing supply and migration equations, see again the Appendix for details. Although new construction may generate some employment directly, we do not include this variable in our econometric model, because the residential construction industry is small relative to total employment. The lagged level of employment is included because it may reduce employment growth if it is large relative to the regional population. Furthermore, the density of employment may affect growth through (dis)economies of agglomeration. Under these assumptions, the following equation obtains:

\[
\Delta emp_{r,t} = e_t + f_t + \delta_1 \Delta pop_{r,t} + \delta_2 \text{GEPR}_{r,t} + \delta_3 \text{epr}_{r,t-1} + \delta_4 \text{SHA}_{r,t} + \delta_5 \text{pro}_{r,t-1} + \delta_6 \text{pop}_{r,t-1} + \delta_7 \text{emp}_{r,t-1} + w_{r,t}.
\]  

(4.5)

Our analysis of internal migration suggests that the endogeneity issue of \( \Delta pop_{r,t} \) is likely to be limited, as a reverse impact of employment growth on population growth appears to be virtually absent. Nevertheless, we instrument this variable with both \( \frac{NPI_{r,t}}{POP_{r,t-1}} \) and
and $\Delta hou_{r,t}$. Estimation results are shown in Table 4.4, where the observations have been weighted by the average regional employment.

Table 4.4

<table>
<thead>
<tr>
<th>Variable</th>
<th>Spec. 1</th>
<th>Spec. 2</th>
<th>Spec. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta pop_{r,t}$</td>
<td>-0.311</td>
<td>-0.323</td>
<td>-0.817</td>
</tr>
<tr>
<td>(0.187)*</td>
<td>(0.279)</td>
<td>(0.448)*</td>
<td></td>
</tr>
<tr>
<td>$GEPR_{r,t}$</td>
<td>0.622</td>
<td>0.624</td>
<td>0.685</td>
</tr>
<tr>
<td>(0.157)***</td>
<td>(0.161)***</td>
<td>(0.176)***</td>
<td></td>
</tr>
<tr>
<td>$epr_{r,t-1}$</td>
<td>-0.189</td>
<td>-0.184</td>
<td>-0.004</td>
</tr>
<tr>
<td>(0.139)</td>
<td>(0.158)</td>
<td>(0.204)</td>
<td></td>
</tr>
<tr>
<td>$SHA_{r,t}$</td>
<td>0.507</td>
<td>0.508</td>
<td>0.525</td>
</tr>
<tr>
<td>(0.297)*</td>
<td>(0.298)*</td>
<td>(0.299)*</td>
<td></td>
</tr>
<tr>
<td>$pro_{r,t-1}$</td>
<td>0.013</td>
<td>0.013</td>
<td>0.013</td>
</tr>
<tr>
<td>(0.007)*</td>
<td>(0.007)*</td>
<td>(0.007)*</td>
<td></td>
</tr>
<tr>
<td>$pop_{r,t-1}$</td>
<td>0.173</td>
<td>0.173</td>
<td>0.164</td>
</tr>
<tr>
<td>(0.028)***</td>
<td>(0.029)***</td>
<td>(0.030)***</td>
<td></td>
</tr>
<tr>
<td>$emp_{r,t-1}$</td>
<td>-0.144</td>
<td>-0.144</td>
<td>-0.151</td>
</tr>
<tr>
<td>(0.019)***</td>
<td>(0.019)***</td>
<td>(0.020)***</td>
<td></td>
</tr>
<tr>
<td>region dummies (39)</td>
<td>incl.</td>
<td>incl.</td>
<td>incl.</td>
</tr>
<tr>
<td>time dummies (29)</td>
<td>incl.</td>
<td>incl.</td>
<td>incl.</td>
</tr>
<tr>
<td>Observations</td>
<td>1131</td>
<td>1131</td>
<td>1131</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.51</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F(instruments for $\Delta pop_{r,t}$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>119.40</td>
<td>16.86</td>
<td></td>
</tr>
<tr>
<td>$p = 0.00$</td>
<td>$p = 0.00$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hansen J statistic</td>
<td>1.87</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$p = 0.17$</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Reported standard errors are robust to arbitrary heteroskedasticity and autocorrelation up to the second order, * indicates significance at 10% level, ** indicates significance at 5% level and *** indicates significance at 1% level. Observations are weighted to regional employment, averaged over time. The outlier region of Flevoland is left out of our sample. The equation further includes a number of dummies that control for administrative shifts in regional borders, which are not reported in the table.

The first specification in this table has been estimated by OLS and as expected, a C test that uses $\overline{NPI_{r,t}}/POP_{r,t-1}$ and $\overline{hau_{r,t}}$ as instruments does not reject orthogonality of $\Delta pop_{r,t}$ to the error term ($p = 0.60$). Hence, the relationships in Specification 1 may be interpreted in a causal way. Nevertheless, we present TSLS results for Equation 4.5, instrumenting with both $\overline{NPI_{r,t}}/POP_{r,t-1}$ and $\overline{hau_{r,t}}$ in Specification 2, and with $\overline{NPI_{r,t}}/POP_{r,t-1}$ only in Specification 3. An F test indicates that $\Delta pop_{r,t}$ is well identified in both specifications. Furthermore, the Hansen J test does not reject our exclusion restrictions.
in the second specification, which justifies in particular our exclusion of housing supply in the employment growth model.

The impact of population growth on employment growth appears to be negative in the short run, although the coefficient of $\Delta \text{pop}_{r,i}$ is estimated rather imprecisely. However, a 10% higher lagged level of the population is associated with a 1.7% higher annual growth rate of employment. The impact of the lagged level of employment is negative with about the same magnitude. This suggests that a long-run relationship exists between these variables that is characterised by a unit elasticity, and that any deviation from it is reduced by almost 20% annually through employment growth.

Our other shifter of labour supply, the age composition of the regional population, appears to have a large and statistically significant impact in the short run. Furthermore, the two labour demand shifters have a positive effect as expected. A 10% increase in employment growth expected on the basis of industrial composition is associated with a 5% increase of actual employment. Nevertheless, the impact of these variables is only statistically significant at the 10% level. Thus, labour demand considerations feature less prominently in the equation than supply side variables.

### 4.4 Labour supply or local consumer demand?

The previous section has indicated that employment adjusts to the regional distribution of the population. Throughout this paper, we have assumed that this adjustment process was driven by the labour market. However, regional population growth may also attract jobs because of increased demand for products that are not traded between regions, such as certain retail products and local services. In this section, we perform a rudimentary check of whether it is labour supply that attracts employment, or local consumer demand. Using information about the industrial composition of regional employment, we are able to make a rough distinction between employment in a sector that exports to other regions or countries, and a sector that produces for local consumption.\(^{27}\) If it is consumer demand that causes employment to adjust, then only the latter sector should respond to population changes. On the other hand, if employment in the export sector adjusts to population in the same way, it is more likely that labour supply has been the main reason for equilibrium adjustment.

\(^{27}\) The export sector consists of the industries agriculture and fishery, manufacturing, construction, transport and communications and banks and insurance, and the local sector consists of merchandise, catering and repair, real estate, other services in the tertiary sector and health care and government.
Descriptive statics for employment in the export sector \( EMP_{r,t}^{EX} \), and employment in the local sector \( EMP_{r,t}^{LO} \), are given in Table 4.1. They indicate that the latter sector is somewhat larger, and that it also has a larger temporal variation than employment in the export sector. Figure 4.5 shows the number of people and the number of jobs in the export and local sector as a share of the national total for the Intermediate zone, where population and employment have grown strongest (see section 4.1). The figure indicates that the share of employment in both sectors has grown to a similar extent as the population share, which would suggest that labour supply has driven employment growth.\(^{28}\)

Our equations for \( \Delta emp_{r,t}^{EX} \) and \( \Delta emp_{r,t}^{LO} \) are derived from the model for total regional employment growth in Equation 4.5. The labour supply variables in these equations remain unchanged, but the demand shifters \( SHA_{r,t} \) and \( pro_{r,t-1} \) are calculated for each sector separately. Furthermore, we enter employment growth in the other sector, in order to account for interactions through crowding out and linkage effects (cf. Thurston and Yezer, 1994). Finally, the lagged level of employment now distinguishes \( emp_{r,t-1}^{EX} \) and \( emp_{r,t-1}^{LO} \). This yields the following equations:

\(^{28}\) It is noteworthy though, that the share of employment in the local sector has grown steadily with the population share, whereas employment in the export sector has started picking up only in the 1980s.
\[
\Delta emp_{r,t}^{EX} = e_{r,t}^{EX} + f_{r,t}^{EX} + \delta_1^{EX} \Delta pop_{r,t} + \delta_2^{EX} \Delta emp_{r,t}^{LO} + \delta_3^{EX} \overline{GEPR}_{r,t} + \delta_4^{EX} \overline{PR}_{r,t-1} + \\
+ \delta_5^{EX} SHA_{r,t} + \delta_6^{EX} pr_{r,t-1} + \delta_7^{EX} pop_{r,t-1} + \delta_8^{EX} emp_{r,t-1}^{EX} + \delta_9^{EX} emp_{r,t-1}^{LO} + w_{r,t}^{EX}, \tag{4.6}
\]

\[
\Delta emp_{r,t}^{LO} = e_{r,t}^{LO} + f_{r,t}^{LO} + \delta_1^{LO} \Delta pop_{r,t} + \delta_2^{LO} \Delta emp_{r,t}^{EX} + \delta_3^{LO} \overline{GEPR}_{r,t} + \delta_4^{LO} \overline{PR}_{r,t-1} + \\
+ \delta_5^{LO} SHA_{r,t} + \delta_6^{LO} pr_{r,t-1} + \delta_7^{LO} pop_{r,t-1} + \delta_8^{LO} emp_{r,t-1}^{EX} + \delta_9^{LO} emp_{r,t-1}^{LO} + w_{r,t}^{LO}. \tag{4.7}
\]

Although the previous section has indicated that \( \Delta pop_{r,t} \) may be treated as exogenous in the equation for total employment growth, we instrument it with \( \overline{NPI}_{r,t}/\overline{POP}_{r,t-1} \) in these sector-specific models. Furthermore, \( \Delta emp_{r,t}^{LO} \) may be endogenous in the equation for \( \Delta emp_{r,t}^{EX} \) and \( \Delta emp_{r,t}^{EX} \) may be endogenous in the equation for \( \Delta emp_{r,t}^{LO} \). Hence, these variables are instrumented with the sector specific labour demand shifters. Estimation results are shown in Table 4.5, where the observations have been weighted by the average total regional employment. Specifications 1 and 3 show OLS results for the export and the local sector respectively, while Specifications 2 and 4 have been estimated by TSLS.

We focus first on the labour supply variables, which should have no role in the export sector if local consumer demand would drive employment growth. Most importantly, a 10% higher regional population increases \( \Delta emp_{r,t}^{EX} \) by about 2%, and \( \Delta emp_{r,t}^{LO} \) by 1 to 1.5%, depending on the estimation method. The elasticity with respect to \( \overline{GEHR}_{r,t} \) is also larger in the export sector, although this is at least partially offset by a negative impact of the lagged level of this variable. These findings appear to be at odds with the hypothesis that jobs have followed people because of markets for local consumption goods, at least at our spatial level of aggregation. Furthermore, we find that employment growth in the other sector has a negative effect once we take account of its endogeneity, and that sector specific share variables appear to be stronger predictors in these models than the aggregate share in Equation 4.5. These two observations are consistent with the view that employment in one sector may grow at the expense of the other sector, but that aggregate employment is determined by the regional supply of labour. It should be noted, however, that the overidentifying restrictions tests cast doubt on the validity of our instruments, so that these results should be interpreted with caution.
Table 4.5
Employment growth in the local and export sector

<table>
<thead>
<tr>
<th>Variable</th>
<th>Export sector</th>
<th>Local sector</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Spec. 1</td>
<td>Spec. 2</td>
</tr>
<tr>
<td>$\Delta pop_{r,t}$</td>
<td>-0.038</td>
<td>-0.976</td>
</tr>
<tr>
<td></td>
<td>(0.229)</td>
<td>(0.598)</td>
</tr>
<tr>
<td>$\Delta emp_{r,t}^{LO}$</td>
<td>0.138</td>
<td>-0.236</td>
</tr>
<tr>
<td></td>
<td>(0.038)**</td>
<td>(0.278)</td>
</tr>
<tr>
<td>$\Delta emp_{r,t}^{EX}$</td>
<td></td>
<td>0.137</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.049)**</td>
</tr>
<tr>
<td>$\overline{GEPR}_{r,t}$</td>
<td>0.786</td>
<td>1.063</td>
</tr>
<tr>
<td></td>
<td>(0.225)**</td>
<td>(0.305)**</td>
</tr>
<tr>
<td>$\overline{epr}_{r,t-1}$</td>
<td>-0.886</td>
<td>-0.699</td>
</tr>
<tr>
<td></td>
<td>(0.225)**</td>
<td>(0.289)**</td>
</tr>
<tr>
<td>$SHA_{r,t}^{EX}$</td>
<td>0.895</td>
<td>0.769</td>
</tr>
<tr>
<td></td>
<td>(0.253)**</td>
<td>(0.278)**</td>
</tr>
<tr>
<td>$pro_{r,t-1}^{EX}$</td>
<td>0.017</td>
<td>0.018</td>
</tr>
<tr>
<td></td>
<td>(0.007)**</td>
<td>(0.008)**</td>
</tr>
<tr>
<td>$SHA_{r,t}^{LO}$</td>
<td></td>
<td>1.176</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.280)**</td>
</tr>
<tr>
<td>$pro_{r,t-1}^{LO}$</td>
<td>0.019</td>
<td>0.010</td>
</tr>
<tr>
<td></td>
<td>(0.029)</td>
<td>(0.030)</td>
</tr>
<tr>
<td>$\overline{pop}_{r,t-1}$</td>
<td>0.197</td>
<td>0.229</td>
</tr>
<tr>
<td></td>
<td>(0.033)**</td>
<td>(0.055)**</td>
</tr>
<tr>
<td>$\overline{emp}_{r,t-1}^{EX}$</td>
<td>-0.120</td>
<td>-0.127</td>
</tr>
<tr>
<td></td>
<td>(0.015)**</td>
<td>(0.017)**</td>
</tr>
<tr>
<td>$\overline{emp}_{r,t-1}^{LO}$</td>
<td>0.036</td>
<td>-0.037</td>
</tr>
<tr>
<td></td>
<td>(0.017)**</td>
<td>(0.054)</td>
</tr>
</tbody>
</table>

region dummies (39) incl. incl. incl. incl.
time dummies (29) incl. incl. incl. incl.
Observations 1131 1131 1131 1131
R-squared 0.50 0.32

F(instruments for $\overline{pop}_{r,t}$) 13.81 5.78
$p = 0.00$ $p = 0.00$
F(instruments for $\overline{emp}_{r,t}^{LO}$) 6.66 $p = 0.00$
F(instruments for $\overline{emp}_{r,t}^{EX}$) 8.48 $p = 0.00$
Hansen J statistic 4.18 2.56 $p = 0.04$ $p = 0.11$

Notes: Reported standard errors are robust to arbitrary heteroskedasticity and autocorrelation up to the second order, * indicates significance at 10% level, ** indicates significance at 5% level and *** indicates significance at 1% level. Observations are weighted to regional employment, averaged over time. The outlier region of Flevoland is left out of our sample. The equation further includes a number of dummies that control for administrative shifts in regional borders, which are not reported in the table.
4.5 Conclusions and discussion

Our empirical analysis identifies housing supply as a driving force behind regional development in the Netherlands. Although a strong correlation exists between regional growth of the number of houses and residents, housing supply does not turn out to be responsive to either population or employment growth once the endogeneity of these variables is taken into account. In contrast, net internal migration appears to be highly sensitive to changes in the regional housing stock, while a growing number of jobs has a negligible impact. We find that the long-run relationship between the number of people and jobs in a region is mainly restored through changes in employment growth. So regional housing supply induces population growth and in the long run, this increase in labour supply is matched by demand.

The prominence of housing supply in our findings may appear surprising as, with the notable exception of Greenwood (1980) and Greenwood and Stock (1990), it is ignored in most of the empirical literature on the interdependency of local population and employment growth. However, as recently observed by Glaeser et al. (2006), the response of local labour supply to shifts in demand depends crucially on the price elasticity of housing supply. These authors show that in US cities where new construction is restricted by severe land use controls, shifts in labour demand push up house prices and wages, but employment is largely unaffected. It follows that in such cities, employment is basically determined by the size of the housing stock. Since housing supply conditions are highly restrictive in the Netherlands as well, our findings are perfectly in line with this work.

Our results are also consistent with strands of the literature on internal migration and regional labour markets. Notably, the importance of housing market conditions for internal migration has been reported in various earlier studies (cf. Gabriel et al., 1992, for the US, Jackman and Savouri, 1992, Cameron et al., 2006, for the UK, and Antolin and Bover, 1997, for Spain). The absence of any significant effect of employment growth on internal migration in our analysis is in line with the mixed performance of regional wage and unemployment variables in the literature (cf. Greenwood, 1993). Furthermore, labour is known to be rather immobile between regions, in particular in most European countries (cf. Eichengreen, 1993, Decressin and Fatas, 1995, OECD, 2005). To the extent that regional labour supply adjusts to demand through internal migration, such findings suggest that the wage elasticity of regional labour supply is limited. On the other hand, the regional demand for labour should be elastic with respect to wages, in particular in a small and open economy such as the Netherlands.
Although short-run elasticities are generally found to be below unity (cf. Bartik, 1991), it seems plausible that the long-run employment response to a shift in wages is substantially larger (cf. Muth, 1990). If regional labour demand is much more sensitive to wages than supply, one should expect to find that employment adjusts to the regional distribution of people rather than the other way around.

Unfortunately, the demand and supply elasticities in labour and housing markets that enable us to interpret the results in terms of underlying economic behaviour could not be estimated, because regional house prices and wages were not available. As a consequence of our choice to analyse annual time-series spanning three decades at the regional level, the range of other explanatory variables at our disposal was also limited. While this has made the identification of causal relationships challenging, this disadvantage of our empirical strategy has been traded off against the possibility to analyse both short and long-run effects in the interdependency of our endogenous variables. Furthermore, the regional panel structure of the data has allowed us to control fully for national trends as well as for all time-invariant regional determinants of growth rates of housing, population and employment.

In interpreting our results, a few other caveats should also be borne in mind. In the first place, labour demand and supply are heterogeneous. Although aggregate employment has been found to adjust to the regional supply of labour, the inclination to follow jobs is likely to rise with educational attainment. If housing supply restricts the total number of workers in a booming region, higher educated workers may outbid the lower educated for housing. The existence of significant differences in educational attainment between regions in the Netherlands supports this view. In the second place, it should be realised that our results have been obtained in a setting which is characterised by restrictive land use regulation and generally tight housing market conditions. It makes sense to expect that new construction attracts workers and jobs in a region where housing supply is highly restricted. However, this finding should not be taken as a recipe for growth enhancement in lagging peripheral regions, where the size of the housing stock by and large reflects demand conditions.

29 However, since housing supply in the Netherlands is almost fully inelastic with respect to prices, adding house prices to the housing supply equation in our analysis would not add a lot of explanatory power in all likelihood. Wage bargaining at the national level reduces regional wage differentials, which are therefore believed to be rather small. Hence, the consequences of omitting wages in the equations for net internal migration and employment growth may be limited as well. The most unfortunate omission in our analysis is probably the absence of house prices in the migration equation. Nevertheless, this loss may also be limited because about half of the housing stock is rental housing, to which various regulations apply. The regional variation in controlled rents is particularly small in the social sector, where rationing is the dominant allocation mechanism. Moreover, it should be realised that house prices and wages are endogenous to regional housing and labour market outcomes. Including these variables would require an extension of the system of three equations with another two equations, thus rendering identification even more complicated.
So why has job growth over the past decades been weaker in the Dutch Randstad area than in surrounding regions? While our analysis points to the role of lagging housing supply, it does not provide explicit evidence of the role of land use planning. However, there is ample evidence that policies such as preservation of the Green Heart area and other Buffer zones between the four large Dutch cities have imposed significant and binding restrictions on new residential development (see chapters 1 and 3). Thus, land use planning has altered the spatial pattern of economic activity in the Netherlands and through economies of agglomeration, it has probably left its marks on productivity too. In other words, there may be substance to the OECD claim that housing market institutions partly explain lagging labour productivity in the Randstad area.

Appendix: Accounting for interregional commuting

In the empirical analysis in sections 4.3 and 4.4, we use weight matrices in order to account for interregional commuting. The matrix $W^1$ applied to employment related variables in the equations for housing supply and internal migration, whereas $W^2$ is applied to population related variables in the model for employment growth.

For the housing supply and internal migration equations, we compute $\overline{EMP}_{i,s} = \sum_j w^1_{ij} EMP_{j,s}$, where $w^1_{ij}$ may be interpreted as the probability that someone working in region $j$ lives in region $i$. Multiplying this probability by employment in region $j$ we get the expected number of people working in $j$ that live in region $i$, and summing over employment regions yields the expected working labour force in region $i$. For the employment growth equation, we compute $\overline{POP}_{i,s} = \sum_j w^2_{ij} POP_{j,s}$, where $w^2_{ij}$ may be interpreted as the probability that someone living in region $j$ would work in region $i$. Multiplying this probability by population in region $j$ we get the expected number of people living in region $j$ that potentially work in region $i$ (the probability is also applied to people that do not participate). The sum over population regions yields weighted potential labour supply for production in region $i$.

In order to avoid endogeneity of the weight matrices, the elements $w^1_{ij}$ and $w^2_{ij}$ are computed using predicted, rather than observed commuting patterns. We predict commuting flows with following gravity model:
The variable $COM_{ij,t}$, the number of commuters living in region $i$ and working in region $j$, is explained by origin and destination-specific effects $A_i$ and $B_j$, and a distance decay function $F(d_{ij})$. None of the parameters depends on the period $t$, we use the variation in commuting flows over time only to obtain more precise estimates. The distance decay function is parameterized as follows:

$$F(d_{ij}) = \exp(\alpha D_i^1 + \beta D_i^2 + \gamma d_{ij}).$$

So we assume that the number of commuters between two regions decreases exponentially with distance. The dummy variable $D_i^1$ corrects for commuting within regions and the dummy variable $D_i^2$ measures border effects. In order to account for regional heterogeneity, we allow all coefficients to vary with the region of living. The parameters $\alpha_i$, $\beta_i$ and $\gamma_i$ are estimated on 1992 – 2002 commuting data from the Dutch Labour Force Survey. Distance between two regions is measured by the average number of car kilometres travelled by commuters, because the largest share of interregional commuters travels by car.\(^{30}\)

The probabilities $w_{ij}^1$ and $w_{ij}^2$ are computed using the predicted commuting flows from model A.2 in the following way:

$$w_{ij}^1 = \frac{AF(d_{ij})}{\sum_i AF(d_{ij})}, \quad w_{ij}^2 = \frac{BF(d_{ij})}{\sum_i BF(d_{ij})}.$$ (4.10)

Note that $\sum_i w_{ij}^1 = 1$ and $\sum_i w_{ij}^2 = 1$, so that these weights can indeed be interpreted as probabilities.\(^{31}\)

Finally, we remark that commuting costs have decreased over time, so that our estimates based on the period 1992 - 2002 overestimate interregional commuting in earlier

\(^{30}\)Estimation results are available upon request.

\(^{31}\)The matrices $W^1$ and $W^2$ differ from the spatial weight matrices that are common in spatial econometric applications (Anselin, 1988) in two perspectives. Firstly, numbers on the diagonal are smaller than one, because diagonal flows have been included in the commuting model. Secondly, computing the required probabilities amounts to column normalization, instead of the usual procedure of row normalization.
years. However, as only about 20% of the work force lives and works in different COROP regions nowadays, the impact on our results of ignoring this is probably limited.
Chapter 5

Compensation of regional unemployment in housing markets

This chapter provides further evidence of the close relationship between regional housing and labour markets, which is a prerequisite for the claim that land use regulation affects local labour market outcomes. While we have focussed predominantly on the Netherlands in previous chapters, the present chapter shows that a close relationship between regional housing and labour markets also exists at the European level. More specifically, the puzzle that inspired this research is the coexistence of a wage curve and persistent regional unemployment differentials. For a variety of countries and time periods, Blanchflower and Oswald (1994) consistently find wages to be 1 percent lower in regions where unemployment is 10 percent up (cf. Groot et al., 1992, Card, 1995, Baltagi and Blien, 1998, Bell et al., 2002). Their analysis contradicts a long-held belief that wages compensate for regional unemployment differentials, which originates from Harris and Todaro (1970) and Hall (1970, 1972). If workers in high-unemployment regions earn lower wages, one would expect regional differences in unemployment to disappear through labour migration in a relatively short period of time. However, it is well established that regional unemployment differentials may be large and very persistent, particularly in European countries (cf. OECD, 2000, 2005, Overman and Puga, 2002).

Two explanations exist for this persistence, which do not necessarily exclude each other. In the first place, barriers to interregional migration, plausibly related to housing market institutions, seem to be substantial (cf. OECD, 2005). For instance, the lack of a sizeable private rental sector may be a major culprit in countries such as the UK, in which owner-occupation is subsidized and a substantial part of the rental market is regulated (cf. Minford et al., 1987, and Hughes and McCormick, 1987). However, as some regional unemployment patterns have persisted for several decades, costly adjustment alone does not seem to be a satisfactory explanation. An alternative view is that regional differences in unemployment

---

1 This chapter is based on Vermeulen and Van Ommeren (2006b, 2008b).

2 For instance, OECD (2005) reports that 80 percent of European regions which were in the upper quintile of the unemployment distribution in 1993 were still in the upper quintile of the unemployment distribution in 2003. For North America, this is about 65 percent.
reflect an equilibrium outcome, implying the existence of compensating differentials. More specifically, workers may accept less favourable labour market conditions in regions that offer a high level of amenities, or they may be compensated through cheaper housing.\(^3\)

Results in the literature on internal migration are generally consistent with the hypothesis that wages and unemployment are compensated in house prices. A somewhat indirect piece of support for an equilibrium interpretation is the famous Lowry paradox, which observes that flows between a pair of regions tend to cancel out almost fully, leaving net flows relatively small (cf. Greenwood, 1975). Furthermore, a number of studies indicate that the sensitivity of interregional migration to wage and unemployment differentials is moderate, in the sense that restoring equilibrium on labour markets through this mechanism would take a long time (cf. Pissarides and McMaster, 1990, OECD, 2000, 2005). Analyses that include regional house prices tend to find that this variable affects migration patterns significantly (cf. Jackman and Savouri, 1992, Cameron and Muellbauer, 1998, Cameron \textit{et al.}, 2006). Notably, Cameron \textit{et al.} (2006) find that the role of variables for local labour market conditions increases significantly after appropriately controlling for local housing market conditions. Perfectly in line with this literature, we have shown in chapter 4 that internal migration in the Netherlands is mainly driven by housing supply, and not by employment growth.

A more immediate evaluation of compensating differentials is provided in the so-called Quality of Life literature, which is surveyed in Gyourko \textit{et al.} (1999). Building on the seminal work by Rosen (1979) and Roback (1982), this literature considers the capitalization of amenity differentials and local fiscal conditions in wages and land rents. A typical result is that wages are lower and house prices are higher in regions that are more amenable, for instance through a more agreeable climate.\(^4\) However, although the interrelatedness of local labour and land markets features centrally in the theoretical framework by Roback (1982), most studies estimate reduced form hedonic wage and house price equations. As a consequence, they do not provide direct evidence on the compensation of local labour market conditions in house prices. Furthermore, focussing predominantly on consumer amenities and local public finance, this literature pays only limited attention to local productivity shifters.

\(^3\) Note that, even if mobility is costly for the average resident, the compensating differentials hypothesis only requires that workers are willing to arbitrage on regional utility differentials at the margin. This makes the existence of barriers to migration an even less plausible explanation for long-run regional disparities.

\(^4\) Marston (1985) is one of the few studies in this literature that focuses on compensation of regional unemployment rates, rather than wages. He finds that high unemployment areas tend to be those with attractive climates and amenities.
Evidence of regional compensating differentials is particularly scarce in Europe. There are a few studies for individual countries such as Norway (Carlsen, 2000), Russia (Berger et al., 2003) and the UK (Blackaby and Murphy, 1995). Cheshire and Magrini (2006) investigate the impact of amenity variables on population growth at the EU level. However, we are not aware of any study to date that considers compensating differentials in housing markets at this level. The main reason for this void in the literature is probably the scarcity of comparable house price data for a sufficiently large sample of European countries. Nevertheless, the persistence of regional unemployment differentials, and the continued policy effort by EU and national governments to reduce them, suggest a particular interest for such an analysis.

This chapter uses the Urban Audit to analyse the existence of compensating differentials in housing markets in Europe. The data have been put together by Eurostat in order to enable comparisons of quality of life between cities in the EU (European Commission, 2004). Next to information on a host of amenities, the Urban Audit contains house prices per square meter, unemployment and income per capita for 142 cities over 12 countries. As we show in section 4.2 of this chapter, the raw data reveal a strong negative correlation between house prices and unemployment over the entire sample, and in each individual country. The estimated capitalization of unemployment and income differentials in house prices appears to be insensitive to the inclusion of amenity controls. Under plausible assumptions on the budget share of housing and the wage curve elasticity, the income loss in high-unemployment regions turns out to be fully offset by a reduction in the local cost of living.

An inherent problem of most capitalization studies is the appropriate control for heterogeneity of workers, jobs and houses (cf. Gyourko et al., 1999). Furthermore, ignoring this heterogeneity may lead to structural biases, as more productive workers tend to sort into more productive locations (Combes et al., 2004). In section 4.3, we address this issue by analysing a Dutch housing demand survey. This micro-level dataset contains a broad range of variables that allow to control for both housing and labour heterogeneity. Moreover, we may now estimate the relationship between unemployment and house prices separately for several subgroups of the population with different levels of education. The compensation of regional income and unemployment differentials turns out to be of the same order of magnitude as in the Urban Audit data.

The theoretical framework underlying this research is presented in the next section. We derive an estimable relationship between land prices and unemployment, income and
amenities in an urban economic setting, following Hoehn et al. (1987). Our model solves for a partial equilibrium in the land market, in which city-level unemployment and income are given. This mirrors our choice to include the same variables directly in the empirical specification, rather than performing an instrumental variables analysis. Necessarily, our interpretation of the negative correlation between unemployment and house prices as a compensating differential is conditional on the appropriateness of these simplifications. However, we argue that under plausible assumptions about the relationship between productivity and the size of the local labour force, a structural interpretation of this correlation is indeed justified.

5.1 Theoretical framework

As our main empirical analysis uses city-level data, it makes sense to derive the model specification in an urban economic framework. A further motivation is that an upward sloping supply curve of land, which is a prerequisite for any capitalization in land prices, obtains naturally in the monocentric model. Hoehn et al. (1987) is one of the few studies in the Quality of Life literature that takes explicit account of city structure, and our approach follows their basic setup (see also Blomquist et al., 1988). Hence, we consider a system of open cities. Migration into or out of a particular city occurs until household utility is the same in each city. As a consequence, all city-level variation in labour market perspectives and amenities has to be compensated somehow in equilibrium. It turns out that by solving for a single open city within this system, we may derive a relationship between land prices and wages, unemployment and the level of amenities.

We consider households that are homogeneous, except for their employment status. In the monocentric model, all jobs are assumed to be located in a Central Business District (CBD) of negligible size. Employed households provide a unit of labour, while incurring

---

5 However, compensation of regional unemployment in housing markets is consistent with a variety of assumptions on productivity and institutions. For instance, in Vermeulen and Van Ommeren (2006b) we provide a general equilibrium model in which productivity differentials result from heterogeneity in the regional endowment of fixed capital, and unemployment results from wage bargaining at the national level. Alternatively, Blanchflower and Oswald (1994) derive an efficiency wage model with exogenous productivity differentials, in which equilibrium results from congestion in a regional facility. Their model may be easily adapted to a model with capitalization in housing markets.

6 In chapter 3, we found that the differential land rents that underlie this long-run upward sloping supply curve have not played a major role in explaining the rise of aggregate house prices in the Netherlands, but this does not imply that they are unimportant at the city level as well.

7 Land use for production is ignored in this setting, although it may be included quite easily. In that case, both firms and households bid for land. Presumably, the bid rent curve of firms is steeper than the bid rent curve of
The earnings net of commuting costs of a household at a distance of \( x \) from the CBD are \( w - t x \), where \( w \) is the price of a unit of labour and \( t \) is the transport costs per unit of distance. When a household is unemployed, there is no interest in living close to the CBD. This would suggest an equilibrium in which unemployed households live near the city fringe. However, as we are not primarily interested in the distribution of household types within cities, we make a number of simplifying assumptions. All households experience random unemployment spells, while facing the same unemployment risk upon entering a city. Moving costs prohibit adjustment of the location within the city after changes in the employment status. As a result, households will base their location choice upon the expected income net of commuting costs \( Y(x) = (1-U)(w-tx) \), where \( U \) denotes the city-level unemployment rate. Furthermore, they fully insure on perfect financial markets against income loss during unemployment spells, so that expected and actual income net of commuting costs are the same in each period.

We may then specify the consumer problem as follows. Household utility \( V(z,s,A) \) is a well-behaved function that increases in the consumption of a numeraire good \( z \) and land \( s \). Furthermore, it comprises a city-specific amenity \( A \), which is modelled as an exogenously supplied pure local public good. Without loss of generality, utility is assumed to be increasing in \( A \). The budget constraint is \( z + r(x)s = Y(x) \), where \( r(x) \) denotes the land price at location \( x \).

By solving \( V(z,s,A) = v \) for \( z \), we obtain \( Z(s,v,A) \), the amount of numeraire goods that is necessary to achieve utility level \( v \) with lot size \( s \) and amenity level \( A \). The bid rent function \( \psi(Y(x),v,A) \) is defined as the maximum price a household with expected income net of transport costs of \( Y(x) \) is willing to bid for a unit of land at location \( x \). It is found by performing the following optimization problem:

\[
\psi(Y(x),v,A) = \max_s \frac{Y(x) - Z(s,v,A)}{s}. \tag{5.1}
\]
The argument that maximizes this expression is called the bid-max lot size $s(Y(x), v, A)$. In equilibrium, rents $r(x)$ and lot sizes $s$ are equal to these functions within the city boundary (cf. Fujita, 1989).

For the interpretation of this model, it is useful to consider the comparative static properties of the bid rent function. By application of the envelope theorem, it follows that

$$\frac{\partial \psi(Y(x), v, A)}{\partial Y} = \frac{1}{s(Y(x), v, A)}.$$  

As the bid-max lot size is nonnegative, the bid rent is increasing in the household income net of commuting costs. By application of the chain rule, we also see that it is increasing in wages, and decreasing in unemployment. In a similar manner, we obtain

$$\frac{\partial \psi(Y-tx, v, A)}{\partial A} = -(1/s(Y(x), v, A))\frac{\partial Z(s, v, A)}{\partial A}.$$  

It is easily seen that $\frac{\partial Z(s, v, A)}{\partial A} < 0$, the higher the city amenity level, the less numeraire goods have to be consumed for households to be equally well-off, so that the bid rent function is increasing in the amenity level. So, as might be expected, people bid and pay more for land in cities with favourable labour market conditions or attractive amenities.

Most capitalization studies use the average land rent in a city as a measure for compensation in housing markets. However, in our framework, the bid rent at the CBD, $\psi(Y(0), v, A)$, may be considered as an appropriate measure for compensation in urban land markets. Cities that are attractive in terms of amenities or labour market opportunities are likely to be relatively large, ceteris paribus. This means that the household that pays the average land rent is located further away from the CBD than a similar household in a less attractive, smaller city. Hence, this household pays partly for living in an attractive city through incurring larger commuting costs. For households located near the CBD, differentials in wages, unemployment and amenities are capitalized in the land market and not in commuting costs. The bid rent concept makes sure that other households in the city attain the same level of utility as these households.

In order to obtain an estimable specification of the bid rent at the CBD, we choose a log linear functional form for utility, so $V(z, s, A) = \alpha \log(z) + \beta \log(s) + \gamma \log(A)$. As is quite common in the urban economic literature, we impose that $\alpha + \beta = 1$. The expression may then be derived by solving the optimisation problem in Equation 1 for this utility function (cf. Fujita, 1989, page 16):

$$\log(\psi(Y(0), v, A)) = \frac{\alpha}{\beta} \log(\alpha) + \log(\beta) + \frac{1}{\beta} \log((1-U)w) + \frac{\gamma}{\beta} \log(A) - \frac{v}{\beta}, \quad (5.2)$$
where we have substituted expected income at the CBD for \( Y(0) \). Note that this relationship between land prices, labour market perspectives and amenities is based on partial equilibrium on land markets.

In a general equilibrium, wages and unemployment result from the interaction of demand and supply on labour markets, and of institutions or other distortions. In our framework, in which each household is assumed to provide one unit of labour, total supply is found by integrating population density over the city surface. Hence, it is seen that labour supply is driven by the same variables as land rents in Equation 5.2. Variation in labour demand may stem from differences in productivity, related to factors such as accessibility to national and international input and output markets, or the availability of natural resources. These productivity differentials may be either weakened or reinforced by (dis)economies of scale. Similarly, amenity differentials may affect productivity through scale economies. The extent to which productivity differentials translate into either wage or unemployment differentials may depend on institutions, such as centralized wage bargaining. So in a more general setting, the relationship between labour market conditions and land prices may be characterised by simultaneity. Nevertheless, there are reasons to believe that the reverse effect of land prices on labour market conditions are limited. As shown in for instance Hoehn et al. (1987), such effects run through the elasticity of productivity with respect to the scale of the local labour force. If this elasticity is zero, then labour market perspectives are independent of the amenability of a city, of its size and of land prices. In this case, wages are determined by the production technology and the price of the output that is sold on (inter)national markets. The empirical literature on agglomeration economies suggests that scale effects in labour productivity are quite limited. For the elasticity of wages with respect to employment density, Rosenthal and Strange (2004) report a range of elasticities from 0.04 to 0.08 in their survey of predominantly US studies. Combes et al. (2004) find an even lower elasticity using French data. This suggests that, as a first order approximation, it is reasonable to assume constant returns to scale in labour productivity, so that wages and unemployment in Equation 5.2 may be justifiably taken as exogenous.\(^9\)

---

\(^9\) This is formally shown in Hoehn et al. (1987) for perfectly competitive labour markets, in which there is no unemployment by definition. It seems fairly innocuous to assume that unemployment is independent of amenities, land prices and city size too, if the city-level production function exhibits constant returns in labour.
5.2 Analysis of the Urban Audit

The Urban Audit has been set up under the authority of the European Commission as a "response to growing demand for an assessment of the quality of life in European towns / cities, where a significant proportion of European Union citizens live" (European Commission, 2004, p. 5). The data consist of a rich set of indicators of the quality of life in cities, collected by various national and local statistical agencies. Eurostat coordinates the data collection process, performs some checks on their quality and consistency, and distributes them through its website. Hence, the Urban Audit provides a unique opportunity to test for the existence of compensating differentials at the European level.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition in the Urban Audit</th>
</tr>
</thead>
<tbody>
<tr>
<td>house price</td>
<td>Average price for a house per m2</td>
</tr>
<tr>
<td>unemployment</td>
<td>Unemployment rate</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>GDP per head</td>
</tr>
<tr>
<td>med. household income</td>
<td>Median disposable annual household income</td>
</tr>
<tr>
<td>days rain</td>
<td>Number of days of rain per year</td>
</tr>
<tr>
<td>hours sun</td>
<td>Average number of hours of sunshine per day (averaged over a year)</td>
</tr>
<tr>
<td>warmest month *</td>
<td>Average temperature of warmest month (in degrees Kelvin)</td>
</tr>
<tr>
<td>coldest month *</td>
<td>Average temperature of coldest month (in degrees Kelvin)</td>
</tr>
<tr>
<td>rainfall</td>
<td>Rainfall (litre/m2) in the reference year</td>
</tr>
<tr>
<td>theatre seats pc.</td>
<td>Number of theatre seats per capita</td>
</tr>
<tr>
<td>tourist stays pc.</td>
<td>Number of tourist overnight stays in registered accommodation per year per resident population</td>
</tr>
<tr>
<td>crime rate pc.</td>
<td>Total number of recorded crimes per 1000 population</td>
</tr>
<tr>
<td>city radius *</td>
<td>Own computation using surface, defined as the total land area (km2) according to cadastral register</td>
</tr>
<tr>
<td>population density</td>
<td>Population density - total resident population per square km</td>
</tr>
<tr>
<td>education class 3</td>
<td>Proportion of the resident population qualified at levels 3-4 ISCED</td>
</tr>
<tr>
<td>education class 4</td>
<td>Proportion of the resident population qualified at levels 5-6 ISCED</td>
</tr>
</tbody>
</table>

Notes: Variables marked with a * are transformation from original Urban Audit data. We have transformed the variables "warmest month" and "coldest month" from degrees Celsius to degrees Kelvin (absolute temperature) in order to avoid problems when taking logarithms. The city radius was based on information about the surface, assuming a circular shape.
**Table 5.2**

Sample properties

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Number of obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
<td>Between</td>
<td>Within</td>
<td></td>
<td>city country</td>
</tr>
<tr>
<td>house price</td>
<td>1266.48</td>
<td>748.51</td>
<td>550.18</td>
<td>401.42</td>
<td>86.69</td>
</tr>
<tr>
<td>unemployment</td>
<td>11.06</td>
<td>5.53</td>
<td>4.15</td>
<td>3.73</td>
<td>3.30</td>
</tr>
<tr>
<td>GDP pc.</td>
<td>21604.44</td>
<td>14515.00</td>
<td>13711.04</td>
<td>7775.51</td>
<td>1436.00</td>
</tr>
<tr>
<td>median household income</td>
<td>15457.21</td>
<td>4329.26</td>
<td>6578.97</td>
<td>1509.73</td>
<td>5467.00</td>
</tr>
<tr>
<td>days rain</td>
<td>167.81</td>
<td>43.27</td>
<td>40.30</td>
<td>26.48</td>
<td>32.00</td>
</tr>
<tr>
<td>hours sun</td>
<td>4.82</td>
<td>1.24</td>
<td>0.91</td>
<td>0.63</td>
<td>3.10</td>
</tr>
<tr>
<td>warmest month</td>
<td>20.04</td>
<td>2.79</td>
<td>2.48</td>
<td>1.42</td>
<td>14.80</td>
</tr>
<tr>
<td>coldest month</td>
<td>2.00</td>
<td>4.44</td>
<td>4.01</td>
<td>2.00</td>
<td>-7.10</td>
</tr>
<tr>
<td>rainfall</td>
<td>736.95</td>
<td>234.67</td>
<td>138.35</td>
<td>209.33</td>
<td>137.40</td>
</tr>
<tr>
<td>share green space</td>
<td>44.34</td>
<td>20.52</td>
<td>22.87</td>
<td>14.70</td>
<td>0.90</td>
</tr>
<tr>
<td>theatre seats pc.</td>
<td>10.29</td>
<td>7.94</td>
<td>5.83</td>
<td>6.85</td>
<td>1.00</td>
</tr>
<tr>
<td>tourist stays pc.</td>
<td>2.15</td>
<td>1.63</td>
<td>1.27</td>
<td>1.21</td>
<td>0.01</td>
</tr>
<tr>
<td>crime rate pc.</td>
<td>81.24</td>
<td>46.43</td>
<td>45.17</td>
<td>25.41</td>
<td>12.70</td>
</tr>
<tr>
<td>city radius</td>
<td>8.20</td>
<td>3.84</td>
<td>2.55</td>
<td>3.30</td>
<td>2.76</td>
</tr>
<tr>
<td>population density</td>
<td>2297.28</td>
<td>1909.08</td>
<td>1052.60</td>
<td>1801.50</td>
<td>44.90</td>
</tr>
<tr>
<td>education class 3</td>
<td>42.67</td>
<td>8.91</td>
<td>9.58</td>
<td>3.89</td>
<td>22.40</td>
</tr>
<tr>
<td>education class 4</td>
<td>16.23</td>
<td>5.33</td>
<td>4.09</td>
<td>4.36</td>
<td>6.20</td>
</tr>
</tbody>
</table>

Notes: We have reported sample properties for the variables “warmest month” and “coldest month” in degrees Celsius for readability.
The cities in our sample are defined on the basis of administrative boundaries. Excluding observations for which essential information is missing, we have a sample of 142 cities over 12 countries. Data in our sample do not refer to the same year of observation for each country, but all refer to some year in the period 1999 - 2003. Table 5.1 shows a list of variables used in our analysis, plus the formal Eurostat definitions. Central variables for our purpose are the average house price per square meter, the unemployment rate and income, as measured either by GDP per capita or by the median disposable household income. As proxies for the quality of life, we observe a range of climate variables. Other proxies for amenability are the proportion of land in green space, the number of theatre seats per capita, the number of tourist overnight stays per capita and the crime rate. We use the city radius, population density and educational composition as additional controls in a sensitivity analysis. Sample properties of all variables are given in Table 5.2, distinguishing variation within and between countries. This table indicates that a significant part of the variation of most variables occurs within countries. For house prices and unemployment, this accounts for almost half of all variation.

*Figure 5.1: Scatter plot of city house prices (vertical) to unemployment (horizontal)*
Given the data collection procedure, it seems almost unavoidable that for most variables, a significant share of the observations is missing. For the controls, we have on average about 110 observations in 10 countries. In our empirical analysis, we deal with this problem by replacing missings in controls by country means, or by sample means if we have no observations for the country. It has been verified that our main results are insensitive to this procedure.

Figure 5.1 shows a scatterplot of the logarithms of house prices and unemployment, relative to national averages. It suggests a strong negative relationship between the two variables. As a first order approximation, a linear model would seem to fit the data well. Furthermore, the relationship appears to be quite homogeneous over countries. Hence, it seems reasonable to pool the data, and estimate a model for compensating differentials in housing markets at the European level.

In section 5.1 we have derived an estimable equation for land prices at the CBD from an urban partial equilibrium model. In order to make this equation consistent with our data, we have to make a few adaptations. From Equation 5.2, the following econometric model may be obtained:

\[
\log(HP_i) = C_{\text{country}} + \alpha_U \log(U_i) + \alpha_w \log(w_i) + \alpha_A \log(A_i) + \epsilon_i, \tag{5.3}
\]

where subscript \(i\) indicates the city, \(C\) is a country-specific fixed effect, and \(\epsilon\) is an idiosyncratic component that is assumed to be orthogonal to the explanatory variables. Rather than the price of land near the CBD, we use the average house price per square meter in the city, \(HP\), as a dependent variable. This should attenuate our estimates with respect to the true compensating differential, as in our model, households in attractive cities pay partly through higher commuting costs. The country fixed effects pick up the constants in Equation 5.2, as well as the national utility level. We include unemployment and wages separately, imposing less structure on the model than in Equation 5.2. The wage differential is proxied by gross domestic product per capita or by median household income, for which we have less

---

10 It should be borne in mind that cooperation of the national and local statistical agencies occurs solely on a voluntary basis, these institutions are not legally required to comply.
11 The correlation between unemployment and house prices is negative for all countries in our sample.
12 Furthermore, we measure prices, rather than (yearly) rents, but what matters conceptually is the user cost of housing. However, user costs may be (approximately) derived from house prices through multiplication with interest rates minus expected capital gains. These variables are largely determined at the national level. Hence, the difference between house prices and rents is accounted for by including country dummies.
observations. As controls for the amenability of a city, we experiment with various sets of variables.

Before presenting estimation results, we briefly elaborate on the interpretation of the labour market indicators. Section 5.1 has made clear that equilibrium land prices depend on both wages and unemployment. However, income variables, as observed in our data, provide only crude proxies for the wage. The wage curve literature has shown that wages relate negatively to unemployment. This implies that wage differentials may be picked up by the unemployment variable as well. Because the extent to which this happens is a priori unclear, we interpret both income and unemployment as indicators of local labour market conditions. In order to compare the coefficients of these variables over various specifications in a consistent manner, we consider the total derivative of house prices with respect to unemployment:

\[
\frac{d \log(HP)}{d \log(U)} = \frac{\partial \log(HP)}{\partial \log(U)} + \frac{\partial \log(w)}{\partial \log(U)} \frac{\partial \log(HP)}{\partial \log(w)} = \alpha_U + \varepsilon_{\text{wage curve}} \alpha_w.
\] (5.4)

This equality indicates that the total effect of unemployment, interpreted now as a proxy for local labour market conditions, equals a direct effect through the unemployment indicator, and an indirect effect through wages. We would expect the latter effect to increase with the quality of proxies for wage differentials. Following Blanchflower and Oswald (1994), we will assume a wage curve elasticity \( \varepsilon \) of -0.1 in our interpretation of estimation results.

Estimates for several specifications of Equation 3 are presented in Table 5.3. Specification 1 includes only unemployment and per capita income. As expected, the relationship between house prices and these two variables is strong, and highly statistically significant. A 10 percent increase in unemployment is associated with 4.3 percent less expensive housing, while a 10 percent increase in income is associated with 3.3 percent more expensive housing. Following Equation 5.4, the total effect of a 10 percent unemployment increase would be a fall in house prices of almost 5 percent. With a budget share of housing ranging between 0.2 and 0.3, this means that the associated fall in the city-level price index is in the order of magnitude of 1 percent.\(^{13}\) As wages should fall by 1 percent too, the wage loss

\(^{13}\) This assumes that there is no city-level variation in the prices of other consumption goods.
associated with increased unemployment appears to be almost fully offset by a cost-of-living effect.\(^\text{14}\)

Table 5.3

Regressions of house prices on city characteristics (Urban Audit)

<table>
<thead>
<tr>
<th>Specification</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>unemployment</td>
<td>-0.434</td>
<td>-0.439</td>
<td>-0.452</td>
<td>-0.454</td>
<td>-0.310</td>
<td>-0.218</td>
</tr>
<tr>
<td></td>
<td>(0.085)**</td>
<td>(0.092)**</td>
<td>(0.104)**</td>
<td>(0.108)**</td>
<td>(0.093)**</td>
<td>(0.059)**</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.328</td>
<td>0.342</td>
<td>0.289</td>
<td>0.193</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.099)**</td>
<td>(0.101)**</td>
<td>(0.093)**</td>
<td>(0.073)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>median household income</td>
<td>1.209</td>
<td>1.298</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.159)**</td>
<td>(0.158)***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>days rain</td>
<td>0.001</td>
<td>-0.001</td>
<td>0.019</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.129)</td>
<td>(0.104)</td>
<td>(0.107)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>hours sun</td>
<td>-0.337</td>
<td>-0.392</td>
<td>-0.341</td>
<td>-0.034</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.144)**</td>
<td>(0.166)**</td>
<td>(0.149)**</td>
<td>(0.077)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>warmest month</td>
<td>3.113</td>
<td>2.320</td>
<td>2.286</td>
<td>4.717</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.555)</td>
<td>(3.133)</td>
<td>(3.132)</td>
<td>(1.261)**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>coldest month</td>
<td>2.434</td>
<td>2.724</td>
<td>1.934</td>
<td>4.469</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.780)</td>
<td>(2.127)</td>
<td>(2.541)</td>
<td>(1.770)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rainfall</td>
<td>-0.016</td>
<td>-0.005</td>
<td>0.002</td>
<td>0.083</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.061)</td>
<td>(0.072)</td>
<td>(0.062)</td>
<td>(0.036)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>share green space</td>
<td>0.089</td>
<td>0.148</td>
<td>-0.052</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.081)</td>
<td>(0.116)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>theatre seats pc.</td>
<td>-0.022</td>
<td>-0.016</td>
<td>0.017</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.051)</td>
<td>(0.043)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>tourist stays pc.</td>
<td>0.037</td>
<td>0.045</td>
<td>0.110</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.028)</td>
<td>(0.032)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>crime rate pc.</td>
<td>0.053</td>
<td>-0.009</td>
<td>-0.038</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.053)</td>
<td>(0.066)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>capital dummy</td>
<td>0.145</td>
<td>0.042</td>
<td>0.231</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.076)*</td>
<td>(0.060)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>city radius</td>
<td></td>
<td></td>
<td>0.102</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.093)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>population density</td>
<td></td>
<td></td>
<td>0.123</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(0.041)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>country effects</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
</tr>
<tr>
<td>Observations</td>
<td>142</td>
<td>142</td>
<td>142</td>
<td>142</td>
<td>76</td>
<td>76</td>
</tr>
<tr>
<td>Countries</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.91</td>
<td>0.91</td>
<td>0.92</td>
<td>0.92</td>
<td>0.84</td>
<td>0.88</td>
</tr>
</tbody>
</table>

Notes: Standard errors robust to heteroskedasticity and correlation within countries in parenthesis. * indicates significance at 10 % level, ** indicates significance at 5 % level and *** indicates significance at 1 % level. All variables are in logarithms. All regressions include country specific fixed effects, for which we do not report the associated coefficients. In Specifications 1 to 4, we use various sets of controls for the quality of life in cities. The final two specifications use median disposable household income rather than GDP per capita. For this variable we have less observations.

\(^{14}\) It has been argued in Dumond et al. (1999) that the cost-of-living differential is overestimated when the consumption bundle is fixed. Presumably, households in expensive cities substitute some housing consumption for consumption of other goods. This attenuates the compensating differential.
In Specifications 2 to 4, we add various groups of controls for the quality of life in cities. Next to unemployment and per capita income, Specification 2 contains several climate variables. Clearly, such variables are exogenous, and they appear to play a large role in similar studies for the US. In Specification 3, we add the share of green space, the number of theatre seats, the number of tourist overnight stays and the crime rate as further proxies for city amenability. These amenities have a man-made character, so that there is a risk of endogeneity. In addition, we include a dummy for capital cities. Two indirect controls for the attractiveness of a city are its radius and population density, which are included in Specification 4.

The coefficients for unemployment and income turn out to be almost insensitive to these model extensions. The point estimate for the effect of income per capita is slightly lower in Specifications 3 and 4, due to a correlation between income and some of the man-made amenities. However, the differences in the estimates are barely statistically significant, and the total compensating differential is virtually unaffected. The estimates of climate effects are rather homogeneous over Specifications 2 to 4. The only statistically significant variable is the average number of hours sunshine, but the sign is unanticipated. This suggests that climate plays a limited role in explaining regional differences within European countries. The man-made amenities in Specifications 3 and 4 do not have statistically significant effects either, and some of them appear with unexpected sign. The capital city dummy in Specification 3 is significant at the 10 percent level, but it becomes insignificant when controlling for city size and population density. The coefficient for population density is statistically significant, but its interpretation is dubious because this variable is endogenous in our theoretical framework, as is the city size. Overall, the evidence of capitalization of quality of life indicators in house prices is surprisingly limited, but for our purposes, the main point is that the estimated compensating differential for local labour market perspectives is robust to their inclusion.

A potential explanation for this anomaly is that housing in places with more hours of sunshine is likely to be less capital intensive. People may invest more in housing quality in locations in which the climate is less agreeable. Controlling for income and amenity variables we would expect a negative effect of the city radius, as in large cities, people pay partly through commuting costs rather than through house prices. The statistical insignificance of this variable may indicate that any bias from considering average house prices rather than house prices near the CBD is limited.

We have performed several sensitivity analyses on the results in this table. In the first place, we have verified that they are unaffected if we drop observations for which one of the control variables is missing, although this makes our point estimates less precise. In Figure 5.1, most outliers are cities in Romania. We have verified that our results are robust to dropping Romania from our sample, although the point estimate of the compensating differential for local labour market perspectives is robust to their inclusion.
In our theoretical framework, we have considered differences in unemployment and wages between cities. Wages are proxied by GDP per capita in specifications 1 to 4, which may be a rather crude approximation. For a subset of cities, we observe median household income, which probably approximates wage differentials better. Specifications 5 and 6 are versions of Specifications 1 and 3 respectively, in which GDP per capita is replaced by this variable. As expected, the estimated effect of unemployment is smaller in both specifications than in Specifications 1 to 4, whereas the effect of the wage proxy is substantially larger. However, making use of Equation 5.4 and a -0.1 wage curve elasticity, these effects add up to a similar compensating differential. Furthermore, the estimated effects of unemployment and median household income are insensitive to the inclusion of control variables in Specification 6. Coefficients for the control variables in this specification are comparable to our findings in Specification 3, although the effects of tourism and whether the city is a capital are somewhat larger, and statistically significant at the 1 percent level.

To what extent may the correlation between house prices and local labour market conditions be interpreted as a causal relationship? In the previous section, we have argued that under plausible assumptions about the elasticity of city-level productivity with respect to the size of the labour force, the issue of reversed causality is of limited importance. In spite of a rather broad set of controls for the quality of life in cities, our estimates may still be biased because of omitted variables. For instance, the level of unobserved local public goods may be higher in cities with more favourable labour market conditions, so that we overestimate the capitalization of unemployment and income in house prices. On the other hand, if labour market conditions are partly compensated in unobserved amenity differentials, the compensating differential in house prices is likely to be underestimated. Furthermore, we have not accounted in this analysis for heterogeneity in housing quality and the labour force, which may lead to structural biases in the presence of sorting. Bearing in mind these caveats, the estimates in Table 5.3 suggest that house prices adjust to local labour market conditions in such a way, that the income loss due to higher unemployment rates and lower wages is almost fully counterbalanced by a fall in the local cost-of-living.

differential decreases slightly. Thirdly, we have included measures for the level of educational attainment of the city population to Specification 4, but this did not affect results either.
5.3 Analysis of a housing demand survey

It has been well recognized in the hedonic pricing and Quality of Life literatures that a failure to properly account for heterogeneity may seriously bias estimates of compensating differentials (cf. Gyourko et al., 1999). We cannot rule out the possibility that this criticism applies to our analysis of the Urban Audit. For example, it may be that workers in high-wage cities spend more on the quality of their house. This would increase the capital intensity per unit of surface. If the price of capital does not vary with city labour market conditions, then we would overestimate the compensating differential. Furthermore, empirical evidence suggests that high-skilled workers sort into cities with a productivity advantage (cf. Combes et al., 2004). The omission of controls for the composition of the workforce may then imply that disparities in local labour market perspectives are not properly measured. In order to deal with these issues at least rudimentarily, we perform an additional empirical analysis using micro data.

The Dutch Housing Demand Survey (Woning Behoefte Onderzoek) is conducted about every 4 years to inform policy makers in the field of housing and spatial planning. We consider the 2002 wave of this survey, which contains about 30,000 cases in the owner-occupier sector. A wide range of issues are covered. Next to the self-reported house value, there is an abundance of controls for housing quality, and we also observe wages and a number of worker characteristics. Regional unemployment rates for three levels of educational attainment are obtained from the 2002 wave of the Dutch Labour Force Survey (Enquête Beroepsbevolking). As in chapter 4, the regional division we consider is the European NUTS3 level, or so-called COROP regions, of which there are 40 in the Netherlands. These regions generally contain one larger city, and a number of adjoining municipalities. The borders have been chosen as to minimise interregional commuting.

By regressing house prices on characteristics and regional dummies, we may estimate the regional component to house prices. Observed characteristics of housing include space-related attributes such the type of house (free standing, semi detached, etc.), the number of rooms and availability of a garden, as well as other attributes such as the period of construction and availability of central heating. Assuming that land is the only input in the housing production process with a price that varies over regions, the regional component may be interpreted as the land price differential. In Figure 5.2, we plot this land price differential.
to the (centred) regional unemployment differential. It suggests a negative relationship between unemployment and land prices, although the correlation is weaker than in Figure 5.1.

\[ \log(HP_{i,r}) = C + \alpha U_i + \sigma w \log(w_r) + X \beta + \epsilon_{i,r}, \]  

\[ (5.5) \]

where \( HP_{i,r} \) denotes the self-reported value of the house for household \( i \), living in region \( r \). The observed quality characteristics of the house, contained in the vector \( X_r \), are now included, but we have omitted controls for amenability. The micro data allow us to use improved proxies for regional wage differentials. We use the average household income, which compares to the median household income in the Urban Audit analysis, as well the average wage and the average quality-controlled wage. The regional component to wages is

\[ \text{The limited number of regions in our present sample would make proper identification of quality of life variables problematic. Our analysis of the Urban Audit data suggests that controlling for amenities does not significantly affect the estimated compensation of labour market perspectives in housing markets.} \]
obtained by regressing hourly wages of full-time working men on age dummies (five), educational attainment (five classes) and region dummies.

Table 5.4
Analysis of a Dutch housing demand survey

<table>
<thead>
<tr>
<th>Specification</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
<th>(6)</th>
</tr>
</thead>
<tbody>
<tr>
<td>unemployment</td>
<td>-0.286</td>
<td>-0.254</td>
<td>-0.162</td>
<td>-0.200</td>
<td>-0.079</td>
<td>-0.200</td>
</tr>
<tr>
<td></td>
<td>(0.061)***</td>
<td>(0.076)***</td>
<td>(0.074)**</td>
<td>(0.057)***</td>
<td>(0.073)</td>
<td>(0.079)**</td>
</tr>
<tr>
<td>average household income</td>
<td>1.332</td>
<td>2.321</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.425)***</td>
<td>(0.265)***</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>uncontrolled wage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.270</td>
<td>1.613</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(0.618)***</td>
<td>(0.577)***</td>
</tr>
<tr>
<td>wage controlled for characteristics housing quality</td>
<td>no</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
</tr>
<tr>
<td>Observations</td>
<td>36385</td>
<td>29698</td>
<td>29698</td>
<td>29698</td>
<td>29698</td>
<td>36385</td>
</tr>
<tr>
<td>regions</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.02</td>
<td>0.37</td>
<td>0.39</td>
<td>0.43</td>
<td>0.41</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Notes: Standard errors robust to heteroskedasticity and correlation within regions in parenthesis, * indicates significance at 10 % level, ** indicates significance at 5 % level and *** indicates significance at 1 % level. All variables are in logarithms.

Estimation results for various specifications of Equation 5.2 are shown in Table 5.4. In Specification 1, we regress house prices on regional unemployment rates only, while ignoring wages and house characteristics. In Specifications 2 to 5 we control for observed quality characteristics of the house, while considering different proxies for the wage level. Specification 6 contains unemployment and the regional component to wages controlled for worker characteristics, while ignoring heterogeneity in housing quality. For Specifications 2 to 5, we do not report coefficients for the housing quality characteristics, but they are generally highly statistically significant, and of the expected sign and magnitude.

Consistent with Figure 5.2 and our analysis in the previous section, Specifications 1 and 2 point to a negative relationship between unemployment and house prices that is highly statistically significant. The coefficient appears to be almost unaffected by controlling for characteristics of the house, which suggests that any biases due to the omission of housing quality controls in the Urban Audit analysis may be limited as well. When we include the average household income, the coefficient is of similar magnitude as in Specifications 5 and 6.

---

19 We account for the fact that the regional variables have substantially less degrees of freedom than the house characteristics by using an estimator of the covariance matrix that is robust to heteroskedasticity and correlation between observations within regions (cf. Moulton, 1986).

20 A comparison of Specifications 5 and 6, making use of Equation 5.4, similarly suggests that the omission of housing quality controls does not bias the estimate of the compensating differential.
of Table 5.3. When wage proxies of increasing quality are included, their coefficients rise and the unemployment coefficients fall. This is consistent with our interpretation that the unemployment variable picks up regional wage disparities through the wage curve, to the extent that these disparities are not properly accounted for by wage proxies. Making use again of Equation 5.4, we note that the implied compensating differential is similar over these specifications, and of the same order of magnitude as found in our Urban Audit analysis.

Table 5.5

<table>
<thead>
<tr>
<th>Education group specific regressions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specification</td>
</tr>
<tr>
<td>unemployment lower educated</td>
</tr>
<tr>
<td>wage lower educated</td>
</tr>
<tr>
<td>unemployment medium educated</td>
</tr>
<tr>
<td>wage medium educated</td>
</tr>
<tr>
<td>unemployment higher educated</td>
</tr>
<tr>
<td>wage higher educated</td>
</tr>
<tr>
<td>aggregate unemployment</td>
</tr>
<tr>
<td>wage controlled for characteristics</td>
</tr>
<tr>
<td>housing quality</td>
</tr>
<tr>
<td>Observations</td>
</tr>
<tr>
<td>regions</td>
</tr>
<tr>
<td>R-squared</td>
</tr>
</tbody>
</table>

Notes. Standard errors robust to heteroskedasticity and correlation within regions in parenthesis, ** indicates significance at 10 % level, ** indicates significance at 5 % level and *** indicates significance at 1 % level. All variables are in logarithms. Coefficient of the constant is not reported. Specifications 1, 3 and 5 are regressions of education group specific house prices on education group specific controls. Specifications 2, 4 and 6 are regressions of education group specific house prices on aggregate controls. In Specification 5, unemployment is unobserved for one region.

We have further accounted for heterogeneity by estimating compensating differentials for separate education groups. This allows us to examine the potential criticism that our results are due to sorting of workers. We may verify for instance whether lower educated workers in high-income cities pay more for their house, even if they live in less expensive neighbourhoods. The groups distinguished are lower educated workers (only primary schooling or lower vocational training), medium educated workers (medium vocational
training), and higher educated workers (higher vocational training or a university degree). For each group, we estimate two specifications of Equation 5.5, using either education group specific unemployment and wage rates, or aggregate unemployment and quality controlled wage rates. Results are shown in Table 5.5.

Specifications 1, 3 and 5, which use education-specific unemployment and wage rates, confirm the capitalization in house prices paid by these specific groups. Comparing the coefficients using Equation 5.4, it appears that the extent of compensation rises slightly with the level of educational attainment, as does the propensity to migrate (cf. Greenwood, 1975). However, it appears to be somewhat smaller than the extent of compensation implied by the estimates reported in Table 5.4. When we include aggregate unemployment and quality controlled wage rates in Specifications 2, 4 and 6, the implied compensating differential is larger. This may indicate that our previous findings are driven to some extent by composition effects in both house prices and labour market indicators. Another interesting finding is that unemployment coefficients fall with educational attainment, whereas wage coefficients rise. This suggests that for the lower educated, labour market perspectives are better captured by unemployment than by wage differentials, which would be consistent with the view that rigidities, such as the minimum wage and centralized wage bargaining, are more relevant for this group. Overall, our results indicate that heterogeneity and sorting in labour and housing markets are potentially relevant issues, which may require further research. Nevertheless, the order of magnitude of the capitalization of unemployment and wages in house prices we find for specific education groups is still consistent with the hypothesis that workers in regions with less favourable labour market conditions are fully compensated in housing markets.

### 5.4 Conclusions

This chapter builds empirical support for the hypothesis that regional unemployment differentials are compensated in housing markets. It is the first to analyse city variation in house prices at the European level, using a dataset that allows to control for a host of amenity variables. The capitalization of unemployment and income suggests that house price levels fully offset the wage loss in regions with less favourable labour market conditions. Hence,
workers in such regions are not necessarily worse off, and regional unemployment differentials may be sustained in equilibrium.  

Our interpretation of the strong negative correlation between unemployment and house prices as a compensating differential is conditional to a number of qualifications. The possibility that house prices affect local labour market conditions, rather than reversely, may be ruled out if one is willing to assume that city production exhibits constant returns to scale in labour. Furthermore, our estimates may suffer from omitted variables, in particular with respect to heterogeneity of households and housing, although a corroborative analysis of a Dutch housing demand survey suggests that the order of magnitude of the estimated compensating differential is affected only to a limited extent by such omissions.

The results in our chapter offer a perspective on the persistence of regional unemployment differentials, and on the limited interregional mobility of labour in Europe. The existence of substantial compensation in housing markets suggests that regional discrepancies may reflect an equilibrium outcome, even if wages correlate negatively to unemployment in the long run. This begs the question why high-unemployment regions should receive national government or EU support. Currently, the EU allocates funds to regions on the basis of local unemployment and GDP per capita, precisely the two variables that we have shown to capitalize in house prices. To the extent that regional support is motivated by equity considerations, the allocation may therefore considerably improve by taking cost-of-living differentials into account.

---

21 Our results may be compared to findings in the US literature. The empirical work in this chapter consistently suggests that unemployment should be interpreted as an indicator for local labour market conditions. In less distorted labour markets, such conditions are likely to be proxied better by wages or income. Given the conventional believe that labour market rigidities play a relatively large role in Europe, it may make more sense to consider compensation of regional wage differentials in the US. Empirical evidence for this country appears to be consistent with the capitalization of wages in cost-of-living differentials. In particular, Dumond et al. (1999) find that nominal wage differentials between cities are much larger than appropriately estimated real wage differentials. Furthermore, in spite of relatively high rates of labour mobility, the persistence of regional disparities is far from negligible in the US (cf. OECD, 2005). This suggests that, at least to some extent, comparable mechanisms are at work as in Europe.

22 Obviously, the omission of other types of variables may have marked our findings as well. For instance, we have ignored the rental sector in our analysis. In some countries, a significant share of the population lives in social rental housing, for which prices are not fully determined in the market. For such groups, the extent of compensation may be different, although house prices and rent levels may be expected to be positively correlated in general.

23 Going one step further, one may even consider the evidence as support for the existence of a long-run nominal wage curve. Our estimates indicate that the large effect of unemployment on house prices should be interpreted as a reflection of lower wages through the wage curve, if regional wage differentials are not properly accounted for. In other words, if a long-run nominal wage curve would not exist, the estimated coefficient for unemployment would be too large to make sense economically in such specifications. The existence of a long-run nominal wage curve is confirmed empirically in Bell et al. (2002).

24 Similarly, Kaplow (1995) addresses the question to what extent transfers should reflect cost-of-living differentials. He argues that, as a benchmark case, transfers should be made proportional, to the extent that the
price differentials are not driven by amenity differentials. Glaeser (1998) considers the same issue in a more formal framework. He finds that some degree of indexing is probably desirable, but that the current extent of indexing of US transfers is too high.
Chapter 6

Urban expansion or clustered deconcentration? An applied welfare economic analysis of growth controls and the foundation of satellites

Greenbelts or urban growth boundaries (UGB’s) are applied in cities all over the world, and their popularity appears to be on the rise both in Europe and the US. The upward effect that such policies exert on house prices in restricted areas is well documented in the economic literature, but much less attention has been paid to their impact on surrounding regions. In locations that are sufficiently close substitutes, households that are somehow tied to the area will push up housing demand. This may give rise to scattered leapfrogging development, or boost growth in nearby communities. For example, the much debated UGB around Portland, Oregon, appears to have spurred population growth in nearby Clark County (Jun, 2004). To the extent that the jobs held by these households remain in the restricted area, growth controls will also push up intercity commuting. For instance, new jobs in the San Francisco Bay Area, where rigid land use restrictions exist, are increasingly held by people living at the outskirts of the region (cf. Ogura, 2005).

The question that concerns us in this chapter is, how the diversion of households from a restricted city to a nearby satellite should be evaluated from a welfare economic perspective. This diversion may be argued to be a harmful side-effect of growth controls, because it raises the total residential land consumption in the region, as well as the number of intercity commuters and the externalities they impose. Furthermore, the costs of providing infrastructure and other local public goods and services may be higher for the resulting pattern of spatial development (cf. Cho, 1997). On the other hand, the widespread popularity of urban containment policies suggests that people attach value to living in a small city, and this idea is

---

1 This chapter is based on Vermeulen and Rouwendal (2008).
2 While an early form of greenbelt regulation existed already in sixteenth century London (Evans, 1999), several European countries nowadays conduct policies that foster the development or preservation of compact cities. Moreover, at the EU level, the pursuit of compact cities is expressed as an explicit policy goal (European Commission, 1999). The proliferation of urban growth boundaries in the US is documented by Nelson and Duncan (1995). Amongst cities in other parts of the world that have been subject to greenbelt regulation are Moscow (Russia), New Delhi (India), Ottawa (Canada), Seoul (Korea) and Tianjin (China) (Cho, 1997).
3 See Fischel (1990) for an early survey or chapters 2 and 3 for more recent references.
also reflected in a theoretical literature on growth controls.\footnote{For instance, Engle \textit{et al.} (1992) argue that population growth may affect welfare in a city negatively because of congestion costs, pollution externalities and rising costs of public goods provision, while Brueckner (1990) considers a direct negative impact of the number of residents in a city on their wellbeing. These type of models have become known in the theoretical growth control literature as \textit{amenity-creation} models, see Brueckner (1999) and chapter 2 of this thesis for surveys.} Under such preferences, an equilibrium in which households are divided over a main city and one or more satellites may yield higher welfare than an equilibrium in which they all live in one big city.

Such considerations seem to have motivated so-called \textit{clustered} or \textit{focussed deconcentration} policies in the 1960s and 1970s. Against a background of substantial negative externalities in large cities and rising suburbanization, governments of various European countries fostered household growth in especially designated and sometimes newly founded satellite towns. The accommodation of growth in a limited number of satellites was preferred to unregulated sprawl, because this allowed for an efficient scale in terms of the supply of local public services and infrastructure, while limiting landscape fragmentation. Typical examples are the UK \textit{New Towns}, the French \textit{Pôles de Croissance} and the Dutch growth centres or \textit{Groeikernen} (cf. Anas \textit{et al.}, 1998). These policies are of interest today, because they are still reflected in land use patterns and policies in Europe – as aptly illustrated for the Netherlands in Figure 1.1, while the popularity of European style urban growth boundaries and greenbelts appears to be on the rise in the US.\footnote{For instance, Irwin and Bockstael (2004) report on the effects of a development clustering policy in Maryland, US, which concentrates development and generates preserved open space.}

In order to evaluate the diversion of households from a restricted city to a nearby satellite, we develop and calibrate a concise general equilibrium model. The distortion that motivates government intervention in land markets is a negative externality of the geographical size of a city, as experienced by its residents. This assumption is similar to the negative population externality that is common in the growth controls literature, but it relates more directly to land use and the role of open space. As all jobs are located in the central business district of the main city, residents of the satellite incur higher commuting costs, but they enjoy living in a city that is smaller. Furthermore, we allow for differences in the attractiveness of both cities, reflecting the level of cultural and historical amenities. This may be particularly relevant in a European setting, in which such amenities contribute significantly to the quality of life in the major ancient cities, while they are generally absent in newly found satellites. We show that taxing the conversion of land to urban use in both cities is a first-best policy response to the city size externality. Founding a satellite is desirable if the gain in surplus exceeds fixed costs that are incurred, modelled here as the costs of intercity
infrastructure provision. In an extension, the optimal foundation of multiple satellites is considered.

\textit{Figure 6.1: Current and permitted future development in Amsterdam (left) and Almere (right)}

Our analysis is applied to the Dutch capital of Amsterdam and nearby Almere. Founded in the 1970s on land regained from the sea, this town was designated as a growth centre that should accommodate population growth from the capital.\textsuperscript{6} The restrictiveness of present land use controls is substantial in Amsterdam and negligible in Almere, which may be inferred from the gap between house prices at the urban fringe and total marginal production costs. Moreover, future plans by the national and local governments consist of strict containment of Amsterdam and a major expansion of Almere. This is illustrated in Figure 6.1, which indicates areas that are presently built-up in these cities by grey zones, and areas in which new construction has been approved of by the national and local governments by black

\textsuperscript{6} An overview of land use regulation in the Netherlands is provided in the first two chapters of this thesis. See Faludi and Van der Valk (1990) for an in depth discussion of the Dutch growth centre policy.
It shows that residential construction in Amsterdam is mainly limited to infill
development, whereas large plots for new construction are available in Almere. 8

We calibrate the model in such a way that present land use restrictions are optimal by
assumption. This turns out to require a city size externality that is so large that in order to
internalize its effect, households in Amsterdam should spend about 10% of their income on
(capitalized) development taxes, while they spend about 6% on land net of these taxes. The
model may be used to evaluate plans for future residential development. For instance, its
comparative static properties indicate how the optimal distribution of households over the
main city and one or several satellites is affected by income and demographic growth. We
also infer optimal population and city sizes in several scenario’s of income and demographic
growth and contrast these to the land use plans that are indicated in Figure 6.1. Finally, we
shed light on the social costs of implementing suboptimal policies, which may result from a
misperception of the type or size of externalities.

Our study adds to a small number of applied welfare economic analyses of land use
regulation such as Cheshire and Sheppard (2002), Bento et al. (2006) and Walsh (2007),
which have been reviewed in chapter 2. It also relates to a concise literature on the Seoul
greenbelt, which is modelled in a theoretical analysis by Cho (1997) and Lee and Fujita
(1999) as a (congestible) multifunctional park that provides citizens with recreational areas,
environmental amenities and scenic views, while Lee and Linneman (1998) provide evidence
that proximity to this greenbelt is capitalized in residential land prices. Reflecting the rise of
‘periurban belts’ in France, Cavailhès et al. (2004) develop a model in which agricultural and
residential land use are mixed in a zone around the urban fringe, but they do not perform a
full welfare analysis of land use policies. To our knowledge, Ogura (2005) presents the only
theoretical model on growth controls that does consider the possibility of intercity commuting
from a nearby satellite, but taking a political economic perspective, this paper ignores the
valuation of policy-induced amenities. To some degree, our analysis of the decision to found a
satellite may be understood within the wider literature on systems of cities (cf. Henderson,
1987), which considers the optimal and equilibrium number of cities in a system as a function
of fixed costs and (dis)economies of scale. In dynamic models, Henderson (1986) and Anas

7 There data were taken from the ‘New map of the Netherlands’ (www.nieuwekaart.nl), a collection of all
national and municipal land use regulations, in the fall of 2006.
8 This map is somewhat imprecise, though, because it does not indicate construction densities and the horizon of
new plans is not always clear. Projections by provincial and municipal governments suggest that net of
demolitions, the housing stock will grow with about 50,000 to 60,000 dwellings until 2030 in both Amsterdam
and Almere. So in relative terms, the satellite is planned to grow at a much higher rate. About a third of all new
construction in the northern part of the Randstad area (‘de Noordvleugel’) is planned to take place in Almere,
while other towns in the region surrounding Amsterdam will expand at a significantly lower rate.
(1992) find that it is optimal to set up a new city much earlier than the date at which it would emerge under laissez-faire. Furthermore, the concept of satellites may bear some similarity to the edge cities that are analysed by Henderson and Mitra (1996). However, land use externalities are generally absent or they remain implicit in this literature.

In the next section, we propose our model for a mother city and a satellite, and we derive first-best policies. The calibration of this model is discussed in section 6.2, where explicit consideration is also given to validation. Comparative static properties and policy analysis are contained in section 6.3. We then consider an extension with multiple satellites. The final section concludes and it puts the policy implications of our model into the perspective of the range of assumptions and simplifications that have necessarily been made.

6.1 Theoretical framework

After outlining model preliminaries and the geographical setting, this section considers the problem of a benevolent planner who wants to maximize social surplus under the constraint that all households reach the same target utility level. It is shown that the solution to this problem may be decentralized as a free market equilibrium with costless household mobility within and between cities through the imposition of appropriate transfers and development taxes. We then consider the desirability of founding a satellite if there are fixed setup costs and discuss the extension of our framework to multiple symmetric satellites. An investigation of comparative static properties is deferred to section 6.3, where we make use of the calibrated model.

Preliminaries and geographical setting
Households have a well-behaved utility function $u = u(z, s, A, S)$, where $s$ denotes the consumption of land and $z$ is the consumption of a composite commodity that represents all other goods, including the capital component of housing. Furthermore, utility is affected by two city level variables $A$ and $S$. The amenity level $A$ reflects the inherent attractiveness of living in a city, due to for instance the presence of historical buildings or cityscapes. It also allows for a first pass on more endogenous factors, such as the variety of local services and

9 These models exhibit city-level agglomeration economies in production that are counterbalanced by congestion effects through rising costs of land and transportation.
10 A number of studies exist, though, that analyse optimal land use policies in a system of cities when intracity transport infrastructure is congestible. See for instance Anas and Pines (2008).
the offer of cultural facilities, which tend to differ strongly between large cities and newly found satellites.

Fundamental to our analysis is the assumption that the utility of living in a city is decreasing in its geographical size $S$. The most immediate interpretation of this externality is that people dislike to be surrounded by bricks and asphalt. The larger a city grows, the more they feel themselves lost in an ‘urban jungle’. As we have discussed in chapter 2, some evidence supporting this view may be found in an analysis of residential transactions in an exurban region in central Maryland, USA by Irwin (2002), who reports that conversion of agricultural land to low-density residential land had a negative impact on surrounding house prices, suggesting that one of the important attractions of open space is simply that it is not developed. In line with this view, stated preference studies indicate that negative externalities of residential development are an important motivation for the preservation of open space (cf. McConnell and Walls, 2005). Another way of interpreting the city size externality is that when $S$ increases, the total amount of space left undeveloped is reduced and the distance to open space at the fringe rises for most residents in the city, which reduces welfare if open space at the city fringe is amenable and accessible to urban residents (see our discussion in the third section of chapter 2). Interpreted this way, the externality captures that society may value not only the total supply of open space in the country, but also its accessibility.\footnote{Since the total stock of open space in a country is typically only marginally reduced by urban expansion, its accessibility is in fact the more important aspect of this interpretation. Access to open space could be modelled more directly by assuming that in order to enjoy it, residents travel to the city fringe at a given frequency, which has to be lower than the frequency of commutes to the CBD. It may be shown that the optimal policy in this setting is a (Pigouvian) development tax, reflecting the increased travel costs that urban expansion imposes on all residents. Although this development tax does not have the same comparative static properties as the optimal development tax that we derive in this section, there is a strong similarity between the two externalities and associated optimal policies.}

However, open space in parks may substitute for proximity to a greenbelt, as discussed in chapter 2. We get back to this point in the concluding section.

The way in which we model the open space externality may be compared to amenity creation models in the theoretical growth controls literature that exhibit a negative externality of population size (Brueckner, 1999). Under the assumption of fixed land consumption, which is generally made in such models, the two externalities are equivalent. In contrast, Brueckner (2001) and Bento \textit{et al.} (2006) consider welfare effects of changing the total amount of undeveloped space, calculated as some given total amount of space minus city size. This approach has the somewhat unrealistic implication that a hectare of open space near the city boundary is valued in the same way by its residents as a hectare at a distance of, say, a
hundred kilometres. The foundation of a satellite can not be optimal then, since it would raise the total residential land consumption.

Figure 6.2: Geographical setting

The geographical setting of our analysis is illustrated in Figure 6.2. We consider a system of two monocentric cities, in which a total number of households $N$ reside. This number is taken to be exogenous, so the system can be interpreted as closed. Each household provides one unit of labour and all jobs are located in the Central Business District (CBD) of the main or mother city $M$. Residents who live at a distance $r$ from this CBD incur commuting costs $tr$, where $t$ denotes commuting costs per unit of distance. Residents of the satellite city $S$ travel to the CBD of their city first, where they enter the intercity infrastructure network, and then to the CBD of the mother city. Living at a distance $r$ of the satellite’s CBD, they incur commuting costs $tr + icc$, where $icc$ denotes intercity commuting costs. So under these assumptions, the satellite’s CBD serves as an intercity infrastructure access point only, and it does not offer any employment opportunities. Note that the intercity commuting costs per unit of distance may be smaller than $t$, depending on the quality of the intercity infrastructure network.

We rule out scattered residential development outside cities, as it would fragment open space at the city fringe and make it less valuable. In the context of our application to the

---

12 It makes little sense in this setting to assume an open system, because growth controls in the mother city would not raise housing demand in the satellite then, whereas in the applications in which we are interested it clearly does.

13 The presence of a negative external effect of city size implies that households have an incentive to locate outside the city, if the negative effect on utility of the higher commuting cost is compensated by the avoidance of the negative external effect of city size. Hence, if we would not impose that all households reside within city boundaries, the presence of this external effect would lead to diffuse residential location patterns around main
cities of Amsterdam and Almere, this assumption is plausible since land use is regulated directly, so residential development outside cities can simply be prohibited.\textsuperscript{14} As a final point, we note that the mother city and the satellite have to be located sufficiently far away from each other, so that the size of one city does not affect the utility of residents in the other.

**The social planner’s problem**

Essentially following the well-established Herbert-Stevens approach, we develop the welfare economic analysis in this chapter by considering a benevolent social planner, who aims to maximize aggregate surplus under the side condition that each household has to reach a given target utility level \( u^* \) (cf. Fujita, 1989).\textsuperscript{15} The contribution of an individual household to the aggregate surplus is defined as the income it generates, minus the costs that have to be incurred to grant it a utility of \( u^* \). Fixing household income at the exogenous wage level \( w \), the optimal allocation may be interpreted as the least costly way to attain the target utility level for all households in the system of cities.

It is useful to invert the utility function with respect to \( z \) for the target utility level \( u^* \), to obtain \( z = Z(u^*, s, A, S) \). The function \( Z \) identifies iso-utility curves for different levels of \( u^* \) and its partial derivatives with respect to the other variables may be interpreted in terms of the marginal willingness to pay for the goods they represent. By assumption, the signs of the partial derivatives are:

\[
\frac{\partial Z}{\partial u^*} > 0, \frac{\partial Z}{\partial s} < 0, \frac{\partial Z}{\partial A} < 0, \frac{\partial Z}{\partial S} > 0. \tag{6.1}
\]

The costs of granting a household the target utility level are then equal to the sum of commuting costs, opportunity costs of alternative land use and the expenditure on the composite commodity \( z = Z(u^*, s, A, S) \). We assume that the alternative land use is agricultural, which yields a rent \( p_a \), and that the price of composite commodities is normalized...
to unity.\textsuperscript{16} Ignoring the costs of founding the satellite, the aggregate social surplus $SS$ is then obtained by integrating the surplus for each household over the total number of households in the two cities:

\[
SS = \int_0^{r^M} \frac{L^M}{S_r} \left( w - tr - p_s s_r^M - Z(u^*, s_r^M, A^M, S^M) \right) dr + \int_0^{r^S} \frac{L^S}{S_r} \left( w - tr - icc - p_s s_r^S - Z(u^*, s_r^S, A^S, S^S) \right) dr,
\]

(6.2)

where $r^i$ denotes the distance from CBD to the fringe in city $i$, $i \in \{M, S\}$, $L^i_r$ denotes the total amount of developable land at a distance $r$ from the CBD of city $i$, and $s_r^i$ denotes the consumption of land assigned to households living at a distance $r$ from the CBD of city $i$. Note that $L^i_r / s_r^i$ equals the household density at a distance $r$ from the CBD of city $i$.

The social planner’s problem is to choose an allocation $\{s_r^i \geq 0, r^i \geq 0, S^i \geq 0\}$ that maximizes $SS$, while satisfying a number of constraints. In the first place, the household density has to integrate over the two cities to the total number of $N$:

\[
\int_0^{r^M} \frac{L^M}{S_r} dr + \int_0^{r^S} \frac{L^S}{S_r} dr = N. \tag{6.3}
\]

Secondly, the total amount of developable land in urban use has to integrate to the (endogenous) geographical size $S^i$ for each city:\textsuperscript{17}

\[
\int_0^{r^M} L^M_r dr = S^M \quad \text{and} \quad \int_0^{r^S} L^S_r dr = S^S. \tag{6.4}
\]

While conditions for the desirability of founding a satellite are discussed later in this section, for now we assume that both cities have a positive size in the optimum. Ignoring the

\textsuperscript{16} In reality, there are costs to converting land from agricultural to residential use, relating for instance to the provision of local infrastructure. The model could be extended with a local public good that is produced using a constant returns technology. Ruling out substitution on the demand side, so that it would be provided with a constant land intensity, a constant would have to be added to the price of agricultural land in Equation 6.2. This is the approach we follow implicitly in our calibration.

\textsuperscript{17} This second set of constraints could be avoided by including city size as a function of $r^i$ directly in the utility function, but we prefer the present equivalent specification because it is more insightful.

145
inequality constraints, the Lagrangian associated with this optimization problem may be written as:

\[ \mathcal{L} = \int_0^{r_M} \left( \frac{w - tr - Z(u^*, s^M, a^M, s^M)}{s^M} - p_a \right) dr \]

\[ + \int_0^{r_S} \left( \frac{w - tr - icc - Z(u^*, s^S, a^S, s^S)}{s^S} - p_a \right) dr \]

\[ + \lambda \left( N - \int_0^{r_M} L^M_S dr - \int_0^{r_S} L^S_S dr \right) + \tau^M \left( S^M - \int_0^{r_M} L^M_S dr \right) + \tau^S \left( S^S - \int_0^{r_S} L^S_S dr \right). \tag{6.5} \]

where \( \lambda, \tau^M \) and \( \tau^S \) are Lagrangian multipliers. The first order conditions associated with this problem are \( \frac{\partial \mathcal{L}}{\partial s^M_r} = 0 \) for every \( r \in (0, r_M) \), \( \frac{\partial \mathcal{L}}{\partial s^S_r} = 0 \) for every \( r \in (0, r_S) \), \( \frac{\partial \mathcal{L}}{\partial r^M} = 0 \), \( \frac{\partial \mathcal{L}}{\partial r^S} = 0 \), \( \frac{\partial \mathcal{L}}{\partial s^M} = 0 \) and \( \frac{\partial \mathcal{L}}{\partial s^S} = 0 \). The first two conditions for surplus maximization refer to the demand for land. They imply that for every \( r \) within the city boundaries we have:

\[ - \frac{\partial Z(u^*, s^M, a^M, s^M)}{\partial s^M_r} = \frac{w - tr - Z(u^*, s^M, a^M, s^M)}{s^M} - \lambda, \]

\[ - \frac{\partial Z(u^*, s^S, a^S, s^S)}{\partial s^S_r} = \frac{w - tr - icc - Z(u^*, s^S, a^S, s^S)}{s^S} - \lambda. \tag{6.6} \]

For future reference, it is useful to note that the left hand side of these expressions can be interpreted as the marginal willingness to pay for land, while the right hand side takes the form of a bid rent function. The next two conditions refer to the optimal city boundaries, and they may be written as follows:

---

18 The problem could be solved more formally by applying optimal control theory, but the same outcome would obtain. See Fujita (1989) for a thorough discussion.
Making use of Equations 6.6, these equations indicate that the marginal willingness to pay for land at the fringe of city $i$ should be equal to the agricultural land rent plus a Lagrangian multiplier $\tau^i$. The final two conditions refer to the optimal city size, yielding:

\[
\tau^M = \frac{\int_0^{S^M_i} \frac{\partial Z(u^*, s^M_r, A^M, S^M)}{\partial S^M} dr}{s^M_r},
\]

\[
\tau^S = \frac{\int_0^{S^S_i} \frac{\partial Z(u^*, s^S_r, A^S, S^S)}{\partial S^S} dr}{s^S_r}.
\]

The left-hand side of these equations may be interpreted as the willingness to pay for a marginally smaller city, integrated over the total number of households in this city. From the comparative statics of $Z(u^*, s, A, S)$ in Equations 6.1, we know that the multipliers $\tau^M$ and $\tau^S$ are positive, as long as both cities have a positive size. Equations 6.7 then imply that the marginal willingness to pay for land at the fringe of city $i$ should exceed the agricultural land rent, so that urban land use is restricted in the social optimum. This suggests that the optimal policy in the presence of a city size negative externality may be decentralized through the imposition of a (Pigouvian) development tax that is equal to the external effect that a marginal extension of the size of a city imposes on its residents. Equivalently, the planner may regulate land use directly in order to obtain city sizes $S^M$ and $S^S$, and the multipliers should then be interpreted as regulatory taxes or shadow prices of land use restrictions.\(^{19}\)

---

\(^{19}\) As discussed in chapter 2, direct land use regulation is much more common than taxation of residential development or residential land consumption, which are equivalent in a competitive setting where builders pass the development tax on to households. Nevertheless, there is some similarity between taxation of development and the Impact Fees that are gaining widespread popularity in the USA.


**Decentralization of the social optimum**

Consider now a situation in which the role of the central planner is limited to setting development taxes $\hat{\tau}^M$ and $\hat{\tau}^S$, and imposing a (possibly negative) lump sum tax $\hat{\lambda}$ on each household, while leaving the allocation of goods and land to competitive markets. Assume further that household mobility within and between cities is costless. A household that resides at location $r$ in city $i$ then faces the budget constraint $p_r^i, s_r^i + Z(\hat{u}, s_r^i, A^i, S^i) = w - \hat{\lambda} - tr$, where $p_r^i$ denotes the land rent and $\hat{u}$ denotes the equilibrium utility level. Under well-known conditions, a unique equilibrium exists that is fully determined by the following conditions (cf. Fujita, 1989). First, equilibrium on land markets requires that $p_r^i$ within both cities equals the bid rent function, which is defined as the maximum rent per unit of land that a household is willing to pay while attaining $\hat{u}$. This condition may be written as:

$$
p_r^M = \max_{s_r^i} \left\{ \frac{w - tr - Z(\hat{u}, s_r^M, A^M, S^M) - \hat{\lambda}}{s_r^M} \right\},
$$

$$
p_r^S = \max_{s_r^i} \left\{ \frac{w - tr - inc - Z(\hat{u}, s_r^S, A^S, S^S) - \hat{\lambda}}{s_r^S} \right\}.
$$

The maximization problem in these equations is resolved when $p_r^i$ equals the marginal willingness to pay for land $-\partial Z/\partial s_r^i$, which yields a condition for the consumption of land $s_r^i$ at each location. The size of each city is determined by the condition that land rents at the city fringe should equal the sum of agricultural rents and the development tax. Finally, the equilibrium utility level $\hat{u}$ is determined by the condition that $N$ households have to be accommodated in the system of cities, as in Equation 6.3.

It can now be seen that the solution to the social planner’s problem satisfies the conditions that together characterise the market equilibrium, provided that the government sets $\hat{\lambda} = \lambda$, $\hat{\tau}^M = \tau^M$ and $\hat{\tau}^S = \tau^S$. Since the social optimum satisfies Equation 6.6, the consumption of land $s_r^i$ solves the decentralized consumer problem, and bid rents are as in Equations 6.9. Furthermore, as Equation 6.7 is satisfied, the bid rent at the city fringe equals agricultural rent plus development tax. Finally, the social optimum satisfies Equation 6.3 by construction. Thus, by setting lump sum and development taxes appropriately, the planner can decentralize the social optimum and the target utility level $u^*$ is attained in a market.
equilibrium. Furthermore, it should be noted that, since this result holds for any target utility, \( u^* \) may be chosen in such a way that the associated lump sum tax equals zero. Hence, a market equilibrium in which appropriate development taxes constitute the only policy intervention corresponds to a social optimum with this target utility level.

Throughout our application of the model, we prefer to consider market equilibria without lump sum taxes or transfers. However, welfare comparisons of such market equilibria are not straightforward, because they generally yield different levels of both utility and surplus. Therefore, we compare the surplus of different equilibria, while holding utility constant through appropriate transfers.\(^{20}\) Social surplus then equals the sum of all lump sum taxes and the total land rent minus opportunity costs of agricultural use.

### When should a satellite city be founded?

The costs of founding a satellite are not explicitly considered in our measure of social surplus in Equation 6.2, but they are a crucial determinant of the desirability of this policy. Ignoring the provision of other local public goods, we assume that these costs consist of the fixed costs of intercity infrastructure provision only. So in our model, in order to create a satellite, the government has to build a road that costs \( FC \).\(^{21}\) The desirability of this investment derives from a comparison of social surplus with and without the satellite, where characteristics of the equilibrium with one city are obtained by constraining all households to live in the main city. Under any target utility level, foundation of the satellite is then desirable if the social surplus in the two city equilibrium exceeds surplus in the equilibrium with one city by more than \( FC \).

Properties of the surplus gain from founding a satellite will be explored numerically in following sections, so the discussion here is confined to some intuitive general properties. Ignoring fixed costs, when would there be a strictly positive surplus gain from founding a satellite at all? The satellite affects outcomes only if some households decide to locate there. Hence, the bid rent in the second city has to exceed the agricultural land rent plus an optimal development tax. Let us first assume that there is no difference in amenability, and that external effects of city size are absent. The satellite is then populated if transport costs to the city fringe exceed intercity commuting costs \( (r^M > icc) \). If the distance between both cities

---

\(^{20}\) Another possible solution to this problem would be to assume public land ownership, so that land rents are distributed over all households and surplus equals zero in all market equilibria. Welfare comparisons of different equilibria could then proceed simply through the comparison of equilibrium utility levels. However, in urban economic models, there is no obvious money metric for differences in utility. Notably, compensating and equivalent variation are problematic, since the marginal utility of income varies with location (Wildasin, 1986). This issue is avoided by keeping utility constant and comparing different surplus levels.

\(^{21}\) We abstract from any relationship between \( FC \) and the intercity commuting costs \( icc \).
should be large enough to avoid any externalities, commuting on the intercity transport link has to be considerably less costly per unit of distance than travel within the main city. It becomes even less likely that households are willing to live in the satellite if we also take differences in the level of urban amenities into account, as these render the main city more attractive. Hence, the demand for a satellite and the surplus it generates are entirely driven by the negative externality of city size. This externality makes living in the main city less attractive, and its internalization in development taxes may raise the optimal population in the satellite further.  

If the costs of providing intercity infrastructure are not too high, it may of course be desirable to found multiple satellites. The system of two cities that we have considered throughout this section may be readily extended with an arbitrary number of satellites, as long as these satellites are assumed to be symmetric in terms of amenability and the intercity commuting cost. This requires straightforward adjustments in the expressions for social surplus (Equation 6.2) and the population constraint (Equation 6.3). The condition for social desirability of founding an additional satellite remains that the gain in social surplus should exceed fixed founding costs, which determines the optimal number of satellites.

6.2 Application to Amsterdam and Almere

This section applies our theoretical framework to the cities of Amsterdam and Almere. While the analysis of the previous section was carried out for an arbitrary well-behaved utility function, the choice of an appropriate functional form is essential for a meaningful applied welfare analysis. Hence, this issue is dealt with at the outset of the present section. Then, a brief discussion follows of the range of data from various sources that are available for calibration and validation of the model. We describe the procedure to find values for the model parameters that are not directly observed. Finally, some properties of the calibrated

---

22 While we have so far assumed that all employment remains in the mother city, the attractiveness of founding a satellite increases strongly if at least a part of the jobs follow the population. Moreover, we have shown in chapter 4 that in the long run, employment adjusts to the local supply of labour, but in our application. However, the consequences of assuming all jobs to be in the Amsterdam CBD are limited for our policy analysis, as long as there are no scale economies in production. For instance, we could have assumed that there is no intercity commuting and that residents in Amsterdam and Almere receive the same wage. Since in our calibration, the model outcome should still match the data on land prices and the distribution of households over these cities, the resulting rise in the attractiveness of Almere would then have to be counterbalanced by an increase in the amenity differential.

23 It should be borne in mind, however, that our assumption that the presence and size of satellites does not affect utility in the main city may become increasingly untenable when their number rises, as they fragment the surrounding landscape.
model are presented, and we validate our setup by comparing model outcomes with data that are not used in the calibration procedure.

**Functional form of utility**

The utility function used in our application is composed of a CES component in household consumption of land and the numeraire good, multiplied by functions of amenability and city size. In order to keep the model tractable, we set the elasticity of substitution between land and the numeraire good equal to 0.5. Some evidence in support for this assumption is presented in our discussion of the model validation. In the notation of section 6.1, we have:

\[
\begin{align*}
    u(z, s, A, S) &= \frac{A(S^0 + S)^{\gamma}}{\alpha z^{-1} + \beta s^{-1}}. \\
    \end{align*}
\]

When interpreting the elasticity of substitution, it should be borne in mind that we have not explicitly modelled the production of housing services with capital and land. Nevertheless, the capital component of housing is implicitly contained in the consumption of numeraire goods.

Next to the CES component in land and numeraire goods, utility is proportional to the amenity level \(A\) and a negative function of the geographical city size \(S\). We set \(A^S = 1\), so \(A^M\) may be interpreted as the relative attractiveness of living in the mother city in terms of access to local public goods other than open space. In choosing a functional form for the city size externality, we have allowed for the possibility that urban sprawl is more of an issue in large cities than in small towns. As long as \(S^0\) is positive, the function \((S^0 + S)^{-\gamma}\) implies that the willingness to pay to avoid a 1\% increase of \(S\) is rising with city size, while it is zero for a city of size zero. In the calibration, we will set \(S^0\) roughly equal to the size of Amsterdam, so that open space externalities are significantly more pressing in this city than in the smaller satellite. This assumption reflects the observation that land use controls are much more permissive in Almere than in Amsterdam, which was already illustrated in Figure 6.1 in the first section.

---

24 This allows us to solve a large part of the model analytically, so that the numerical burden reduces to the search of roots in a limited number of nonlinear equations.

25 Local governments in the Netherlands tend to impose strong restrictions on high rise residential construction. Hence, the loss of keeping substitution of capital for land implicit in our model is probably limited.

26 Note that when we set \(S^0 = 0\), the willingness to pay to avoid a 1\% increase of \(S\) does not depend on city size. In this case, the optimal restriction of residential land use in the main city and the satellite will be roughly comparable.
Data

We choose the year 2002 as a base year for our calibration, considering annualized income and expenditures on land, numeraire consumption goods and transportation. Our discount rate is set at 5%, which is slightly higher than the real long interest rate in this period. For a number of exogenous city variables, such as transport costs to the CBD and the share of land in residential use, we consider data for Amsterdam only. While it is possible that these are different for Almere, but we do not want to introduce additional sources of heterogeneity in our model, in order to facilitate interpretation of the results. Table 6.1 presents data and estimated parameters for both calibration and validation of our model. A detailed account of sources and estimation methods is given in the Appendix. In particular, we have made use of data and results in Rouwendal and Van der Straaten (2008), who perform a hedonic analysis of house prices in Amsterdam. An estimate of the shadow price of present land use restrictions in both cities is obtained by comparing the price of new houses at the city fringe with total marginal construction costs.

Table 6.1
Data for the cities of Amsterdam and Almere

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data used for calibration</strong></td>
<td></td>
</tr>
<tr>
<td>number of households (1000)</td>
<td>405</td>
</tr>
<tr>
<td>average disposable household income (1000 €)</td>
<td>24</td>
</tr>
<tr>
<td>expenditure on land as a share of household income (%)</td>
<td>16</td>
</tr>
<tr>
<td>share of total municipal land in residential use</td>
<td>0.4</td>
</tr>
<tr>
<td>transport costs (€ / m)</td>
<td>0.34</td>
</tr>
<tr>
<td>transport costs from Almere to Amsterdam fringe (€)</td>
<td>3100</td>
</tr>
<tr>
<td>agricultural land rent plus conversion costs (€ / m²)</td>
<td>2.05</td>
</tr>
<tr>
<td>shadow price of local land use restrictions (€ / m²)</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>-1.6</td>
</tr>
<tr>
<td><strong>Data used for validation</strong></td>
<td></td>
</tr>
<tr>
<td>quality controlled house price (index)</td>
<td>144</td>
</tr>
<tr>
<td>median lot size (m²)</td>
<td>95</td>
</tr>
<tr>
<td>area of municipality in land (km²)</td>
<td>165</td>
</tr>
<tr>
<td></td>
<td>131</td>
</tr>
</tbody>
</table>

Notes: See appendix for a discussion of estimation procedures and data sources.

In terms of the number of households, Amsterdam is clearly a much larger city than Almere. Although households are on average smaller in Amsterdam, the number of residents still exceeds Almere by almost a factor 5. About 40% of the land in Amsterdam is in

---

27 Some data sources refer to another year in the period 2000 – 2005.
residential use, while the rest is used for infrastructure, industrial production, open space, agriculture and water. In order to account for this in the model, we impose that at each location in both cities, a share of 40% is available for residential use (so $L'_r = 0.8 \pi r$). Another striking feature of Table 6.1 is that after controlling for characteristics of the dwelling, houses are almost 50% more expensive in Amsterdam than in Almere. Clearly, the premium paid by households that live in Amsterdam has to be compensated through either reduced commuting costs or a higher level of amenities. Presumably in response to the large price differential, median lot sizes in Amsterdam are significantly smaller than in Almere. Finally, we observe that estimates of the shadow price of land use regulation in both cities confirm that planning is much more restrictive in Amsterdam than in Almere, as was suggested by Figure 6.1. The data even indicate that residential land use in Almere is effectively subsidized.

Choice of parameters that are not directly observed
While $N$, $w$, $t$, $\omega$ (the share of urban land in residential use) and $p_A$ are estimated directly, other model parameters have to be inferred by comparing properties of the implied equilibrium to data. In the utility function, we may set $\beta = 1$ without loss of generality. The parameter $\alpha$ is then chosen in such a way that the budget share of land in Amsterdam equals the observation in Table 6.1. The parameter $\gamma$ is set in such a way that the optimal development tax in Amsterdam equals the estimate of the shadow price of the restrictiveness of land use regulation in this city. Note that we do not use the estimated shadow price of land use controls in Almere, since it is negative and in our model, the optimal development tax is nonnegative. Instead, we set $S^0$ to 100 km$^2$, which approximately equals the amount of land in residential use in Amsterdam, so that the optimal development tax in Almere is small (in the calibrated model we have $\tau^S = 2.52$). The amenity level $A^M$ is set in such a way that the equilibrium number of households in Amsterdam is equal to the observed number. Finally, $icc$ is set equal to the sum of the commuting costs from the Amsterdam CBD to the fringe plus the costs of commuting from the fringe of Amsterdam to the Almere CBD, as reported in Table 6.1. In the general equilibrium, these parameters have to be chosen simultaneously, yielding $\alpha = 479$, $\gamma = 0.272$, $A^M = 1.026$ and $icc = 5733$. With these values, the city size externality is so important for utility that in order to internalize it properly, households

---

28 In order to maintain internal consistency in the model, we also assume that it is the total amount of land in residential use in the city creates the externality $S'$, but this does not change the interpretation of the results.
Chapter 6

Amsterdam need to spend about 10.8% of their disposable household income on development taxes.

Model validation

In determining the model parameters, we have not made use of the observations in the lower panel of Table 6.1. This information is used to assess the performance of the calibrated model, by comparing it to the model outcomes as reported in Table 6.2. Our model is of course a highly stylized description of the equilibrium in both cities, so it is not reasonable to expect that the data used for validation are perfectly reproduced by the calibrated model. Nevertheless, it would be reassuring to find values in the same order of magnitude.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>average land rent (€ / m²)</td>
<td>20.7</td>
<td>6.0</td>
</tr>
<tr>
<td>average lotsize (m²)</td>
<td>186</td>
<td>293</td>
</tr>
<tr>
<td>area of municipality (km²)</td>
<td>188</td>
<td>46</td>
</tr>
</tbody>
</table>

Notes: Output generated with the calibrated model.

The first statistic that may be used for validation is the intercity house price differential of 44%. As shown in Table 6.2, land in Amsterdam is more than three times as expensive as land in Almere according to the model, which suggests that it overestimates the land price differential. However, the quality controlled house price differential is at best a very rough estimate of the land price differential. Since lots are smaller in Amsterdam, and since land expenditure is only a part of housing expenditure, the gap may be smaller than it seems at first sight. The second statistic considered is the average lot size in Amsterdam and Almere. In the model, these lot sizes are about twice as high as in the data, but their ratio is almost exactly the same. The difference in levels arises from the fact that in the land use statistics, local infrastructure, certain consumer services (such as shops and local bank offices) and small parks are attributed to residential use. Hence, the amount of land in residential use in our data is much larger than the medium lot size times the number of households.

29 Finally, the actual surface of the Amsterdam municipality is only about 10% smaller than in the calibrated model. The size of the Almere municipality is much smaller in the model than in reality, but this is due to a higher share of agricultural land within the municipal borders, and probably also a smaller share of land in residential use within this city.
Figure 6.3 shows land rents and lot sizes as a function of the distance to the CBD in both cities, using the calibrated model again. As expected, land rents are falling with distance, and they jump to the agricultural land rent at the city fringe, the difference being the development tax. The average slope of the land rent function in Amsterdam is -6.2% per kilometre, which compares reasonably with the -9.0% per kilometre reported in Rouwendal and Van der Straaten (2008). Given our calibration strategy, these slopes should coincide if average lot size in our model would exactly match the average lot size in the data. Lot sizes in Amsterdam rise on average with about 4.0% per kilometre, which again compares reasonably with the slope of +2.4% in the data used by these same authors.

In particular, this second finding gives some confidence in our choice of the elasticity of substitution between land and the composite commodity, while suggesting that if anything, this elasticity was chosen too highly. Hence, the calibrated model appears to perform reasonably well, particularly in view of its highly stylized characters.

With the calibrated model, we may calculate the surplus gross of founding costs that was generated by setting up the satellite Almere. To this aim, we first derive the equilibrium that would result if all households were to reside in Amsterdam. In this equilibrium, the city size increases with about 12%, and the optimal development tax rises to almost 16 € / m². In order to maintain the target utility level \( u^* \), households need to receive a lump sum transfer of 837 €. The difference between the surplus in the two city equilibrium and the surplus in this

---

30 By differentiation of the bid rent function (Equation 6.9) with respect to distance, it may be seen that restrictions or taxes on residential land use which reduce lot sizes lead to steeper land rent gradients. Indeed, in Figure 6.3, land rents fall steeper with distance to the CBD in Amsterdam than in Almere.

31 We thank Willemijn van der Straaten for kindly providing us with this information, which is not reported in the paper.

32 Note that with a substitution elasticity of zero, as in a Leontief utility function, lot sizes do not vary with distance to the CBD. This is the case that is often considered in the theoretical literature on growth controls.
equilibrium then equals 99.7 million €, representing a present discounted value of about 2 billion €. It is this amount that may be spent at most on fixed founding costs.\footnote{There is some reason to believe that the costs of providing intercity infrastructure are roughly in this order of magnitude. The costs of constructing the Betuwelijn, a railroad with a length of 100 kilometres, are about 6 billion €, and the distance between Amsterdam and Almere is about a third of this length.}

6.3 Comparative statics and policy analysis

Conditional on the assumptions that underlie our model and its calibration, a welfare economic framework for the evaluation of land use policies has now been obtained. In this section, we present comparative statics of the optimal policy, as well as an indication of the social costs of implementing suboptimal policies. Furthermore, we contrast the optimal allocation of households over the system of cities with government plans, as illustrated in Figure 6.1, for various scenarios of income and demographic growth.

Comparative static analysis

The extent to which both the surplus of founding a satellite and the optimal development tax in both cities depend on key model parameters is reported in Table 6.3. As in the previous section, this surplus is calculated as the difference between the surplus in the two-city equilibrium and the surplus in the equilibrium with one city in which the same utility level is attained, and it is interpreted as the annualized amount that may be spent on fixed founding costs. In order to shed light on the underlying model mechanics, the table also reports adjustments on the extensive margin (city size) and the intensive margin (average population density) of land use in each city. These elasticities may be summed to obtain the responsiveness of the number of households in each city with respect to model parameters.

Let us consider the impact of a 10% increase in intercity commuting costs (amounting to 573 €). A rise in these costs makes living in Almere less attractive. Hence, the equilibrium share of households that locate in Amsterdam expands from 87% to 90%. Increased demand for land pushes up prices here, so the average density raises by 1.4%. Households that remain in the satellite have lots that are 13 $m^2$ larger on average, substituting away from the consumption of numeraire goods. In response to the increased city size, the optimal development tax in the main city rises slightly, while it falls with 23% in Almere. Perhaps most significantly, the surplus of founding the satellite falls with 41% after a 10% rise in intercity commuting costs. This suggests that the surplus of founding Almere could have been
Table 6.3

<table>
<thead>
<tr>
<th></th>
<th>S^M</th>
<th>Main city</th>
<th>Satellite</th>
<th>SS</th>
</tr>
</thead>
<tbody>
<tr>
<td>icc</td>
<td>0.22</td>
<td>0.14</td>
<td>0.26</td>
<td>-2.30</td>
</tr>
<tr>
<td>A^M</td>
<td>0.71</td>
<td>0.47</td>
<td>0.85</td>
<td>-6.67</td>
</tr>
<tr>
<td>γ</td>
<td>-0.62</td>
<td>0.44</td>
<td>1.11</td>
<td>2.06</td>
</tr>
<tr>
<td>w</td>
<td>0.54</td>
<td>-0.99</td>
<td>0.37</td>
<td>3.71</td>
</tr>
<tr>
<td>N</td>
<td>0.53</td>
<td>0.35</td>
<td>0.63</td>
<td>1.58</td>
</tr>
</tbody>
</table>

Notes: The variables N^M and N^S denote the population in the main city and satellite respectively. See Section 2 for the interpretation of other symbols. The elasticities in this table reflect changes in variables between different equilibria, where the target utility level is adjusted in each equilibrium so that there are no lump sum transfers. They are computed numerically by evaluating the equilibrium while multiplying a specific parameter by 1.001 and then multiplying the relative change in all output variables by 1000.

much higher if it had been setup closer to Amsterdam, although negative externality effects might then have been induced that are not accounted for in our model.\(^{34}\) Another interesting implication is that, with a long run decline in transportation costs, the foundation of satellites becomes increasingly attractive. On the other hand, congestion on the intercity infrastructure network, which happens to be substantial in reality, raises the social costs of this policy.

The comparative static impact of raising the amenability of Amsterdam is qualitatively similar to the effect of a rise in intercity commuting costs. The attractiveness of the main city is increased and the distribution of households over the cities and land consumption adjust accordingly. Quantitatively, however, the effects are much larger. A 1% increase in A^M already leads to a 1.2% increase the in share of households in Amsterdam, and a 13% loss in surplus. Besides the way in which amenities enter utility in our calibrated model, this is also a consequence of the fact that the amenability of Amsterdam matters directly for a much larger group of households than the intercity commuting costs. Note that while amenability is exogenous in our model, it may be regarded as a first pass on endogenous differences in attractiveness, such as the existence of agglomeration economies in production and consumption.\(^{35}\) This first pass then suggests that positive agglomeration externalities reduce the social surplus of founding a satellite.

Comparative static properties of the other parameters may be interpreted along similar lines. As it is the negative externality of city size that motivates government intervention, it is

---

\(^{34}\) Ignoring intercity externalities, the optimal distance between Amsterdam and Almere would be zero in our model, but this is not consistent with our interpretation of the city size externality. At least, if residents of Amsterdam would want to enjoy true open space at the urban fringe, the satellite should be so far away that it is not visible from there. However, one would think that a 10 kilometres distance would suffice for this, rather than the 30 kilometres that separate these cities presently.

\(^{35}\) As long as satellites are small relative to the main city, scale effects in this city are only marginally affected by their foundation.
not surprising that both optimal development taxes and the social surplus from founding a satellite are elastic with respect to the parameter $\gamma$. In response to higher development taxes, households reduce their consumption of land and the population density in both cities increases. The distribution of households shifts towards the satellite, as the externality renders the main city less attractive. An increase in $w$ raises the demand for land, which is obviously a normal good. The income elasticity of average lot sizes in Amsterdam is approximately equal to unity, which is also the income elasticity of the demand for land that is implied by our utility function. The size of Almere is much more sensitive with respect to this variable than Amsterdam, the income elasticity of the number of households in Almere being equal to 2.9. Hence, the social surplus from founding the satellite is also highly elastic with respect to household income, and under a long-run upward trend in incomes, this policy becomes increasingly attractive. Finally, an increase in $N$ pushes up the demand for land as well, and as prices rise, land use in both cities adjusts accordingly along the intensive and the extensive margin. Hence, the average consumption of land falls in both cities, and the distribution of households shifts towards the satellite. The social surplus of founding Almere is also highly elastic with respect to the total number of households that are accommodated in the system.

**Social costs of suboptimal policies**

While for the calibration of our model, it was assumed that negative externalities of city size were large enough to justify the observed shadow prices of land use restrictions, it is also possible that land use regulation is set too restrictively. Table 6.4 explores the welfare economic consequences of setting a suboptimal policy. The three columns refer to different true values of the externality parameter $\gamma$ and the rows contain policy scenario's whose optimality is conditional on a perceived value of this parameter. For each column, we report social surplus for a target utility that obtains under the optimal land use policy without lump sum transfers. Note that surplus values cannot be compared across columns, because they refer to different utility functions and target utility levels.\(^\text{36}\)

For a meaningful comparison, it is perhaps most useful to consider the second column of Table 6.4, in which the true city size externality parameter equals 0.136. For sufficiently large fixed costs of founding the satellite, it is optimal to accommodate all households in a single city. The first best development tax is then equal to 6.58 € / m\(^2\). If the government fails to levy a development tax in response to the externality, social surplus is reduced by about

\(^{36}\) See our discussion in section 6.1.
17%, or almost 2% of disposable household income.\textsuperscript{37} If the government sets land use regulation at a level that is too restrictive, as it mistakenly perceives a value $\gamma = 0.272$, 7% of the social surplus is lost. Under a true externality parameter of 0.136, the social surplus of founding a satellite gross of fixed founding costs is positive if development taxes are set either optimally or too restrictively. However, under optimal development taxes, only 9 million € would be left annually for fixed founding costs.

Table 6.4

<table>
<thead>
<tr>
<th></th>
<th>$\gamma = 0$</th>
<th>$\gamma = 0.136$</th>
<th>$\gamma = 0.272$</th>
</tr>
</thead>
<tbody>
<tr>
<td>One city, $\tau_M = 0$</td>
<td>0.595 (first best)</td>
<td>0.962</td>
<td>0.630 + FC</td>
</tr>
<tr>
<td>One city, $\tau_M = 6.58$</td>
<td>0.439</td>
<td>1.164 (first best)</td>
<td>1.267 + FC</td>
</tr>
<tr>
<td>One city, $\tau_M = 15.88$</td>
<td>0.157</td>
<td>1.079</td>
<td>1.375 + FC</td>
</tr>
<tr>
<td>Two cities, $\tau_M = 6.40$, $\tau_S = 0.39$</td>
<td>-</td>
<td>1.173 - FC</td>
<td>1.395</td>
</tr>
<tr>
<td>Two cities, $\tau_M = 14.00$, $\tau_S = 2.52$</td>
<td>0.211 - FC</td>
<td>1.104 - FC</td>
<td>1.475 (first best)</td>
</tr>
</tbody>
</table>

Notes: The table shows welfare effects of land use policies under various scenarios of true and perceived city size externality parameters. True values of this parameter are in columns, and policy scenarios in rows. In each column, target utility is the utility level obtained in the first best equilibrium, in which there are no lump sum transfers and development taxes are set as in the baseline calibration. The term $FC$ refers to the annual fixed costs of founding the satellite. Surplus values cannot be compared across columns, as they refer to different target utility levels.

Obviously, if no negative externality of city size exists, all households should be accommodated in one city, and no development taxes should be levied. If the government does levy a development tax, misperceiving the externality parameter to be 0.272, social surplus is reduced by 74%. In this scenario, the benefits of founding a satellite gross of fixed costs are positive. So, even if there is no land use externality, suboptimal land use restrictions may render the foundation of a satellite socially desirable. The last column of Table 6.4 indicates that the foundation of a satellite is socially desirable as long as annualized fixed costs do not exceed 100 million €, if $\gamma$ equals its calibrated value. Failing to implement land use restrictions costs 57% of the social surplus, gross of fixed founding costs.

Optimal planning in scenarios for demographic and income growth

Although we have so far analysed optimal development taxation, direct land use regulation is the more common way to steer land use patterns. In the Netherlands, national and local governments plan both the amount of land for residential development and the number of

\textsuperscript{37} This number is smaller but in the same order of magnitude as the net social costs of growth boundaries in the case of Reading, UK, as estimated by Cheshire and Sheppard (2002). These authors found that relaxing it substantially would lead to a welfare gain of almost 4% of household income. See also chapter 2 of this thesis.
houses to be built in a municipality, and any mismatch between regulated supply and market demand is consequently reflected in shadow rents on residential land use. As indicated by Figure 6.1, the majority of new houses in the system Amsterdam-Almere is to be realised in the satellite. It makes sense to contrast these plans to the optimal distribution of additional households over these cities in our model. Table 6.5 indicates the number of new households that should optimally be accommodated in Almere under various scenarios. The dimensions of these scenarios are the number of new households to be accommodated in the system and disposable household income.

Table 6.5

<table>
<thead>
<tr>
<th>∆N</th>
<th>Y = 24000 €</th>
<th>Y = 32000 €</th>
<th>Y = 40000 €</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>63000</td>
<td>110145</td>
<td>137999</td>
</tr>
<tr>
<td>1000</td>
<td>63243</td>
<td>110463</td>
<td>138356</td>
</tr>
<tr>
<td>10,000</td>
<td>65432</td>
<td>113325</td>
<td>141575</td>
</tr>
<tr>
<td>100,000</td>
<td>87902</td>
<td>142301</td>
<td>174008</td>
</tr>
</tbody>
</table>

Notes: The table shows the optimal number of households for various values of the disposable household income and the number of additional households to be accommodated in the system.

If we keep disposable household income at the level at which the model is calibrated, about 75% of all households should be accommodated in the main city, virtually irrespective of their number. This proportion contrasts starkly with planned construction in Figure 6.1, casting doubt on the social desirability of these plans. However, we have seen that the optimal proportion of households in Amsterdam is fairly sensitive to income. With a real income growth rate of 1 - 2% per year over a horizon of 30 years, which is roughly the horizon of planning documents, this effect is therefore considerable. If no new households were to be accommodated in the system, a real income increase of 33% would shift the optimal proportion of households in Almere from 13.5% to 23.5%, and a 67% increase would raise it to almost 30%. So if the costs of demolishing and reconstructing dwellings could be ignored, houses should be destroyed in Amsterdam and rebuilt in Almere, while all lot sizes should be increased. Since this is a very costly thing to do in reality, it may be sensible to anticipate the demand effects of future income growth in present land use plans. If for instance, 100,000 new additional households are to be accommodated in the system and a 33% real income increase is projected, only about 20,000 new houses should be built in Amsterdam, and the rest in Almere. All other scenarios in Table 6.5 in which disposable household income exceeds the calibrated value involve a reduction of the number of households in Amsterdam.
One should realize, however, that adjustments in the land consumption of individual households are ignored in this table, although our comparative static results indicate that these are significant as well. Through this channel, the optimal size of Amsterdam is increasing in both income and the total number of households.\textsuperscript{38} Hence, the findings in this table do certainly not imply that, in the face of income and demographic growth, geographical growth boundaries around this city should remain as they are currently drawn.\textsuperscript{39} Another caveat is that transport costs within and between cities are assumed to remain constant in these scenarios, although in reality, the time costs of travel are likely to increase with income. As we have seen, higher transport costs make Amsterdam a more attractive location, thus counteracting the income effect. Finally, with rising surplus of founding a satellite, it may become preferable to accommodate households in a third new city. This possibility is further explored in the next section.

\subsection*{6.4 Extension with multiple satellites}

At the end of section 6.1, we have briefly indicated how our theoretical framework could be extended with multiple symmetric satellites. Maintaining parameter values that were obtained in the calibration, we now explore the consequences of this extension for our policy analysis. Table 6.6 shows social surplus gross of founding costs as a function of the number of satellites, as well as the optimal distribution of households over the resulting system of cities. In order to enable the comparison of surplus in different equilibria, the target utility is held constant at the equilibrium level in a system with one satellite and no lump sum transfers. The policy setting to which this corresponds is a government that decides to found a certain number of satellites in addition to the one that exists already. Development taxes are chosen optimally in all equilibria considered.

When founding costs are ignored, social surplus is increasing in the number of satellites, but the associated surplus gain falls with each additional satellite. Hence, the optimal number of satellites may be determined if founding costs are known. For instance, it is not optimal to found a second satellite as long as these costs exceed 59 million € per year,  

\begin{itemize}
\item[38] With a 67\% income increase and no additional households, the optimal size of Amsterdam increases with 32\%, with 100,000 additional households and no income growth, it increases with 11\%, and with both income and demographic growth, it increases with 47\%.
\item[39] The elasticity of optimal total residential land consumption with respect to income equals about 1.0. The evidence in chapter 3 suggested that income induced demand shifts are not accommodated at all by the supply of residential land, as a consequence of government interventions in land and housing markets. If our assumptions about the land use externality are valid, it follows that this extent of restrictiveness cannot be socially optimal.
\end{itemize}
and with annualized fixed founding costs of about 25 million €, the government should set up three satellites in addition to the one that is already in place. As the third and fourth columns in Table 6.6 indicate, the number of households in the main city and a typical satellite are both decreasing in the number of satellites. Nevertheless, given the calibrated parameters in our model, even in a system with 7 satellites, the main city should still contain about two thirds of the population.

<table>
<thead>
<tr>
<th>#(satellites)</th>
<th>SS (10^9 €)</th>
<th>ΔSS (10^6 €)</th>
<th>N^M / N</th>
<th>N^N / N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.48</td>
<td>99.7</td>
<td>0.865</td>
<td>0.135</td>
</tr>
<tr>
<td>2</td>
<td>1.53</td>
<td>58.6</td>
<td>0.794</td>
<td>0.103</td>
</tr>
<tr>
<td>3</td>
<td>1.57</td>
<td>40.0</td>
<td>0.748</td>
<td>0.084</td>
</tr>
<tr>
<td>4</td>
<td>1.60</td>
<td>29.6</td>
<td>0.716</td>
<td>0.071</td>
</tr>
<tr>
<td>5</td>
<td>1.63</td>
<td>23.0</td>
<td>0.691</td>
<td>0.062</td>
</tr>
<tr>
<td>6</td>
<td>1.64</td>
<td>18.6</td>
<td>0.672</td>
<td>0.055</td>
</tr>
<tr>
<td>7</td>
<td>1.66</td>
<td>15.4</td>
<td>0.656</td>
<td>0.049</td>
</tr>
</tbody>
</table>

Notes: The table indicates the social surplus associated with an increasing number of satellites, as well as the distribution of households over the system of cities. The second column derives from the first one, indicating the surplus gain from founding the marginal satellite. Target utility is the utility level that is obtained in the equilibrium with one satellite without lump sum transfers. In each equilibrium, development taxes are assumed to be set optimally.

As we have seen, the surplus of founding a satellite is elastic with respect to model parameters and as a consequence, the optimal number of satellites must be sensitive to these parameters as well. Again, given the institutional context in which housing supply in the Netherlands takes place, it is interesting to see how the optimal number of satellites alters with the number of households that are to be accommodated in the system. Hence, Figure 6.4 shows the number of households in the main city and a representative satellite as a function of the number of new households, when an optimal policy with respect to the foundation of satellites is conducted. We assume annualized fixed founding costs of 60 million €, so that foundation of a second satellite is just not desirable in the calibrated equilibrium.

Given these fixed founding costs, the foundation of a satellite becomes optimal with 5,000 additional households already. At this point, the optimal number of households in the main city drops to 370,000, whereas the optimal number of households in both satellites drops to 52,000. Foundation of the third satellite becomes desirable when 58,000 new households are to be accommodated in the system, and the number of households in the main city and all satellites then drops to a slightly higher value than with 5,000 additional households.
Interestingly, the peaks in the number of households in each city become lower, when the total number of households in the system increases, so demographic growth does not appear to call for major expansions of the main city or the first satellite in this model.

**Figure 6.4: Number of households in main city and a representative satellites under demographic growth**

With annual fixed founding costs of 60 million € and an income elasticity of the surplus of 6.4 (see Table 6.3), the equilibrium number of satellites is particularly sensitive to household income. If this rises to 32,000 €, it is already optimal for the government to found 5 additional satellites in our model. In the resulting system of cities, almost half of all households remain in the main city and each satellite contains less than 10% of the total population. So, although our analysis in the previous section suggested that when expected real income growth is taken into account, new households should be predominantly accommodated in Almere, it now appears that, as long as founding costs are not too high, they should rather be accommodated in new satellites in these scenarios.

### 6.5 Conclusions

We have shown that the existence of a negative externality of city size may, from a welfare economic perspective, justify the imposition of growth controls and the foundation of satellites. With rising incomes and declining transport costs, the foundation of satellites becomes increasingly attractive. This suggests that clustered deconcentration, a policy that is or has been conducted in various European countries, may be a socially preferable alternative to unregulated urban sprawl. Even so, growth controls should be less restrictive in satellites only to the extent that the externality is less relevant for people in small towns than for
inhabitants of a big city. In particular, it is never optimal to subsidize land use in a satellite with this type of externality.

The widespread popularity of urban containment policies renders the existence of a negative externality of city size plausible \textit{a priori}, and it is commonly assumed in a class of theoretical growth control models (cf. Brueckner, 1999). It should be borne in mind, however, that the welfare economic motivation for a clustered deconcentration policy depends crucially on the precise specification of this externality. For instance, if the relevant externality relates to the total stock of open space, as in Brueckner (2001) and Bento \textit{et al.} (2006), it is never optimal to found a satellite, as this increases residential land use at the regional level. If on the other hand, people value proximity to public parks much more than access to open space outside cities, as suggested by Cheshire and Sheppard (2001), neither the imposition of growth controls nor the foundation of satellites are called for. And to the extent that traffic congestion externalities are relevant, congestion tolls are preferable to growth controls in a first-best environment. Making use of a calibrated model, we find that the optimal land use policy is also highly sensitive to the quantitative significance of the city size externality. Moreover, the social costs of implementing a suboptimal policy appear to be substantial. Hence, policymakers should acquire a thorough understanding of the type and size of land use externalities before embarking on clustered deconcentration.

Our analysis is applied to the cities of Amsterdam and Almere. In the model calibration, parameters for the negative externality of city size are chosen that render the observed shadow price of land use restrictions optimal. It is implied that households in Amsterdam should spend about 10\% of their income on a development tax, or alternatively, on the increase in prices that is caused by land use restrictions. While this extent of restrictiveness is optimal in our analysis by assumption, the calibrated model may be used to shed light on plans to accommodate new housing demand in the region predominantly in Almere. In a comparative static analysis, we find that \textit{ceteris paribus}, about 75\% of new households should be located in Amsterdam. If expected income growth is taken into account, it makes sense to concentrate household growth in Almere, but Amsterdam should be allowed to expand nevertheless, because household demand for land is pushed up. Furthermore, both demographic and income growth make it increasingly attractive to divert new households to new satellites, if we allow for them. Hence, it seems difficult to reconcile present plans for restrictions around Amsterdam and growth in Almere with the optimal policy that is dictated by a negative externality of city size.
A number of caveats apply to these policy recommendations. Land use restrictions in Amsterdam exist partly because of its proximity to an airport and some areas near this city do arguably have special environmental or historical value. We abstract from such considerations in our model. Interpretation of the income growth scenarios is somewhat troubled by the fact that housing and urban structure are not malleable in practice, while our analysis assumes that they are. A large share of the housing stock in Amsterdam is allocated to the social rental sector, so our assumption of market-based housing supply is not fully appropriate. Furthermore, labour markets and economies of agglomeration have been dealt with in a very stylized manner. Finally, heterogeneity and distributional aspects are ignored in this chapter, even if various studies indicate the relevance of such issues (cf. Cheshire and Sheppard, 2002, Bento et al., 2006). In particular, even if we abstract from any rent seeking behaviour that it might induce (chapter 2), benefits from the direct regulation of land use that is common in the Netherlands accrue to a significant extent to the owners of land, and a full analysis of welfare effects should therefore take account of their proper weight in aggregate social welfare.

Appendix: Data used for the model calibration

This appendix accounts for the data sources and estimation procedures used to obtain the figures in Table 6.1.

- The number of households in Amsterdam and Almere in the year 2002 is reported by Statistics Netherlands.
- The median lot size is computed from transaction records by the Dutch Association of Realtors (NVM) in the years 1999 and 2000. As a measure for lot size, we have used the total surface for condominiums, and the lot size as recorded by the land registry for single family dwellings. The amount of land used by condominiums is smaller than the total surface in the case of high-rise buildings, but land use was not observed in our data for many apartments. As the share of condominiums is significantly larger in Amsterdam, this implies that we may overestimate the land use per household in this city in particular. On the other hand, the amount of high-rise residential buildings is limited by regulation, so that this bias may be limited as well. Furthermore, it should be borne in mind that these figures refer to the owner-occupier sector, whereas the social rental sector is particularly large in Amsterdam. Since social housing
construction is rather insensitive to market signals, this implies that we may underestimate the average lot size for the total housing stock in this city.

- Rouwendal and Van der Straaten (2008) estimate the average price of residential land in Amsterdam in a hedonic analysis of house prices as 806 € per m$^2$. We have estimated the average lot size in Amsterdam as 95 m$^2$, so the value of land in an average house amounts to about 77,000 €. Discounting with a rate of 5%, this yields an annual expenditure on land of 3,800 €. The average disposable household income in Amsterdam is 24,000 €, using data from a Dutch housing demand survey (WBO) for the year 2002. Hence, we estimate the average expenditure share of land in the household budget to be about 16% in Amsterdam.

- At the municipal level, 37% of the non-agricultural land is allocated to residential use (data for 2005, provided by the municipal government of Amsterdam). This figure may underestimate the share of space in residential use within the urban area, given the way municipal borders are drawn. Using the same data as in Rouwendal and Van der Straaten (2008), the share of land in residential use has been estimated to be 53% in the centre of Amsterdam, and 36% in a more peripheral neighbourhood (Zuider Amstel). For the calibration, we use a share of 40%. Note that this is also in accordance with the share of land in residential use within urban areas in Reading (38%) and Darlington (43%), as reported by Cheshire and Sheppard (2002).

- As jobs in Amsterdam are scattered over the entire city, it seems problematic to calibrate annual transport costs to the CBD by estimating travel times and inferring costs and the valuation of time. Instead, we calibrate the parameter $t$ on the slope of the bid rent curve. In a hedonic analysis of house prices in Amsterdam, Rouwendal and Van der Straaten (2008) report that a 1 kilometre increase in the distance to the city centre decreases the value of a house by 9%, conditional on a range of control variables. We use this coefficient to estimate the transport costs per unit of distance from the CBD. By use of the envelope theorem, the derivative of the bid rent function with respect to transport costs equals $\frac{\partial p_i}{\partial r} = -t/s_i^* \log(p_i)$, where $s_i^*$ follows from solving the consumer problem. We rewrite this to $t = -p_i^*/s_i^* \log(p_i)$. From the estimates in Rouwendal and Van der Straaten (2008), it follows that $\frac{\partial \log(p_i)}{\partial r}$ is equal to -0.00009. For $p_i^*/s_i^*$ we substitute the average annual expenditure on land, which equals 3,800 € (see our discussion of the expenditure share of land in the
disposable household income). This yields an estimate of the annual travel costs per meter of distance from the CBD of 0.34 €.

- In an analysis of possibilities for new construction in North Holland, SEO(2003) estimates the price of agricultural land at 4 € / m², and the costs of conversion to residential land at 37 € / m². It is assumed here that the share of conversion in the total construction costs is in accordance with the share of land conversion in the total production by building contractors in national accounts, and the estimate of the conversion costs obtains by multiplying this share with the average construction costs per square meter in North Holland.

- The shadow price of land use regulation is estimated by subtracting the price of agricultural land and conversion costs from the price of residential land at the city fringe. The Amsterdam city fringe is represented by the Bovenkerkerpolder in the south of this city. Ecorys-NEI (2004) estimates the value of a newly constructed house in this area to be 344,000 €. Subtracting land, conversion and construction costs, they estimate the shadow price of land use regulation to be 42,000 € per house. These calculations assume a density of construction of 26 houses per hectare. Assuming that 40% of the land is used for housing, this yields an average housing size of 154 m². Hence, the shadow price is 273 € per meter, which amounts to 14 €/m² per year. The same study estimates the shadow price of land use regulation in Almere to be - 5,000 € per house, which amounts to -1.6 €/m² per year. This estimate suggests that the price of new housing in this city is not sufficient to cover all costs associated with its land use and construction, so that residential land use in Almere is effectively subsidized.

- The quality controlled house price differential is obtained by regressing the logarithm of house prices on housing characteristics and dummies for Amsterdam and Almere, using the WBO data again. The characteristics used are the type of house (detached, semi-detached, terraced corner, terraced non-corner, apartment), the number of rooms, the size of the living room and the kitchen, availability of an elevator, garage, garden, balcony, central heating, double glazing and the period of construction. Controlled for these characteristics, housing in Amsterdam is 35% more expensive than the national average, and in Almere it is 6% less expensive.

40 SEO (2003) estimates the shadow price of land use regulation in Amsterdam to be 550 €/m², which is almost twice as high as our estimate. However, local conversion and construction costs are estimated more roughly in this study, and it considers average house prices in Amsterdam, rather than prices at the city fringe. Nevertheless, this suggests that our estimate of the shadow price of land use regional in this area is conservative.
The area of the municipalities refers too land only, so it ignores cannels, lakes and other water. It should be noted that the municipal borders are drawn quite widely around the built up area. For instance, the municipal share of land in agriculture was 18% in Amsterdam and 33% in Almere (Bodemstatistiek 2000). Hence, this is likely to be a poor proxy for the size of the two cities, although it still gives some rough idea of their order of magnitude.

Theoretically, we have modelled the intercity infrastructure as a direct link between the CBD’s of the main city and the satellite. In reality, residents of Almere have to travel to the Amsterdam fringe (knooppunt Watergraafsmeer). From that point onwards, they face about the same travel costs as people who live near the fringe of Amsterdam. Hence, we proxy the transport costs faced by a resident of Almere by the sum of the transport costs from Almere to the fringe of Amsterdam and the transport costs from the fringe of Amsterdam to the CBD. The transport costs from the fringe of Amsterdam to the CBD follow from our estimate of \( t \) and the size of Amsterdam. The distance from Almere to the fringe of Amsterdam is 25 kilometres, and the average velocity during rush hours is about 60 kilometres per hour. The Dutch Transport Research Centre (AVV) estimates the valuation of travel time in 2005 to be 8.43 € per hour, and the variable costs of car use are estimated to be 0.101 € per kilometre. This results in daily commuting costs between Almere and the Amsterdam city fringe of about 12 €. With 260 working days a year, the annual costs are then about 3100 €.
Chapter 7

Conclusions

The two central questions in this thesis, as identified in its introduction, concern the impact of land use regulation on aggregate housing market outcomes and regional labour markets, as well as the normative evaluation of such consequences. Land use regulation is understood to encompass not only restrictions on the quantity and location of developable land, but also restrictions on the type of housing that is built on it, as well as implicit taxes levied by local governments. This concluding chapter will sum up and interpret the evidence, as presented in the various essays, in the light of these two questions. Furthermore, we tentatively discuss some policy implications of our findings, while sketching a future research agenda that could yield more substance to these implications.

The impact of land use regulation on aggregate housing market outcomes

Findings in this thesis consistently suggest a limited sensitivity of housing supply to demand conditions in the Netherlands. Notably, in chapter 3, new construction in the owner-occupier sector was estimated to rise with only about 0.04% after a 1% price increase in the same year. Using a comparable methodology, Mayer and Somerville (2000b) report a one-year response for the US that is higher by about a factor 100. A response through the quality of new construction in the owner-occupier sector was found to be limited as well. Our estimated price elasticity of residential investment was even lower, and it appeared to be negative for total new construction. In a long run analysis, we did not find any evidence that housing supply is responsive to prices either.

Surveys of the literature in chapters 2 and 3 reveal a substantial body of evidence suggesting that land use regulation restricts housing supply and raises prices, even if it turns out to be difficult to identify the impact of specific measures directly. Could this type of policy explain the low price elasticity of housing supply in the Dutch case as well? The most immediate evidence that in the Netherlands, regulation imposes binding restrictions on the supply of residential land is the price gap between land that is zoned for residential use and agricultural land (chapter 1). This difference may be interpreted as the shadow price of land use restrictions, thus quantifying the extent to which these are binding, or equivalently as a scarcity rent on residential land or a regulatory tax. Some indication of the economic
significance of these scarcity rents was provided in our calibrated model for Amsterdam and Almere (chapter 6), where households in Amsterdam where found to spend about 10% of their disposable income on the regulatory tax, which was more than they spent on land itself.

As we have discussed in chapter 2, some alternative explanations for a low price elasticity of housing supply do not stand to scrutiny. For instance, if market distortions would have been inherent to the housing construction industry, high prices and inelastic supply should be observed as a rule in other countries too, but as we have seen, housing supply is much more elastic in for instance the US, and the Dutch long-run upward trend in real house prices is exceptionally high from an international perspective (OECD, 2004a). On the other hand, if changes in house prices reflect scarcity rents on residential land, our finding that the volume of residential investment is almost fully inelastic may be reconciled with a construction industry that is reasonably competitive. Another falsifiable explanation for the limited price-responsiveness of new construction is that the scarcity of residential land would be due to the small geographical size of the Netherlands and its high population density. This would imply the existence of scarcity rents on all land, but the largest part of the land in the Netherlands is used for agriculture, which does not command a scarcity rent. Furthermore, our findings with respect to the quality of location of new housing supply did not support a competitive explanation in which differential land rents would have pushed up housing and land prices because of increasing scarcity of attractive locations.

Substantial delays in construction at VINEX locations in which land was de facto zoned for residential use already show that spatial planning at the national level is not the only inhibition to housing supply. Nevertheless, besides restrictions on the type of housing that did not conform market demand, a factor that may have played a role here was the implicit taxation of land use for private residential construction by municipalities, in order to recover cross subsidization of the social housing sector and the provision of local public goods. Legal privileges of land owners and the limited availability of alternative locations for new residential development may have made negotiations between municipalities and developers particularly cumbersome and lengthy. Probably, such negotiations would have been much speedier if there would not have been a planning induced scarcity rent to split up anyway. Hence, in its broad definition, land use regulation is likely to have played an important role in these delays.

Clearly, there are other institutional factors that account for the limited price-responsiveness of housing supply as well. In particular, rent controls have reduced incentives for investment in the social housing sector, and the relationship between aggregate prices and
CONCLUSIONS

supply in this sector has been further evaded by all kinds of subsidies, some of which with a counter-cyclical nature. While such institutions provide a plausible explanation for a loose or even negative relationship between aggregate house prices and new construction in the social rental sector, they do not account for a low price elasticity in the owner-occupier sector. Moreover, if the owner-occupier sector would not be hampered by land use regulation, one would expect that lagging supply in the social rental sector would be compensated by production in this sector, thus restoring the positive relationship between total housing supply and prices.

The impact on regional labour market outcomes
If land use regulation marks aggregate housing market outcomes to a large extent, then this policy is bound to affect regional housing market outcomes too, because land use and location are bundled. Moreover, if a strong interdependency between local housing and labour markets exists, there may be a further impact on regional labour market outcomes. Our thesis supports the presence of such indirect effects in two essays. Evidence of the interdependency between local housing and labour markets has been provided at the European level in chapter 5, on compensation of regional unemployment in housing markets. Chapter 4 has offered a closer look at the impact of housing supply on local population and employment growth in the Netherlands.

Urban Audit data for 142 cities over 12 EU countries have revealed a strong negative correlation between unemployment and house prices. We have estimated a relationship between local labour market perspectives, as measured by unemployment and income, and intercity house price variation, while controlling for a host of amenity variables. The evidence suggested that workers are compensated in housing markets to a significant extent, so that regional differences in unemployment may reflect an equilibrium outcome. These findings have been corroborated in an analysis of Dutch housing demand survey data, which accounted for housing and worker heterogeneity. The existence of compensating differentials in housing markets may reconcile two conflicting observations, which are the high persistence of regional unemployment differentials in Europe and the existence of a wage curve, a negative relationship between regional unemployment and wages.

Chapter 4 has provided more evidence on the potential impact of land use regulation on regional labour market outcomes in a joint analysis of regional housing supply, internal migration and employment growth. Employment was found to adjust to the regional supply of labour, while net internal migration was predominantly determined by regional housing
supply and not by employment growth. Growth of the regional housing stock responded only moderately to changes in the number of people and jobs. We have attributed the inelastic supply of aggregate housing to a significant extent to land use regulation, so this policy is likely to account for the lack of responsiveness to demand conditions at the regional level as well. In particular, as discussed in chapter 1, agricultural land in the Randstad area is widely available, but land use policies have prevented its usage for residential development in the Green Heart area and on many other locations in the vicinity of the large cities. Consequently, residential land in this area commands a substantial scarcity rent. The fact that the Randstad area has lagged behind surrounding areas in terms of job growth should thus be attributed to a planning-induced lack of housing supply.

A welfare economic perspective on land use regulation

In chapter 6, we have developed a welfare economic framework for the analysis of compact development and clustered deconcentration policies. As argued in chapter 1, these are characteristic features of Dutch land use planning. For instance, Figure 1.1 has illustrated that between 1995 and 2004, transformations of open space to urban use in the Randstad area occurred predominantly in relatively large contiguous areas that are attached to urban areas, thus adhering to the principles of compact development and clustered deconcentration. Similarly, the Dutch government imposes tight land use restrictions around Amsterdam, while accommodating a substantial part of regional demographic growth in the nearby town of Almere. We have applied our analysis to this latter case.

The type of externality that would naturally justify compact cities is a negative externality of geographical city size. We have shown that the first-best equilibrium in the presence of this externality may be obtained by the imposition of growth controls and that it may be desirable to accommodate housing demand in a nearby satellite, provided that fixed founding costs are sufficiently low. With rising incomes and declining transport costs, the foundation of satellites becomes increasingly attractive, which suggests that clustered deconcentration may be a socially preferable alternative to unregulated urban sprawl. Even so, growth controls should be less restrictive in satellites only to the extent that the externality is less relevant for people in small towns than for inhabitants of a big city. In particular, with this type of externality it is never optimal to subsidize land use in a satellite, as is currently happening in the case of Almere.

It should be borne in mind, however, that the welfare economic motivation for a clustered deconcentration policy depends crucially on the precise specification of this
externality. Different plausible specifications of land use externalities, such as the assumption that households value local parks rather than open space at the urban fringe (see for instance the evidence in Table 1.1), lead to radically different policy implications. Furthermore, in the calibrated model, we found that the optimal land use policy is also highly sensitive to the quantitative significance of the city size externality, while the social costs of implementing a suboptimal policy amount up to several percentage points of disposable household income.

Potential implications for policy

The results in chapters 3 and 4 sketch a picture of aggregate and regional housing markets as being largely supply driven. While they do not contain any formal normative analysis, these findings do raise doubts about the efficiency of the present level of restrictiveness. An almost complete absence of price responsiveness to market conditions means that supply does not respond to revealed demand at all. It is difficult to imagine market distortions that would render aggregate and local housing demand so wrong that land use planning should fully ignore it in order to attain the social optimum. At least, the strong negative externality of city size that we considered in chapter 6 is not sufficient, as the income elasticity of aggregate residential land use equals unity in an equilibrium with optimal policy, whereas it appears to be zero under present land use restrictions. Hence, although the body of empirically well-founded welfare economic analyses of land use regulation in the Netherlands is presently too thin for firm policy conclusions, common sense suggests that society would be better off if both aggregate and local housing supply were allowed to respond to market conditions to a significant extent.\(^1\) Of course, this is not to say that the government should fully withdraw from interventions in the land market, as the benefits of land use regulation are substantial. Rather, land use regulation may be too restrictive at the margin, so that in order to attain an efficient outcome, it should be relaxed in some ways or at certain locations. This calls for tailor-made evaluations, which focus on specific aspects of this policy.

To the extent that compact city and clustered deconcentration motives underlie government plans to accommodate a disproportionate share of regional demographic growth in Almere and to preserve strict growth controls around Amsterdam, this policy may be evaluated with the calibrated model of chapter 6.\(^2\) Optimality of the present level of

---

\(^1\) See for instance Cheshire and Sheppard (2005), who propose a manner to introduce price signals into land use planning decision-making.

\(^2\) Other motives for the preservation of growth controls around Amsterdam play a role as well, such as the proximity of a major airport and areas with intrinsic environmental and cultural value. Of course, a full discussion of the efficient allocation of land should also consider land use within the city boundaries, such as the
restrictiveness around Amsterdam requires a negative externality of city size that is so large, that households in this city should spend about 10% of their income on a development tax, or alternatively, on the increase in prices that is caused by land use restrictions. In a comparative static analysis, we find that even for this choice of parameters, about 75% of new households should be located in Amsterdam. If expected income growth is taken into account, it makes sense to concentrate household growth in Almere, but Amsterdam should be allowed to expand significantly nevertheless, because household demand for land is pushed up. Furthermore, both demographic and income growth make it increasingly attractive to divert new households to new satellites, if we allow for them. Hence, it seems difficult to reconcile present plans for restrictions around Amsterdam and growth in Almere with the optimal policy that is dictated by a negative externality of city size.

Our analysis in chapter 6 has understated the social costs of maintaining growth controls around Amsterdam to the extent that economies of agglomeration are present, which imply additional productivity gains if this city is allowed to expand. The same holds true for growth controls around the other large cities in the Randstad area and the preservation of the Green Heart. Through a higher rate of job growth, a more relaxed planning policy would probably have increased productivity in this area, which appears to be lagging behind the development of productivity in other major metropolitan areas (OECD, 2007).

Perhaps, the most important recommendation that may be derived from this thesis is the need to acquire a better understanding of land use externalities and the way in which they should be optimally addressed. The empirical literature shows that costs as well as benefits of land use regulation may be large, so there is much to gain, but there is also much to lose (chapter 2). The optimal land use policy that was derived in chapter 6 depends strongly on assumptions about the nature and extent of these externalities, and we have shown that wrong judgements might lead to very costly policies. Similarly, in their study of land use regulation in the British town of Reading, Cheshire and Sheppard (2002) found that the benefits of relaxing land use restrictions may exceed costs by an amount of up to about 4% of net household income in terms of equivalent variation. This is an order of magnitude larger than the social costs of mortgage interest deductibility, which have been recently estimated for the Netherlands at 0.4% of GDP at most (Van Ewijk et al., 2006). However, while consequences

significant amount of industrial land in the west, which could perhaps be beneficially transformed into residential use.

3 Through spatial sorting of the active population into the regions with the highest employment density, agglomeration economies might be further enhanced. However, this sorting process may be hindered by policies that limit housing mobility, such as the tax on housing transfers. Although we focus on land use regulation in this thesis, it is thus important to bare the potential consequences of other housing market policies in mind.
of the present fiscal treatment of housing have received significant attention from economists and the wider society, welfare economic effects of land use regulation are still barely understood and largely ignored.

A future research agenda

Without any pretension of being exhaustive, we conclude this thesis by suggesting several avenues in which our understanding of the consequences and desirability of land use regulation could be enhanced (see also chapter 2). In terms of positive analysis, more work should be done on the identification of impacts of specific government interventions in land and housing markets, while meeting the econometric challenges to policy evaluation. For instance, to what extent is elastic supply hampered by either aggregate supply of residential land, the location of this land or by regulation of quality? How do urban land markets function under restrictive direct land use regulation, and does this setting give rise to certain agency problems? How do institutions in the rental market and financing schemes for the provision of local public goods affect the relationship between demand and supply in the owner-occupier segment?

The measurement of land use externalities that exceed the local level is challenging as hedonic methods are unlikely to capture the full value of benefits, but the relative valuation of nearby parks and open space at the city fringe is of crucial importance for the design of optimal land use plans. Progress in this domain should therefore be made by employing different empirical methods. Negative externalities of land in industrial use should be taken into consideration as well. The national and local governments have been fairly generous with the supply of this type of land, which is somewhat paradoxical in the light of strict limits on the supply of residential land and the strong valuation of open space that his presumes.

For a full evaluation of land use policies, more attention should also be paid to its wider economic effects. We have shed some light on one example, which is the impact that restrictions on the supply of residential land in a region may have on productivity, through economies of agglomeration. Another issue that has been discussed by Van Ewijk et al. (2006) is the potential impact of housing market distortions on labour supply, because expensive housing reduces real wages. In general, there may be many distortions in the economy that drive a wedge between direct effects of land use regulation in housing markets and its social costs when all general equilibrium effects are taken into account.

In this respect, the relationship between planning of land use and infrastructure is a particularly important issue. Chapter 6 has indicated that the efficiency of clustered
deconcentration policies depends strongly on intercity infrastructure investment, and the reverse is likely to hold as well. Furthermore, one of the rationales for compact development that we have not explicitly dealt with is that a high density of development fosters the use of public transit systems, which society may deem desirable. Hence, future work should consider the efficiency of land use regulation and infrastructure investment in an integrated framework.

Distributional effects of land use regulation have not received a lot of attention in the literature either. Do the benefits of this policy accrue disproportionally to the rich, as has been suggested by Cheshire and Sheppard (2002)? And what about the distribution of costs? Another interesting dimension is redistribution between households and landowners. Direct land use regulation implies the existence of scarcity rents, which are substantial in the case of the Netherlands. To whom do these rents accrue if agricultural land is converted to residential use? How should we weigh the small group of land owners that is made rich by this type of regulation in the social welfare function, and does this alter the conclusions of policy evaluations that are purely based on efficiency considerations? Could further welfare losses be incurred because different parties devote resources to land rent seeking?

Finally, the skewness of distributional effects of land use regulation in multiple dimensions, as well as the fact that in the early 1990s, the Dutch median voter has become a homeowner, call for a political economic analysis of this policy. Could it be that voting for local land use restrictions leads to inefficient policies because outsiders do not have a say? Under what conditions would policy competition between local governments yield an efficient outcome? What would then be the optimal level of governance for land use policies? Could it be that voting for national housing policies leads to inefficient outcomes because generations that have not entered the housing market yet are not sufficiently represented? Perhaps, if it can be plausibly shown that voters do not have the right incentives for establishing an efficient land use policy, the complicated stage of empirical welfare analysis may be partially bypassed by transforming institutions so as to repair these incentives.
Bibliography


Bibliography


BIBLIOGRAPHY


Gordon, R. J. (2004). Why was Europe left at the station when America’s productivity locomotive departed? NBER Working Paper no. 10661.


BIBLIOGRAPHY


Samenvatting (summary in Dutch)

Essays over woningaanbod, ruimtelijke ordening en regionale arbeidsmarkten

In landen en steden over de hele wereld hebben hoge huizenprijzen de aandacht gevestigd op ruimtelijke ordening en op het mogelijke effect van dit beleid op het functioneren van woningmarkten. Zo is de prijs van een appartement in Manhattan door restricties op de hoogte van gebouwen ruim twee keer zo hoog als de bouwkosten, en het Britse ruimtelijke ordeningsbeleid is recentelijk onder hevige kritiek gekomen te staan, zowel door het hoge niveau van huizenprijzen, als door hun instabiliteit. Desalniettemin is de economische literatuur over ruimtelijke ordening in beschrijvende en in normatieve zin beperkt, hetgeen verrassend en onwenselijk lijkt in verband met de omvang en het belang van de woningmarkt. Wonen is immers voor de meeste huishoudens de grootste kostenpost van hun budget, en voor eigenaar-bewoners vormt de eigen woning vaak het grootste aandeel van hun investeringen.

Ook in Nederland grijpt de overheid langs verschillende wegen in op de woningmarkt. Aan de ene kant wordt de vraag naar woningen bevorderd door de fiscale behandeling van de eigen woning en door het huurbeleid, terwijl er anderzijds beperkingen op het aanbod worden gelegd door ondermeer de ruimtelijke ordening. In het bijzonder beperkt het ruimtelijke beleid het aanbod van woningbouwgrond door aan te geven waar wel en niet gebouwd mag worden. De waardesprong die een stuk landbouwgrond in de Randstad maakt als de bestemming ervan gewijzigd wordt in woningbouw is illustratief voor de mate waarin dit soort beperkingen bindend zijn. Daarnaast kan het ruimtelijke beleid eisen opleggen aan het type woning dat gebouwd wordt, zoals bijvoorbeeld de bevordering van hoge dichtheden op VINEX locaties. Tenslotte kunnen gemeenten via de prijs van bouwrijpe grond impliciete belastingen opleggen aan nieuwbouw in de koopsector, waarmee het aanbod van lokale voorzieningen en nieuwbouw in de sociale sector gesubsidieerd worden. Dit soort beleid, waar we in dit proefschrift naar verwijzen als ruimtelijke ordening in de brede zin (regulering van grondgebruik), creëert verschillende baten, zoals in het bijzonder de bescherming van waardevolle open ruimte. De combinatie van subsidies op woningvraag en restricties op het aanbod maakt wonen echter wel kostbaar. Reële huizenprijzen zijn in dit land dan ook meer dan verdrievenigd sinds het begin van de jaren zeventig.
In dit proefschrift dragen we bij aan de beperkte economische literatuur over ruimtelijke ordening door ons te richten op de effecten van dit soort beleid in Nederland. Het bevat zowel empirisch onderzoek, waarin we trachten om ons inzicht in de aanbodkant van de woningmarkt te verdiepen, als normatieve analyse gebaseerd op welvaartseconomische theorie. In het normatieve deel richten we ons vooral op twee voor Nederland karakteristieke eigenschappen van het ruimtelijke beleid, namelijk het bevorderen van compacte steden en gebundelde deconcentratie. Een derde aspect dat in dit proefschrift centraal staat is de doorwerking van dit beleid op regionale arbeidsmarkten, die aannemelijk lijkt vanwege de bundeling van grondgebruik en locatie. De opbouw van het proefschrift is als volgt. In hoofdstuk 3 belichten we de relatie tussen ruimtelijke ordening, woningaanbod en prijzen op geaggregeerd niveau. Op de doorwerking van ruimtelijke ordening op regionale arbeidsmarkten gaan we in de hoofdstukken 4 en 5 in. We evalueren dit beleid vanuit een welvaartseconomisch perspectief in hoofdstuk 6. Een uitgebreide discussie van de relevante literatuur wordt aangeboden in hoofdstuk 2. Tenslotte bevatten de hoofdstukken 1 en 7 respectievelijk een inleiding en conclusies.

**Woningaanbod en ruimtelijke ordening op nationaal niveau**

Woningaanbod blijkt in Nederland nauwelijks gevoelig voor veranderingen in prijzen (hoofdstuk 3). In een tijdreeksanalyse van woningaanbod in de koopsector vanaf 1970 vinden we dat nieuwbouw met 0.04% toeneemt na een reële prijsstijging van 1% in hetzelfde jaar. Een studie van woningaanbod in de VS die vergelijkbare methoden hanteert, rapporteert een elasticiteit die zo’n factor 100 hoger is. Ook de reactie van het aanbod door een verbetering van de kwaliteit van nieuwe woningen blijkt beperkt, terwijl de geschatte prijsselasticiteit voor het volume van investeringen in woningen nog lager is, en voor de totale nieuwbouw zelfs negatief. We vinden geen aanwijzingen voor een elastisch woningaanbod op de lange termijn.

De internationale literatuur wijst op een negatief verband tussen de prijsselasticiteit van woningaanbod en de restrictiviteit van ruimtelijke ordeningsbeleid, hoewel het moeilijk blijkt om de uitwerking van specifieke maatregelen te identificeren (hoofdstuk 2). Is dit verband ook in Nederland van toepassing? De meest directe aanwijzing hiervoor is het verschil tussen de prijs van grond met woningbouwbestemming en de prijs van landbouwgrond, dat met name in de Randstad substantieel is. Dit verschil kan geïnterpreteerd worden als een schaduwprijs van restricties op grondgebruik, die de mate waarin deze restricties bindend zijn kwantificeert. Het is equivalent met een schaarstepremie of reguleringsbelasting op grondgebruik voor wonen van dezelfde hoogte. In hoofdstuk 6 werd een indicatie gegeven
SAMENVATTING

van het economische belang van deze schaarstepremies. In een gestileerd model hebben we laten zien dat de geobserveerde schaduwprijs in Amsterdam overeen komt met een belasting ter hoogte van 10% van het besteedbaar huishoudinkomen, en dat inwoners van deze stad hier gemiddeld bijna twee keer zoveel aan uitgeven als aan de grond exclusief belasting.

We hebben in hoofdstuk 2 ook laten zien dat verscheidene andere verklaringen voor de lage aanbodselasticiteit geen stand houden. Bijvoorbeeld, als marktverstoringen inherent aan het bouwproces zouden zijn, dan zouden hoge prijzen en inelastisch aanbod als regel ook in andere landen waargenomen moeten worden. Het woningaanbod is in Nederland echter beduidend minder elastisch dan bijvoorbeeld in de VS, en reële huiziprijzen zijn hier in de afgelopen decennia ook harder gestegen dan in de meeste andere landen. Als veranderingen in huizenprijzen daarentegen gedreven worden door schaarstepremies op woningbouwgrond, dan zou onze bevinding dat het volume van investeringen in woningen niet gevoelig is voor prijzen in overeenstemming kunnen zijn met een redelijk competitieve bouwsector. Een andere falsifieerbare verklaring voor de lage aanbodselasticiteit is dat de schaarste van bouwgrond volgt uit het feit dat Nederland een klein en dichtbevolkt land is. Deze veronderstelling zou impliceren dat er schaarstepremies betaald moeten worden voor elke vorm van grondgebruik, maar het grootste deel van de Nederlandse grond wordt nog steeds gebruikt voor landbouw en dit vereist geen substantiële schaarstepremie. Daarnaast is gebleken dat de kwaliteit van nieuwbouwlocaties sinds het begin van de jaren 1970 niet veel slechter is geworden, dus de stijging van huizenprijzen kan ook niet verklaard worden uit het schaarser worden van aantrekkelijke locaties.

De vertragingen op VINEX locaties, waar grond *de facto* al voor woningbouw bestemd was, tonen aan dat ruimtelijke ordening op nationaal niveau niet de enige belemmering op nieuwbouw vormt. Echter, naast restricties op het type woning die niet met de marktvraag in overeenstemming waren, hadden deze vertragingen waarschijnlijk ook te maken met de impliciete belasting die gemeenten heffen op grond voor woningbouw in de private sector, om lokale publieke goederen te financieren en de sociale sector te subsidiëren. Het zelfrealisatiebeginsel en de beperkte aanwezigheid van alternatieve nieuwbouwlocaties zullen de onderhandelingen tussen gemeenten en ontwikkelaars nog moeizamer gemaakt hebben. Deze onderhandelingen zouden veel soepeler verlopen zijn als er geen schaarstepremie te verdelen was. Ruimtelijke ordening in de brede definitie heeft dus wel degelijk een belangrijke rol gespeeld bij de vertragingen op nieuwbouwlocaties.

Er zijn natuurlijk andere institutionele factoren die bijgedragen hebben aan de beperkte prijsselasticiteit van het woningaanbod in Nederland. Het huurbeleid heeft
bijvoorbeeld de prikkels om te investeren in de sociale sector verminderd, en de relatie tussen prijzen en aanbod in deze sector is verder verzwakt door allerlei subsidies, waarvan sommigen een anticyclisch karakter hadden. Zulke instituties vormen een plausibele verklaring voor een zwak of zelfs negatief verband tussen prijzen en nieuwbouw in de sociale sector, maar ze kunnen niet verklaren waarom de aanbodselasticiteit in de koopsector zo laag is. Bovendien, als ruimtelijke ordening de woningbouw in de koopsector niet zou belemmeren, dan zou men verwachten dat achterblijvend woningaanbod in de sociale sector gecompenseerd zou worden door productie in deze sector, om zo het verband tussen prijzen en het totale woningaanbod te herstellen.

**Ruimtelijke ordening en regionale arbeidsmarkten**

Als ruimtelijke ordening zo’n grote invloed heeft op het functioneren van de woningmarkt op nationaal niveau, dan moet dit beleid ook doorwerken op regionale woningmarkten. Als er bovendien ook een sterke relatie bestaat tussen uitkomsten op regionale woning- en arbeidsmarkten, dan kunnen er repercussies zijn op het functioneren van regionale arbeidsmarkten. De samenhang tussen locale woning- en arbeidsmarkten is ondermeer gebleken uit de sterke negatieve correlatie tussen werkloosheid en huizenprijzen voor 142 steden in 12 EU landen uit de *Urban Audit*. Op basis van deze data hebben we in hoofdstuk 5 een verband geschat tussen perspectieven op de locale arbeidsmarkt, zoals gemeten door werkloosheid en inkomen, en verschillen in locale huizenprijzen, terwijl we het voorzieningenniveau bij benadering constant gehouden hebben. Hieruit kwam naar voren dat de beroepsbevolking in behoorlijke mate gecompenseerd wordt in woningmarkten, zodat regionale verschillen in arbeidsmarkt perspectieven een evenwichtsuitkomst zouden kunnen zijn. Deze bevindingen worden ondersteund in een analyse van het Nederlandse Woning Behoefte Onderzoek uit 2002, waarin gecontroleerd is voor heterogeniteit van huizen en van de beroepsbevolking. Op Europees niveau kan het bestaan van compensatie in woningmarkten twee tegenstrijdige observaties met elkaar in overeenstemming brengen, namelijk de sterke persistentie van regionale werkloosheidsverschillen en het bestaan van een *wage curve*, een negatief verband tussen regionale werkloosheid en lonen.

Een regionale tijdreeksanalyse van de samenhang tussen woningaanbod, binnenlandse migratie en werkgelegenheidsgroei in Nederland (hoofdstuk 4) heeft meer licht geworpen op de potentieel belangrijke rol van ruimtelijke ordening. Hieruit is namelijk gebleken dat de werkgelegenheid zich aanpast aan het regionale arbeidsaanbod, terwijl netto binnenlandse migratie vooral bepaald wordt door het regionale aanbod van woningen, en niet door
werkgelegenheidsgroei. De groei van de regionale woningvoorraad blijkt niet bijzonder gevoelig voor veranderingen in het aantal banen of mensen. Het ligt voor de hand om de gebrekkige gevoeligheid van het regionale woningaanbod voor deze vraagfactoren aan ruimtelijke ordening toe te wijzen, omdat ook de lage prijsselasticiteit van het nationale woningaanbod in belangrijke mate verklaard lijkt te kunnen worden door regulering van grondgebruik (hoofdstuk 3). Consistent met deze verklaring observeren we dat voor woningbouw geschikte landbouwgrond in de Randstad ruimschoots aanwezig is, maar dat beleid verhinderd heeft dat het hiervoor aangewend werd in gebieden zoals het Groene Hart en de Buffer zones tussen de grote steden (hoofdstuk 1). Dit betekent dat de lage werkgelegenheidsgroei in deze regio ten opzichte van omliggende gebieden een indirect gevolg is van een door ruimtelijke restricties opgelegd tekort aan woningen.

Een welvaartseconomisch perspectief op ruimtelijke ordening

We hebben in hoofdstuk 6 een welvaartseconomisch raamwerk opgezet voor de evaluatie van twee kenmerkende eigenschappen van het Nederlandse ruimtelijke ordeningsbeleid, namelijk het bevorderen van compacte steden en gebundelde deconcentratie. Hoe groot de rol van dit soort beleid is blijkt onder meer uit het feit dat nieuwbouw in de Randstad voornamelijk plaatsvindt in relatief grote aaneengesloten gebieden die aan reeds bestaande stedelijke gebieden grenzen (hoofdstuk 1) en uit het voornemen van de overheid om restricties op grondgebruik rond Amsterdam grotendeels te handhaven en een substantieel deel van de nieuwbouw in de Noordvleugel te accommoderen in Almere. We hebben onze analyse toegepast op dit laatste voorbeeld.

Het soort marktverstoring dat het compacte steden beleid zou kunnen motiveren is een negatieve externaliteit van de omvang van een stad. Zo’n externaliteit zou op kunnen treden als mensen het onprettig vinden om door bebouwing omringd te worden, of als ze waarde hechten aan open ruimte aan de stadsrand, die immers minder bereikbaar wordt als een stad groeit. We hebben laten zien dat er dan een optimaal evenwicht bereikt kan worden door het opleggen van groeirestricties. Als de vaste stichtingskosten niet te groot zijn, dan kan het bovendien wenselijk zijn om de vraag naar woningen in een nabijgelegen satellietstad te accommoderen. Stijgende lonen en dalende transportkosten maken het stichten van een satelliet steeds aantrekkelijker, zodat gebundelde deconcentratie vanuit maatschappelijk oogpunt te prefereren zou kunnen zijn boven ongereguleerde groei van steden. Toch moeten groeibeperkingen in de satelliet alleen minder restrictief zijn dan in de moederstad voor zover de negatieve externaliteit van stadsgrootte minder belangrijk is voor mensen in kleine steden.
SUMMARY IN DUTCH

dan inwoners van een grote stad. In het bijzonder kan dit type externaliteit nooit een motivatie zijn voor het subsidiëren van grondgebruik in de satelliet, zoals nu in Almere lijkt te gebeuren.

Men moet hierbij echter wel bedenken dat de welvaartseconomische motivatie voor het compacte steden beleid en gebundelde deconcentratie cruciaal afhangt van hoe deze externaliteit geformuleerd is. Een volstrekt ander soort ruimtelijk beleid zou bijvoorbeeld gevoerd moeten worden onder andere plausibele specificaties van open ruimte externaliteiten, zoals de aanname dat huishoudens locale parken waarderen in plaats van open ruimte aan de stadsrand (hoofdstuk 2). Bovendien vonden we in een gekalibreerde versie van het model dat het optimale ruimtelijke beleid bijzonder gevoelig is voor de grootte van de negatieve externaliteit van stadsgrootte, en dat de maatschappelijke kosten van het implementeren van suboptimaal beleid op zouden kunnen lopen tot enkele procenten van het besteedbaar huishoudinkomen.

Implicaties voor beleid
Het beeld dat de empirie in de hoofdstukken 3 en 4 van dit proefschrift ten aanzien van nationale en regionale woningmarkten schetst, is dat deze voornamelijk aanbodgestuurd zijn. Hoewel dit resultaat geen formele welvaartsanalyse omvat, doet het toch vragen rijzen ten aanzien van de wenselijkheid van de huidige mate van restrictiviteit van de ruimtelijke ordening. Een bijna volstrekte afwezigheid van gevoeligheid voor marktcondities betekent dat het aanbod niet beantwoordt aan de vraag, zoals die blijkt uit prijzen. Het is moeilijk om factoren te bedenken die de nationale en locale vraag naar woningen zo verstoren, dat ruimtelijke ordening ze volledig zou moeten negeren om een maatschappelijk optimum te bereiken. Op zijn minst is de sterke negatieve externaliteit van stadsgrootte die we in hoofdstuk 6 geanalyseerd hebben niet voldoende, want de inkomenselasticiteit van het totale residentiële grondgebruik is bij benadering gelijk aan 1 in een evenwicht waarin optimaal beleid gevoerd wordt, terwijl deze elasticiteit gelijk aan 0 lijkt te zijn in het huidige beleid. Hoewel de huidigewelvaartseconomische literatuur over ruimtelijke ordening in Nederland te beperkt is om sterke beleidsconclusies te trekken, suggereert dit wel dat de samenleving beter af zou zijn als zowel het nationale als het locale aanbod van woningen meer op marktcondities zouden kunnen reageren. Dit betekent natuurlijk niet dat de overheid niet in de grondmarkt zou moeten interveniëren, omdat dit soort beleid ook substantiële baten genereert (hoofdstuk 2). Waarschijnlijk is ruimtelijke ordening daarentegen wel te beperkend aan de marge, zo dat het op bepaalde manieren of op sommige plaatsen soepeler zou moeten worden
om een maatschappelijk optimum te bewerkstelligen. Dit vraagt om evaluaties die op specifieke aspecten van dit soort beleid focussen.

Voor zover het bevorderen van compacte steden en gebundelde deconcentratie de huidige beleidsvoornemens motiveren om restricties rond Amsterdam te handhaven en een groot deel van de woningvraag in Almere te accommoderen, kunnen we dit beleid evalueren met het gekalibreerde model dat in hoofdstuk 6 van dit proefschrift ontwikkeld is. Het optimale karkater van het huidige niveau van restrictiviteit rond Amsterdam vereist hierin een negatieve externaliteit van stadsomvang die zo groot is, dat huishoudens in deze stad gemiddeld zo’n 10% van hun besteedbare inkomen aan een ontwikkelingsbelasting moeten uitgeven, of aan de toename in prijzen die het gevolg is van directe regulering van grondgebruik. In een comparatief statische analyse vinden we dat zelfs voor deze keuze van parameters zo’n 75% van de nieuwe huishoudens in Amsterdam gehuisvest zou moeten worden. Als de verwachte inkomensgroei in de analyse wordt betrokken, dan wordt het wenselijk om meer huishoudens in Almere te accommoderen, maar Amsterdam zou dan toch significant in omvang moeten groeien, omdat de vraag naar woningoppervlak per huishouden toeneemt. Bovendien maken bevolkings- en inkomensgroei het steeds aantrekkelijker om nieuwe huishoudens in nieuwe satellieten te vestigen, als het stichten hiervan is toegestaan. Het is daarom moeilijk om de huidige overheidsplannen voor restrictief beleid rond Amsterdam en expansie van Almere in overeenstemming te brengen met het optimale beleid dat uit een negatieve externaliteit van stadsgrootte zou volgen.

Deze analyse onderschat de maatschappelijke kosten van het handhaven van groeiberperkingen rond Amsterdam ook nog eens omdat we geen rekening gehouden hebben met het bestaan van agglomeratievoordelen. Immers, groei van deze stad zou dan tot een toename van de productiviteit kunnen leiden. Hetzelfde geldt voor groeiberperkingen rond de andere grote steden in de Randstad en de bescherming van het Groene hart. Middels een hogere groei van de werkgelegenheid zou een meer ontspannen ruimtelijke ordeningsbeleid waarschijnlijk bijgedragen hebben aan de productiviteit in deze regio, die minder snel groeit in termen van arbeidsproductiviteit dan andere metropolitane gebieden in de OESO (hoofdstuk 4).

Misschien is de belangrijkste beleidsimplicatie die uit dit proefschrift naar voren komt de noodzaak om een beter begrip te ontwikkelen van open ruimte externaliteiten en de manier waarop beleid hier idealiter mee om zou moeten gaan. De empirische literatuur laat zien dat zowel de kosten als de baten van ruimtelijke ordening groot kunnen zijn, zo dat er veel te winnen is bij dit soort beleid, maar ook veel te verliezen (hoofdstuk 2). Het optimale beleid in
ons gekalibreerde model voor Amsterdam en Almere hangt in sterke mate af van het karakter en de omvang van open ruimte externaliteiten, en we hebben laten zien dat de samenleving een hoge prijs zou betalen voor een verkeerde inschatting ervan. Ook in een studie van ruimtelijke ordening in de Britse stad Reading werd gevonden dat de baten van een minder restrictief beleid de kosten konden overstijgen met zo’n 4% van het netto huishoudinkomen in termen van equivalente variatie. Dit is een veelvoud van de maatschappelijke kosten van de hypotheekrenteaf trek, die in Nederland recentelijk geschat zijn op maximaal 0.4% van het BBP. Echter, terwijl de gevolgen van de huidige fiscale behandeling van de eigen woning veel aandacht krijgen van economen en van de bredere samenleving, worden de welvaartseffecten van ruimtelijke ordening nog steeds slecht begrepen en grotendeels genegeerd.
The Tinbergen Institute is the Institute for Economic Research, which was founded in 1987 by the Faculties of Economics and Econometrics of the Erasmus Universiteit Rotterdam, Universiteit van Amsterdam and Vrije Universiteit Amsterdam. The Institute is named after the late Professor Jan Tinbergen, Dutch Nobel Prize laureate in economics in 1969. The Tinbergen Institute is located in Amsterdam and Rotterdam. The following books recently appeared in the Tinbergen Institute Research Series:

381. O.A.C. VAN HEMERT, *Dynamic investor decisions.*
382. Z. ŠAŠOVOVÁ, *Liking and disliking: The dynamic effects of social networks during a large-scale information system implementation.*
386. V. PANCHENKO, *Nonparametric methods in economics and finance: dependence, causality and prediction.*
394. E.A. MOOI, *Inter-organizational cooperation, conflict, and change.*
395. A. LLENA NOZAL, *On the dynamics of health, work and socioeconomic status.*
397. R. HUANG, *Three essays on the effects of banking regulations.*
400. W. JANSSENS, *Social capital and cooperation: An impact evaluation of a women’s empowerment programme in rural India.*
402. S. DOMINGUEZ MARTINEZ, *Decision making with asymmetric information.*
403. H. SUNARTO, *Understanding the role of bank relationships, relationship marketing, and organizational learning in the performance of people’s credit bank.*
404. M.Á. DOS REIS PORTELA, *Four essays on education, growth and labour economics.*
405. S.S. FICCO, *Essays on imperfect information-processing in economics.*
411. J.F. SLIJKERMAN, Financial stability in the EU.
412. W.A. VAN DEN BERG, Private equity acquisitions.
413. Y. CHENG, Selected topics on nonparametric conditional quantiles and risk theory.
415. F. RAVAZZOLO, Forecasting financial time series using model averaging.
417. M. POPLAWSKI RIBEIRO, Fiscal policy under rules and restrictions.
419. L. RATNOVSKI, A Random Walk Down the Lombard Street: Essays on Banking.
420. R.P. NICOLAI, Maintenance models for systems subject to measurable deterioration.
421. R.K. ANDADARI, Local clusters in global value chains, a case study of wood furniture clusters in Central Java (Indonesia).
422. V. KARTSEVA, Designing Controls for Network Organizations: A Value-Based Approach.
423. J. ARTS, Essays on New Product Adoption and Diffusion.
425. M. VAN DER VOORT, Modelling Credit Derivatives.
427. E. BEKKERS, Essays on Firm Heterogeneity and Quality in International Trade.