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Book section

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Adam Smith devoted half as much again to the analysis of the 'rent of land' as he did to the 'wages of labour'; Alfred Marshall in his Book IV, on the *Agents of Production,* had 5 times as much material on land as he had on labour and an additional separate chapter in Book V on urban land; Paul Samuelson's classic *Economics* still devoted chapters to both land and labour and land came first: but labour got more coverage. A modern economics syllabus will acknowledge three factors of production – land, labour and capital (land still usually comes first) - but unless the student is one of that almost extinct breed, an agricultural economist, land will likely never be mentioned again.

When Adam Smith was writing somewhere around 12% of the population of Europe lived in cities and even in the most urbanised country – England – it was barely more than 20 percent (Bairoch, 1988). Glasgow and Edinburgh combined had a population of about 100,000 although Scotland was not far behind England in urbanisation. According to Piketty (2014) the value of agricultural land in Britain was more than three times that of annual GDP around 1775 but well under one tenth by 1960. It is not surprising that economists lost interest in land.

But land is making a comeback. Other data in Piketty suggest one reason. While all residential property in Britain was worth about the same as annual GDP all the way from 1700 to about 1960, by 2010 it was worth three times as much. By the end of 2013 houses accounted for 61% of the UK's net worth: up from 48.7% 20 years previously (ONS, 2013). Applying the rule of thumb that the rebuild value of the stock of residential property is roughly equal to the total value of GDP, then the value of the land on which the housing stock sat went from 1.28 times that of GDP in 1992 to 1.74 times 2013 UK GDP. The more painstaking calculations of Knoll *et al.*, (2014) conclude that the UK was in fact far from the top of the international league in terms of the contribution land price increases made to total house price increases in the period 1950 to 2012 (with almost all the increase in land prices taking place post-1970): they estimated land prices contributed from 74 to 96 percent to the increase in house prices with the greatest contribution in Finland. The relative value of residential land has risen in all countries for which there are estimates. In the US, although still lower than in the UK, it rose from a lower base and shows more regional variation (Piketty, 2014).

There seem to be at least two main reasons for this dramatic turnaround in the value of land relative to other assets and to GDP over the past 50 years or so. The first is the resurgence of agglomeration economies leading to a resurgence of major cities. Agglomeration economies are a form of externality affecting both total factor productivity but also welfare directly via agglomeration economies in consumption. The classic discussion of agglomeration economies

in production is usually traced to Marshall (1890) although the basic ideas go back at least to Adam Smith and the division of labour. Marshall's exposition of why cities provided more productive locations was in terms of manufacturing and specialisation. But the decline in manufacturing, the increase in firm and plant sizes with their internal economies of scale and, above all, the overall reduction in transport costs and the switch to road transport for goods (Anas and Moses, 1979) caused both a diaspora of manufacturing from cities and a reduction in the importance of agglomeration economies in industry. This process, from after WWII until around 1980, was the period of 'urban decline' especially obvious in the great cities generated by the industrial revolution – the Glasgows, Detroits and Essens of the industrialised countries.

However to the initial surprise of those questioning the ability of cities to survive (Pettengill and Uppal, 1974) and the predictors of the death of distance (Cairncross, 1997) from about 1980 cities have made a striking comeback (see, for example, Cheshire 1995; 2006; Kahn and Costa, 2000). The growing sectors of advanced economies, tradeable services such as finance or business services, R & D, Higher Education, Media or cultural industries, are subject to particularly important agglomeration economies (Graham, 2009); and so are expanding consumption activities such as tourism, museum visiting or live performance and sports events. Both jobs and people, especially the college educated with more spending power, have been increasingly attracted to cities. This has bid up the price of land and housing, the more so in the more central parts of the largest cities.

If the resurgence of cities, promoted by the renewed force of agglomeration economies in both production and consumption, is one reason for the rise in the relative value of land, the second is the continuing rise in real incomes coupled with the strong income elasticity of demand for living space, whether in houses or gardens or indeed in parks and recreational areas. If land for living on were in perfectly elastic supply this would not increase its relative price. But it is not. Partly this may be because of agglomeration economies themselves making space in larger cities more desirable and, all else equal, space is more expensive the larger a city is (as is explored in section I of this collection); but partly (as the readings in section IV of this collection make clear) because policy has increasingly constrained urban land supply by restrictive land use regulation – planning or zoning. In other words, to misquote Mark Twain, 'buy land they've stopped us making any more'. Because, of course, until urban growth boundaries or Green Belts were imposed from the 1950s onwards, a major activity was making more urban land: mainly by building new transport systems (except in the Netherlands where they really did make land). So in the past 50 or 60 years, in more and more of the richest countries, policy has all but stopped the 'production' of urban land. And as demand has risen with rising incomes (and population) so has the real price of land.

The salience of land and property markets in both the popular conscientiousness and in terms of economic significance has correspondingly risen. This has been partly, but still only partly, reflected in the work of economists. As one of us remarked in the introduction to a previous

Edward Elgar volume (Cheshire and Duranton, 2004) there has been a surge of papers on urban or spatial economics published in mainstream economics journals over the past 15 years and "… this reflects the renewed interest of the economics profession…"

This renewed interest of mainstream economists in land and land markets is reflected in this volume: 24 percent of our selections are from front ranking general interest economics journals and published since 2000; another 21 percent are from similarly recent issues of the leading 'field' journal in urban economics.

But as was implied above, interest in land markets was powerful in the early stages of the intellectual development of the subject because land itself was so economically important. Many of the pioneers of economics, notably David Ricardo – made powerful contributions still embedded in current thought. Ricardo is not represented here but a less known economist of that period, the extraordinary Johann Heinrich von Thünen, is, if indirectly. Von Thünen is still underappreciated as a pioneering economic thinker – perhaps partly because so little of his work has been translated into English, and that which has, is so powerfully about land and spatial economics. His seminal work *Isolated State*, on analysing how market forces with transport costs give rise to distinct and predictable patterns of agricultural land use and relative prices, is the exception. But as our first reading makes clear his contribution was far wider and was extraordinary.

William Alonso (1960) extended von Thünen's central concept of bid rent curves to an urban context in which the focal point is the Central Business District (CBD) where jobs are concentrated. This implies the only significant spatial characteristic of a location is its distance from the city centre. Von Thünen's farmland, where distance from the market was the driving force determining the agricultural use of land, becomes land for housing, plants, offices, and infrastructure. Rural economics morphs into *urban economics* where the main objective is to explain the internal structure of cities: how land is distributed among activities and why cities have one or several CBDs. So we also have to have older thought represented in this volume. Much of the fundamental economic thinking and analysis of land and land markets has historic roots since land was so salient in the early development of the subject.

Somewhat reluctantly we decided not to have the founding ideas explained by their originators. Von Thünen is represented by two review papers; Ricardo is not represented directly at all and Henry George again by a review paper in the last section dealing with how taxation and local public goods interact with land markets. Our oldest paper is a classic but dates only from 1956 – a paper by Charles Tiebout which Google Scholar records as having nearly 15,000 cites (and counting); 38 times as many as the extraordinarily original and path breaking work of von Thünen.

We divided the collection into five sections. The first two contain papers on the theory of land markets. The first of these provides a historical overview through to the development of the powerful 'monocentric city model' – the founding contribution to what was called the 'New

Urban Economics' in the early 1970s. Section II provides readings which move theory forward, in particular to provide insight into multicentric cities, the role of agglomeration economies and how these interact with urban land markets and the land market aspects of urban dynamics. Section III is devoted to the issue of 'what gets capitalised?' This provides an explanation of why land markets are so important in terms of social welfare and, in particular, in the distribution of overall social welfare. Section IV concentrates on land market regulation and the economic effects of planning or zoning. Not only is this an area to which the editors have themselves contributed but it has rapidly developed over the past 15 years or so. It is of growing interest to economists and policy makers alike as there is increasing recognition of how widespread and significant the economic impacts of land use regulation are. The April 4th edition of *The Economist* in 2015 devoted both the editorial and a major article to the subject, for example. The final section looks at studies of land markets in the context of understanding better both local public goods and access to them and the role of land in (local) tax.

I   FOUNDATIONS AND ANALYTICAL ORIGINS

Our first two readings are different perspectives, by two very different economists, on the work of von Thünen. Reading [1] is by Paul Samuelson, the most influential economist of the modern era and the first winner of the Nobel Prize. As he says, von Thünen is, amongst geographers and location theorists, a 'founding God' while he is all but unknown to economists. He was born in 1783, into a landed family in norther Germany, and was practically employed running his family estates for most of his life. But he had a remarkably original and analytical mind. His theoretical contributions arose from studying precisely what he did – a point emphasised in Reading [2] by Colin Clark. Von Thünen's contribution to the economics of land markets arose from a very simple but formally derived general equilibrium model where there is a single central market (the town), homogenous land but transport costs which vary by type of crop. In passing, Samuelson notes von Thünen devised – almost incidentally – the idea of 'iceberg' transport costs elaborated by Samuelson himself in his famous article (Samuelson, 1954a). In von Thünen's abstract rural landscape, land use would become specialised in concentric rings, with the choice of product or crop in each ring determined by transport costs of the crop. Von Thünen was university educated and intellectually curious. He was aware of the work of Smith and Ricardo but, according to Samuelson, he had already grasped the essentials of this model by the time he was 20 years old; considerably ahead of Ricardo's work on rent theory. In the world in which he existed, however, pressure to publish did not exist and his *Isolated State* did not appear until 1827. But his contribution went far beyond just this simple model of land use in a rural world with high transport costs. He introduced marginal analysis and the analysis of the returns to labour and to capital as well as land. He made a great advance in formal modelling and the use of mathematics. He also conceived of and analysed the concept of general equilibrium. All on the basis of an almost introspective rumination on his estate accounts.

Colin Clark [Reading 2] was an entirely different type of economist to Samuelson. He was an applied and almost self-taught economist who made startling contributions to, for example, the development of national income accounting (Clark, 1932), to various tools of locational analysis, such as 'economic potential' and empirical generalisations such as the urban population density function (Clark, 1951). In the later part of his career he was an agricultural and development economist and his contribution here draws on that side of his work, as well as his interest in locational analysis. He reviews von Thünen's contribution as an informed agricultural economist with a powerful historical perspective and insight. As an economist he recognises both the wider importance of von Thünen's insights and theoretical contribution but he shows how it was based on an extraordinarily detailed record of and inspired interpretation of the practical conditions of early 19th Century German rural conditions.

We now move forward 150 years to the development of modern urban economics and the analysis of urban land markets. William Alonso [Reading 3] is represented by his earliest work – a short article of 1960 – rather than the better known book of his PhD thesis, of 1964. It is the bare bones of his adaptation of the von Thünen model (explicitly acknowledged) to an urban context with only two urban land users: businesses in the Central Business District (CBD) and residents. But the driving force is there: the trade-off of land costs against transport costs. So, given that jobs and therefore income earning opportunities are concentrated in the CBD, the consumers' trade-off is between higher costs of transport and lower prices of space. Equilibrium entails all land available for consumption being consumed given the price and consumers of land being indifferent between locations despite the price of land varying systematically by location with respect to the CBD. In turn this implies the powerful insight that, in equilibrium, land prices vary systematically with distance from the CBD and so land consumption and residential densities similarly vary. Land prices, land consumption and so urban density all drop out of this simple model because of the properties required of equilibrium. Alonso also hints at, but does not here develop, the implications of different types of business uses with location contributing differently to their profits, and different types of households – for example many or few children, high or low income – with different preferences for land compared to other goods and different abilities to pay, potentially leading to different residential locational choices. He also suggests how one could incorporate asymmetric transport costs or multiple employment concentrations.

Mills [Reading 4] – still faithful to von Thünen – puts his emphasis on production functions and factor substitution as land prices vary. This allows him to focus on how the fabric of cities varies systematically as land prices increase towards the CBD and land is substituted out of the construction process. He goes on to show that if one assumes that there are economies and diseconomies of scale this leads also to not just cities but cities of different sizes. While he is making strong simplifying assumptions Mills is able formally to demonstrate not only the properties of urban equilibrium described above (the simultaneous determination of the price

of land its allocation between uses and its density of occupation) but also the emergence of cities of different sizes and a differentiated form of the urban built environment.

Our final reading in this introductory section [Reading 5] is by Capozza and Helsley (1989). This moves the monocentric urban model into a dynamic context. It shows how the price of land and its rent may in these circumstances diverge as expectations about future patterns of change get capitalised into prices but not reflected in rents. Development may become discontinuous. We might think of this as an explanation of how 'urban sprawl' naturally arises as part of a dynamic but efficient process. This is an important and widely cited contribution although in a world where 'urban containment' is frequently imposed by policy, the discontinuity in land values at the urban edge arising from the effects of expectations analysed by Capozza and Helsley may be dwarfed in practice by regulated land scarcity (see Cheshire and Sheppard 2005); and the longer the policy of containment has been imposed the more significant its relative effect on land value discontinuity is likely to become.

II   BEYOND THE MONOCENTRIC MODEL

The monocentric city model – pioneered during the 1960s by Alonso (1964), Muth (1969) and Mills (1967 and 1972) – laid the foundation of much of modern urban economic analysis. The model describes a particular urban spatial structure with firms concentrating in one focal point – the CBD – and households residing around and commuting to the CBD. The model evolved during a time when cities were still considered to be largely 'monocentric', with employment concentrated in the CBD and households commuting to this centre. Since the 1960s, however, many cities have become less and less 'monocentric' driven by suburbanisation of households and decentralisation of firms. A new strand of literature – beyond the monocentric model – has emerged.

Reading [6], Mieszkowski and Mills (1993), describes the so called suburbanisation phenomenon of households and the decentralisation of firms and synthesises the two main theoretical explanations; the natural evolution theory and the fiscal-social problems approach. The natural evolution theory describes the suburbanisation process largely as consequence of rising real incomes over time, technological progress in intra-urban transportation and house building and changes over time in the comparative advantage of different income groups at commuting longer distances to work. The fiscal-social problems approach can be considered to be a generalisation of the Tiebout (1956) model. The emphasis is on fiscal and social problems of central cities such as high taxes, low quality of public goods and services, racial tensions, crime or congestion and pollution. In a setting where heterogeneous households sort according to preferences for local public goods and services, affluent households will try to avoid redistributive taxes by residing in richer, income-stratified communities and this process may be reinforced by exclusionary and fiscally motivated land use controls. Mieszkowski and

Mills conclude that both theories interact and so both help us understand the suburbanisation process.

Whereas in the monocentric model land use by firms (in the CBD) and residents (outside the CBD) are strictly separated and mixed land use does not exist, Reading [7], Wheaton (2004), points out that nowadays in the United States actual employment is almost as dispersed as residences. The paper goes on to show that this urban form can easily be generated in a model that assumes land can have mixed rather than exclusive use at any location. At one extreme, very high agglomerative forces, long commutes and high congestion levels will lead to concentrated employment in a CBD. At the other extreme, if agglomerative forces are low, dispersed employment, zero commutes and an absence of congestion is the outcome.

On the empirical side, Reading [8], McDonald and McMillen (2000), provides a fascinating 'snapshot' of the suburbanisation and decentralisation process and provides some empirical micro-foundation of the factors that determine the dispersion of employment and residences. McDonald and McMillen explore the determinants of suburban real estate development in the residential, commercial and industrial sectors by focusing on one particular US metropolitan area, Chicago, and the period between 1990 and 1996. Their empirical findings illustrate the importance of employment sub-centres and highway interchanges for attracting industrial and commercial developments. Residential development was attracted to a particular employment sub-centre. It also formed some clusters of its own in between major highways.

Reading [9], Burchfield *et al.* (2006), another empirical contribution, describes and helps understand a related phenomenon – urban sprawl – and identifies its determinants. The authors demonstrate that, perhaps surprisingly, overall sprawl in the United States remained largely unchanged between 1976 and 1992 but that this varied dramatically across metropolitan areas. They show how certain geographical features (ground water availability and rugged terrain), decentralized employment, early public transport infrastructure, uncertainty about metropolitan growth, and unincorporated land in the urban fringe, all increased sprawl.

While Readings [8] and [9] focus on development at the periphery of urban areas, Reading [10], Koster *et al.* (2014), is concerned about the form of the CBD. Urban land should properly be thought of as urban space, and this paper, in a way which is complementary to Reading [4] by Mills, deals with its vertical dimension and the agglomeration economies associated with it. Koster and co-authors argue that the presence of many tall, high-rise office buildings in the CBD cannot be explained by standard urban economic models alone (higher land prices meaning land is substituted out of buildings so they become taller). They show that Dutch firms are willing to pay a substantial premium for space in taller buildings, presumably due to a combination of within-building agglomeration economics, a landmark and a view effect.

The standard monocentric city model builds on a number of restrictive assumptions. These assumptions were increasingly challenged. One important assumption of the standard model

raised particular attention: the assumption of perfectly malleable housing. In some sense the city is assumed to be rebuilt from scratch in every period. The standard model thus ignores the fact that the housing stock is durable but depreciates. A number of urban growth models, reviewed in Brueckner (2000), have enhanced the standard framework by assuming either that housing is irreversible or can be redeveloped according to obsolescence conditions. Reading [11], Rosenthal and Helsley (1994), provide a direct empirical test of the durable housing theories by exploring the mechanisms that lead to redevelopment of individual parcels of land. Using data for Vancouver, B.C., they first estimate the price of vacant and developed land. They then go on to demonstrate that housing is redeveloped when the price of vacant land exceeds the price of land in its current use, providing support for theoretical models of urban spatial growth.

Reading [12], Glaeser and Gyourko (2005), also draws on this literature on durability and urban development. Its seminal contribution, however, is that it shifts the focus towards urban decline. Glaeser and Gyourko point out that new supply – at least in cities that are not tightly regulated – is elastic in the upswing when prices rise faster than construction costs, but the housing stock is nearly perfectly inelastic in bust phases, because the existing housing stock is durable. Put differently; the housing supply curve is kinked. Thus, cities exhibit asymmetric responses in periods of growth and decline. Declining cities initially suffer price declines rather than population losses. Moreover, the combination of inexpensive housing and weak labour demand in declining cities attracts households with low levels of human capital.

Conversion of land from agricultural to urban use is not only irreversible but also associated with uncertainty. Reading [13], Titman (1985), made an important contribution to the literature by introducing and applying real option theory to real estate. Titman points out that "valuing the vacant land as a potential building site is not […] straightforward since the type of building that will eventually be built on the land, as well as the future real estate prices, are uncertain." Titman's model yields a valuation equation for pricing vacant lots and provides a strong intuition about the conditions under which it is rational to postpone irreversible investment decisions [to build or not build] until a future date. The key insight is that "a vacant lot can be viewed as an option to purchase one of a number of different possible buildings at exercise prices that are equal to their respective construction costs."

The next paper, Reading [14], again by Cappoza and Helsley (1990), develops a model of an urban area with growth and uncertainty, thereby providing a synthesis of the literature on models of urban growth, in particular durable capital and perfect foresight models and models that consider optimal investment decisions under uncertainty. Cappoza and Helsley assume that household income, rents and prices for land all follow stochastic processes – hence the title of the paper; the stochastic city. They demonstrate that in their framework, even though investors are assumed to be risk neutral, uncertainty affects both land rents and land prices in equilibrium. This is because conversion of land from agricultural to urban use is irreversible. Urban growth affects both urban and agricultural land prices but not rent levels. The impact of

uncertainty in their framework is fourfold. First, it delays land conversion from agricultural to urban use. Second, uncertainty induces an option value to agricultural land. Third, it causes land at the urban boundary to sell for more than its opportunity cost in other uses (the real option value). Fourth, uncertainty reduces equilibrium city size.

The final paper in this Section, Reading [15], Bulan et al. (2009), provides empirical evidence for the real options framework over alternative models such as simple risk aversion and quantifies the extent to which uncertainty – through creating a real option to wait – delays investment. Using data on condominium developments in Vancouver, B.C., built between 1979 and 1998, they find that increases in both idiosyncratic and systematic risk lead developers to delay new real estate investments. A one-standard deviation increase in the return volatility reduces the probability of investment by about 13 percent – the same reduction in development as triggered by a 9 percent reduction in prices. One additional novel contribution of Bulan and co-authors is that they explore the impact of competition on the relationship between idiosyncratic risk and investment propensity. They demonstrate that increases in the number of potential competitors located near a development project diminish this negative relationship, suggesting that competition erodes real option values.

III   WHAT GETS CAPITALISED?

This section includes a range of contributions exploring the extent to which attributes of land and locations get capitalised into the price of land. The short answer seems to be that under the right circumstances almost everything one can measure; not just the existing 'quantity' of an amenity or environmental good or bad but apparently expected future values of those attributes of land. There are qualifications relating to the supply conditions of land (discussed in Section IV) and the extent to which houses or other property is correctly conceptualised as an asset not just a flow of current services but, such caveats aside, the evidence suggests that the land market is quite remarkably efficient at reflecting even nuanced differences in local crime (Gibbons, 2004), for example, or expected future noise disturbance. The papers in this section have been chosen because they represent studies of a wide range of attributes of urban locations: local public goods such as schools; amenities such as open space; changes in accessibility or expected future changes in ambient noise (from aircraft). The final selection [Reading 19] investigates both theoretically and empirically how these price effects (or capitalisation effects) relate to changes in willingness to pay, welfare changes.

Reading [16], Cheshire and Sheppard (2004), builds on an earlier study of the same housing market (Cheshire and Sheppard, 1995) but focuses on the effects of differences in school quality on housing prices. Perhaps a major contribution of the earlier study had been to explore in the context of an explicit land rent function the extent to which the locational attributes of housing really were capitalised into land prices (not just 'left' in the value of houses). The study reproduced here was far from the first to evaluate the impact of school

quality on house prices and in some ways the methodology was, as the authors explain, deliberately a little old fashioned (compared, for example, to Black, 1999; or Gibbons and Machin, 2003). This was because the authors wanted to isolate the impact of not just school quality but the quality of different types of schools and how the value of school quality interacted with other attributes (such as the capacity of the physical structure of homes to accommodate children) and varied with the risk of future changes. Another advantage they perceived of their technique was that it estimated not an average price associated with the quality of local schools but a price function. This, they found, implied that price was strongly non-linear with respect to measured school quality and the real premium attracted for houses in better school catchment areas came at the very top of the distribution of school quality where 'free' state (public) schools were competing with private schools. This non-linearity was confirmed in the context of the US by a later study by Chiodo *et al.*, 2010. This implies that the price associated with access to better local schools can only be estimated once both the characteristics of the house and the measure (and risk of change) of school quality are known. The findings were nevertheless striking. In the context of the housing market they analysed, in which access to any given school was almost absolutely determined by the address of the house, moving a house with the mean characteristics of the whole sample from the worst to the best primary school was associated with a price increase of 33.5 percent and from the worst to the best secondary school with an increase of 18.7 percent.

Reading [17] by Anderson and West tackles the value of access to open space. Again this is not the first study in this area (Irwin, 2002, for example, looked at this in a quite convincing way) but it is the first convincingly to chase down the way in which the value of green open space varies with not just the character of that space[1] but its context. By this is meant the interaction between such factors as the local neighbourhood demographic composition, its mean incomes and density as well as a systematic variation according to distance from the CBD. To illustrate the findings, if the green space was a golf course it was more highly valued the closer it was to the CBD but also if the neighbourhood demographic was over weighted with the middle-aged group. The value of public green space rose as the private supply fell; that is, controlling for distance from the city centre, it had greater value in higher density neighbourhoods. Results also suggested a strong income elasticity of demand for open space; everything else equal it was more valuable in higher income neighbourhoods. One puzzle left unsolved is the relationship between the value of open space and local crime rates. Anderson and West found a not very well-determined positive relationship between the value of open space and the local crime rate. This was investigated more fully by Troy and Grove (20008) who found that if one

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[1] Irwin's 2002 contribution had been to show that the more permanently green space was safeguarded, the greater its value tended to be but otherwise greenspace was not much differentiated. On the other hand one could add her findings to the balance sheet of evidence favouring the conclusion that land markets capitalise not just current values but expected future ones too.

disaggregated local parks by local crime rate they systematically fell in value as the crime rate rose and in neighbourhoods with the highest crime rates relative to the city average parks became 'disamenities'; people were willing to pay a premium to live further away from them.

Reading [18], by Gibbons and Machin, 2005, investigates a specific aspect of one of the fundamentals of urban land markets, the centre of the models of Alonso (1964) or Mills (1967): that is accessibility – or changes in it. They analyse willingness to pay for transport improvements in London in 1999 when the metro-style transit system (the 'tube' or 'underground') and a light rail system were extended at the same time. Their approach is a methodologically innovative adaptation of the classic hedonic model employed in the two previous readings. It is quasi-experimental, using repeat sales price information and meticulously comparing the before and after effect. They argue this is the 'conceptually more attractive approach' since it makes the identification of the causal role of the transport change more transparent. They identify a statistically and economically highly significant, distance dependent effect. Whether this gives a more precise estimate of the actual willingness to pay is open to question, however, since their actual estimate might be downward biased because of omitted anticipation effects.. They compare their results with a conventional cross-sectional analysis over the whole extent of London with proximity to stations as a control. This method they find gives a larger estimated willingness to pay for access to the rail network serving London. As they acknowledge 'this might be [because] there are price changes in anticipation of the new lines opening' (i.e. they did not really fully capture the 'before' situation); but they judge it more likely that the larger effect reflects omitted variables because anticipatory capitalisation requires housing to be treated as an asset and it is implausible that buyers would be willing to take the bus to work for a prolonged period before the new stations opened. That is, however, a judgement and there is evidence from other studies that there can be anticipation even by owner occupiers.

The next selection, Reading [19], by Kuminoff and Pope (2014) changes focus to factors other than supply side considerations (discussed in Hilber and Mayer, 2009) that drive a wedge between capitalisation effects and the public's willingness-to-pay for local public goods and services, amenities or externalities. Kuminoff and Pope illustrate that in a setting with trading between heterogeneous buyers and sellers in a market, capitalization effects may not necessarily have a welfare interpretation comparable to that of Rosen's (1974) hedonic model, which assumes perfectly elastic local demand for housing and thus implies full capitalisation. The authors stress that it is often unclear how to interpret capitalisation effects in the hedonic model because of the economic implications maintained in that model. One critical assumption is that the gradient of the hedonic price function is constant over time. As the authors point out, this assumption is problematic; even small changes in an amenity can trigger tipping effects, via Tiebout sorting, that can produce large changes in other features of equilibria. Thus, it is unclear how to interpret capitalisation effects even in settings with perfectly elastic housing demand, where the price elasticity of supply should no longer affect

the extent of capitalisation. In the empirical part of the paper the authors use boundary discontinuity designs and focus on school quality to show that capitalisation effects may understate parents' willingness-to-pay for public (state) school improvements by as much as 75 percent. It is important to note here that regardless of the welfare interpretation of capitalisation effects, their accurate measurement is vital, also from a political economy or distribution point of view (Hilber, forthcoming). This is because capitalisation effects matter – in opposite directions – for property owners (homeowner and landlords) and renters.

The last Reading [20] in this section, by Mense and Kholodilin (2014), tackles directly the issue of how far expectations of future attributes of locations get capitalised in house prices. They have the nice test bed of a natural experiment: the planning, announcement and then revision of flight paths associated with the development of the new Berlin-Brandenburg International Airport. This is a good test-bed because it was announced long in advance (in 2004); and its impact and the details of its planning were very widely publicised in advance; its flight paths were announced initially in 2010 but changed, then later finalised, in 2011. It was initially scheduled to open in 2012 but design and construction faults associated with fire safety, meant that opening was postponed to 2014 and then postponed again. In 2016 it was still not open. Thus any measured price changes in housing markets reflecting the noise generated by aircraft are all anticipatory. Mense and Kholodilin in fact do not use transactions prices but offer or asking prices. They investigate the difference this makes, adjusting for time on the market (other research suggesting this was related to the size of the ultimate discount of transactions from asking price) and then comparing subsamples more and less affected by the expected noise. From this they conclude their estimates likely underestimate the capitalised effect of expected noise but they cannot quantify this likely bias. However they carefully model the likely noise from proposed take-off paths and find significant discounts varying with projected height of aircraft and slant angles.

IV   REGULATING LAND MARKETS

Land markets are amongst the most highly regulated of all markets yet until recently economists have not paid much attention to either the economic effects of such regulation or to its rationale. This section gathers together readings mainly investigating the effects of regulation. Most focus on the impact of land use planning and its impact on housing and welfare.

Land use regulation and the constraints it places on the supply of 'urban space' can take many forms. These include restrictive and delayed planning permissions, height restrictions, preserved view corridors, conservation areas and other preservation policies, minimum lot size restrictions and other types of exclusionary zoning, as well as urban containment policies such as the imposition of Green Belt' or 'growth boundaries'.

To understand why the main focus of interest has been on the impact of regulation on housing consider the land use patterns for England and in particular for London. Table 1 illustrates land use patterns for three areas of the country: Greater London; the region of the South East; and England as a whole.

Table 1: Land Use percentages in London, the South East and England

Area	Domestic buildings	Other buildings	Roads	Paths	Rail	**All Built**	Domestic gardens	Green space	Green Belt	Water	Other & Unclass.	**All 'Green'**	Total '000 hectares
London	8.7	4.7	12.2	0.8	1.1	**27.5**	23.8	38.2	22.1	2.8	7.5	**64.8**	159.6
South East	1.3	0.7	2.4	0.1	0.1	**4.6**	6.2	84.8	16.6	2.7	1.6	**93.7**	1,938.7
England	1.1	0.7	2.2	0.1	0.1	**4.3**	4.3	87.5	12.4	2.6	1.4	**94.3**	13,232.4

Source: London First (2015)

Land for residents - under housing and in domestic gardens, covers about one third of the Greater London Authority (GLA) - the jurisdictional area of London. If one adds urban green space to get a total of all land used for consumption purposes, rather than for production, then 60.7 percent of land use in London is for residential related purposes. This suggests that land used for housing related consumption makes up an important share of total land use and regulation of such land is thus crucial to both urban form and, because regulatory constraints determine the long-term responsiveness of housing supply to demand shocks, the cost of housing.

The economically thriving GLA has one of the oldest and most restrictive policies of urban containment and preservation in the world, making it a particularly interesting to study. Reflecting its varied and powerful containment and preservation policies, London is a very 'green city' with 52 percent of the GLA area covered by domestic gardens or green space. Commercial buildings and transport use only 18.8 percent of the land. It has a Green Belt, on which it is nearly impossible to get any planning permission, surrounding the urbanised area with its boundaries more or less static since 1955 (Hall, 1975). Even within the GLA jurisdiction, the Green Belt occupies 32,500 hectares, 22.1 percent of the land – mostly as private farmland. But the 32,500 hectares of Green Belt within the GLA is dwarfed by the more than 480,000 hectares of Green Belt land surrounding the GLA, in the rest of southern England.

It is these Green Belt constraints, in conjunction with all other planning policies aimed at preserving, protecting or containing that make residential land artificially scarce (across England as a whole houses and their gardens cover only some 5.4 percent of all space with all other buildings and transport adding another 3.1 percent) and housing some of the dearest in

the world; according to some measure[2], the second most expensive in the world. Planning restrictions thus have benefits in the form of preserved open space or historical heritage but they also produce a serious increase in housing costs.

Reading [21] by Cheshire and Sheppard, 2002, is the first attempt rigorously to quantify the impact on welfare, measured as income equivalent, of land/space supply restrictions operated through the planning system. Most systems of planning or land use regulation restrict development in at least some locations. There are good economic reasons for doing so since land markets are subject to endemic problems of market failure and, unregulated, will undersupply public open space, both in urban and country parks, or National Parks; fail to protect valued scenery and habitat; and not fully reflect any environmental costs of different patterns of development. Restricting supply will at least locally increase the price of housing (though this may reflect the social value attached to not developing particular tracts of land such as habitat or scenic areas). So attempts to estimate the economic effects of planning may evaluate the effect on prices of houses; and if they do that they may also try to include the impact of higher land prices on the characteristics of houses. Higher land prices will cause land to be substituted out of house production – new houses will be smaller as well as more expensive – and if people value space in houses (and gardens) then there will be a welfare loss associated with the reduced size/increased density of housing as well foregone income paying for it. However if planning also produces amenities – as the example of protecting valued scenery or urban open space implies – then the net cost will not be measured by the increase in house prices even fully adjusting for reduced space because of the welfare gains from the increased supply of amenity or environmental public goods.

So Reading [21] starts from micro-level data on house transactions and the characteristics of the buyers of those transacted houses to estimate a structure of demand for housing characteristics including as attributes a simplified representation of amenities generated by planning; namely separation of industrial and residential land uses; and the provision for two different types of open space: i) that which is publically accessible, mainly urban parks, inside the urban area and ii) privately owned land without public access mainly in the form of 'Green Belt' or equivalent land surrounding the urban area. Using this estimated structure of demand, the estimated land price function derived from the hedonic model, and the observed incomes of the households in the transacted houses, Cheshire and Sheppard then estimate the implied indirect utility function associated with the observed situation, calibrated in money terms. It is then possible to estimate the equivalent variation in income (the welfare change expressed in money terms) that would be associated with supplying more land via the planning system but at the expense of less land in open space and more mixing of industrial and residential uses. This produces two measures of the impact on net welfare of the observed level of restriction

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[2] According to Globalpropertyguide.com (last accessed 6/2016) the buying price per square metre of housing in the UK (London) is the second highest in the world, topped only by the tiny city state and income tax haven Monaco.

on urban development: i) a mild relaxation, modelled by allowing the total urban footprint to expand until the price of land at the edge was estimated to have fallen by about 25 percent; then ii) a further relaxation sufficient to allow the price of land at the urban fringe to fall to what was judged to be the lowest possible price necessary to secure any transfer of agricultural land to housing. In both these scenarios internal space constraints were also relaxed so that they were close to the lowest observed in the least restrictive English city examined. And in both scenarios the loss of valued planning-produced amenities entailed in supplying more land for housing was included in the net measure. The final result was that the biggest welfare gain was associated with the most significant relaxation of constraints. This implied that the existing restrictive policy entailed a loss of household income equivalent to a tax of 3.9 percent and that this relaxation would be associated with a 71 percent increase in the urbanised area compared to the status quo. Since the estimates were based on individual observations it was also possible to explore the distributional consequences of these changes.

The next Reading [22] by Fischel, 2001, is in some ways a complement. Central to the Cheshire and Sheppard net welfare estimates is their measurement in terms of income equivalent. This is a flow. Fischel looks at the reasons for restrictive planning in terms of asset values – wealth: a stock measure. His argument is that as the relative price of houses increases so housing becomes a relatively more significant element in individuals' asset portfolios. Since houses are immobile and not very liquid as assets this means that home-owners are faced with an increasingly powerful incentive to defend the value of their homes – their most important assets – and they will do this by voting for more restrictive local planning regimes. So local government is conceptualised as a corporation maximising the value of its residents' homes. It does this by means of its control over zoning and development on the one hand and taxes and the supply of local public goods, such as schools, on the other. Thus it has the capacity to increase the value of its 'homevoter' residents' assets both by restricting supply and improving the (capitalised) value of local public goods.

A few more recent studies have tried to causally link regulatory restrictiveness to house prices. Reading [23], Quigley and Raphael (2005), is a short paper and provides some early direct evidence for California that local regulatory stringency is a key driver of local housing costs. The starting point of their analysis is the observation that regulatory stringency varies widely across Californian local jurisdictions. This is in part because California has the most extreme form of autarky in land-use regulation of any U.S. state. Quigley and Raphael also point to the tax system as a determinant of the stringency of land use planning – a theme that we will revisit when discussing Reading [26]. Property taxes are strictly limited to 1 percent – thus providing few fiscal incentives to permit residential development – while local jurisdictions are permitted a share of local sales tax receipts, in turn incentivising retail developments over housing. Empirically, Quigley and Raphael find strong evidence in support of their proposition that local regulatory stringency affects local costs of owner-occupied and rental housing. Consistent with this, they also find that new housing construction is lower in more

regulated cities and that the supply price elasticity of housing varies depending on a city's regulatory stringency.

Reading [24], Saiz (2010) approaches the issue of house prices and regulatory constraints from another direction. His starting point is a very painstaking study of the topography of all the metro areas in the continental US using remote sensing data to calculate physical constraints on urban land supply: land lost to sea or fresh water or to slopes too steep for building. He finds considerable variation in this across cites but, more interestingly, that the extent of physical constraints on land supply is itself highly correlated with the severity of regulatory constraints (estimated using the Wharton Residential Urban Land Regulation Index). He then develops an extension of the familiar monocentric city model to show that not just levels but growth in house prices should be expected to be determined by these space constraints because they will influence not just the size of the housing stock but the price elasticity of supply, so its response to price changes. Housing supply is thus a function of both physical and regulatory restrictions on space. Deploying the Fischel 'Homevoter' argument of Reading [22] and examining house price growth over time across metro areas, he concludes that in fact there is reverse causation with physical constraints tending to increase house prices all else equal and then those higher prices generating an incentive for more restrictive regulation. Estimated supply elasticities by metro area thus ultimately stem from physical constraints but these interact with the incentives to have more restrictive local regulation.

Reading [25] by Glaeser and Ward (2009) empirically explore the causes and consequences of land use regulation, focusing on the regulatory microcosm of the Greater Boston area. They first document that the number of land use regulations has been increasing strongly over time and varies very widely over space. The only factor that is able to predict local regulatory restrictiveness is historic density levels. They then document that minimum lot size restrictions and other types of land use controls are associated with reductions in new construction activity, consistent with the notion that land use controls are a production restraint on housing. Interestingly, Glaeser and Ward find that local regulations are not associated with higher local house prices once they control for contemporary density and demographics. They rationalise this finding with the proposition that municipalities in the Greater Boston area are sufficiently close substitutes, so that local supply constraints do not affect local prices. In a setting with nearly perfect substitutability, supply constraints would still matter, but only at the aggregate – Greater Boston area – level. Put differently, the authors argue that housing demand may be pretty elastic across municipalities within the metro area. They state that "[t]he same abundance of similar, small jurisdictions that makes Greater Boston a natural place to examine the impact of land use controls on new construction makes the area a much less natural place to examine the impact of land use controls on price. There are so many close substitutes for most towns that we would not expect restricting of housing supply in one town to raise prices in that town relative to another town with similar demographics and density levels. Restrictions on building in one suburban community should

not raise prices in that community relative to another town with equivalent amenities, any more than restrictions on the production of Saudi Arabian crude will raise the price of Saudi Arabian crude relative to Venezuelan crude. Of course, Saudi Arabia's quantity restrictions will still raise the global price of oil, but this cannot be seen by comparisons of prices across oil producers."

Although this argument has some intuitive appeal, it is at least questionable whether towns in the Greater Boston area are indeed close substitutes, similar to Saudi Arabian and Venezuelan crude oil. In this context, it is worth pointing out two other recent studies (Hilber and Mayer, 2009; Lutz, 2015) that have focused on the Massachusetts-New Hampshire area (with the Boston area at its core) do find evidence suggesting that differing price responses to demand shocks can be attributed to differing housing supply price elasticities, which in turn are determined by physical or regulatory supply constraints.

Reading [26] by Hilber and Vermeulen (2016) revisits Glaeser and Ward's (2009) proposition for Greater Boston that within metro areas differences in local supply constraints may not matter much for the extent to which demand shocks are capitalised into house prices. Hilber and Vermeulen point out that while small towns in the Boston area may indeed be fairly close substitutes, the same is not true for example for different metro areas in the US or for Local Authorities in the UK. They also refer to recent theoretical work that assumes heterogeneity in tastes (in the spirit of Readings [27] and [33] discussed below). In such a setting, "local supply constraints may raise prices because they constrain the number of households so that the marginal household has a higher willingness to pay for residing in a particular place."

Hilber and Vermeulen develop a simple theoretical framework to make a point in case, demonstrating that under realistic assumptions (households have idiosyncratic tastes and sort endogenously over heterogeneous locations), local long-term supply constraints can be expected to influence the house price-earnings elasticity. The authors then go on to test their sole theoretical prediction that house prices respond more strongly to changes in local demand shocks in places with tight supply constraints. Focusing on local planning authorities in England and exploiting a unique panel dataset that spans 35 years, the authors identify three different types of local long-term supply constraints: regulatory constraints, constraints arising from physical scarcity of developable land, and uneven topography. Addressing various endogeneity concerns using an instrumental variable technique and instruments to identify their measures for regulatory restrictiveness and physical degree of development, the authors find that regulatory constraints – in conjunction with strong demand – are the main cause of the extraordinarily high prices in large parts of England, especially the Greater London Area and the South East of the country. Scarcity of developable land matters too, in a causal sense, but the effect is highly non-linear – essentially confined to highly urbanized areas. Finally, topography matters in a statistical sense but the effect is small quantitatively. Another

interesting result is that the adverse effects of supply constraints are stronger during boom than bust periods, consistent with the 'kinked supply curve' argument in Reading [12].

Reading [27], Hilber and Robert-Nicoud (2013), complements the other papers in this section in that it focuses on the origins (or causes) of land use regulation rather than their economic impact. The starting point of their analysis is the simple observation that "the spreading adoption of land use regulations is a phenomenon that seems to accompany the rise of urbanization". Interestingly, they point out that San Francisco and New York – two 'superstar cities' – were the first cities in the U.S. to adopt some form of zoning laws. The two 'superstar cities' were not only the first cities to adopt stringent regulations, they are now also amongst the most tightly regulated cities in the country. Hilber and Robert-Nicoud provide an original explanation for these stylised facts. Employing a discrete choice model, in which a given population of mobile households has heterogeneous tastes over a set of cities, the authors model residential land use constraints as the outcome of a political economy game between owners of developed and owners of undeveloped land. Stringent land use controls benefit the owners of developed land via increasing property prices but hurt the owners of undeveloped land via increasing development costs. Hence, more desirable locations can be expected to be more developed and, as a consequence of political economy forces, more regulated. One important contribution of the formal theory is that it expands the dominant political economics view (Reading [22]) by assuming that planning boards cater to the interests of all landowners. Instead of modelling local land use restrictions purely as the outcome of majority voting by homeowners versus renters, Hilber and Robert-Nicoud stress an alternative mechanism in addition to voting: lobbying. Owners of undeveloped land and owners of developed land (homeowners *and* landlords) form two competing lobbies that influence planning boards by way of lobbying contributions in a 'one-dollar-one-vote' system. This contrasts to a voting model that gives an implicit weight of one to owners to occupants (homeowners and renters) but no weight at all to landlords (because they cannot vote) or owners of undeveloped land. Hilber and Robert-Nicoud also provide strong evidence for a sample of US metropolitan areas that is consistent with their model of landowner influence.

The next Reading [28], (Glaeser, Gyourko and Saks, 2005) focuses primarily on the effects on housing prices of more restrictive zoning (or planning). Their main focus is, as the title suggests, housing in Manhattan but they include a brief analysis of office buildings in Manhattan and a comparative analysis - using a different measure of the cost of restrictiveness - for 21 of the biggest metro areas in the US.

They start by providing some descriptive evidence of the fall in the construction of new high rise buildings in Manhattan and the increase in the costs of space. They describe regulatory restrictions and provide some case studies of successful battles to prevent new building. Their central estimate of the impact of these restrictions on the costs of housing in Manhattan employs the idea of a 'regulatory tax'. This is defined as the difference between the marginal costs of constructing an additional square foot of space and its price. In a free, unregulated and

competitive market, construction would continue up to the point at which the costs (price) of an extra unit of space just equalled the cost of producing it. Given that the development industry is competitive (a point they deploy some evidence to support) then the difference between the observed price – in a competitive market, equal to the marginal revenue – and the observed costs of producing an extra square foot of space, is a measure of the costs of regulatory constraints – the 'regulatory tax'. For individual houses, of course, there is the difficult issue of accurately measuring the necessary cost of additional land to support the extra – or marginal - unit of space but the authors ingeniously sidestep this problem by focusing only on high rise apartment blocks. For these, land costs are given and extra space is produced by building higher, so the costs of land drop out of the calculation.

Their results show that the measured 'regulatory tax', while cyclical because housing prices are more cyclically sensitive than construction costs, rose over time in Manhattan; was in no year zero and since 2001, the price of space in apartments had consistently been more than double that of the costs of producing it. They argue that in commercial zones tenants have no interest in opposing construction or maximising the value of the buildings they occupy, so expect the 'regulatory tax' to be much lower for commercial buildings. This they find is the case. In some years the costs of construction were higher than the price of office space and never exceeded it by more than 50 percent.

Reading [29], Cheshire and Hilber, 2008, is the only study of the effects of regulatory restrictiveness on non-residential property with the exception of the short section in Reading [28] which found no measurable cost was imposed on office space in Manhattan. The situation in the UK, and to a lesser extent in Europe, is significantly different the authors point out. Indeed their motivating evidence is the costs of office space in Birmingham, a declining industrial city in the British midlands. As would be expected, construction costs for office space in Birmingham were only about 50 percent of those in Manhattan; but the price of office space was 44 percent more than in Manhattan. Applying the same measure of the costs imposed as employed by Glaeser *et al*, 2005 they estimate that the price of a marginal square foot of office space in Birmingham, averaged over a 6 year period to 2005, was in fact 2.50 times the costs of building it. This was not the highest measured 'regulatory tax' however: in London's West End the comparable figure was 8, about 5 in the City of London and about 4 in Frankfurt or Stockholm. So the evidence was of really large costs imposed on the occupiers of office space in all British office centres (partially excepting Newcastle) and nearly all European ones. The only European city where the estimated 'regulatory tax' approached that of Manhattan was Brussels.

The authors also provide an analysis showing quite convincingly that the 'regulatory tax' measure really did capture the impact of regulatory restrictiveness. Changes in it and variations across cities were driven not by demand side factors but by supply constraints. There was evidence that local restrictiveness responded to the value communities attached to job creation – the regulatory tax fell as local unemployment rose, controlling for demand.

Moreover there was additional evidence supporting the important role of incentives in moderating planning restrictiveness. In the UK in 1990, business property taxes were changed from a local to a national tax, removing any fiscal incentive at all from local jurisdictions to allow office development. They were legally required to provide services for any new buildings but new buildings transparently generated no local revenues. Because one of the most important jurisdictions – in the context of office space -–was exempt (the City of London), it was possible to estimate the impact this change in incentives had, via its tighter restriction on supply, on the costs of office space. This turned out to be larger than any feasible business property tax would have been.

V   TAXES AND LOCAL PUBLIC GOODS

Reading [30] by Tiebout (1956) is the most cited paper in this volume – perhaps in spatial economics. It is simple but original and ingenious, tackling an issue very current at the time it was written and still relevant today. A colourful account of its origins and intellectual context is provided in Leven (2003). Samuelson (1954b) had just published a paper arguing that for 'pure public goods' there was an all but insolvable problem of gauging demand. Individual demands were additive but the incentives were not to reveal true preferences but to 'free ride' on the choices and taxes of others. This, Tiebout argued, was logically correct for those public goods produced by central government but did not apply to local public goods or expenditures. For these consumers could 'vote with their feet' (Tiebout may have invented this phrase - he certainly popularised it). On the assumption that access to a given local public good depended on living within the jurisdiction (reasonable for schools if not so reasonable for some other local public goods) and 'consumer-voters' were free to move between jurisdictions, then they could choose to live in the jurisdiction offering the mix of public goods and taxes most suited to their preferences and incomes – their demand for local public goods. Given certain assumptions about the form of the production function for local public goods of varying types and the structure of demand for different mixes of local public goods, one can think of a varying set of 'optimal community sizes'. This will provide incentives for local communities either to attract additional residents if they are below their 'optimum' size or price residents out if they are above that size. As Tiebout concludes, his model implies that in a country with a federal structure such as the US, where many, even the majority of, public or collective goods are locally provided, there does exist an effective system of preference signalling; a point on which Samuelson had concluded most negatively that 'no decentralized pricing system could serve to determine optimally…levels of collective consumption'.

Reading [31], Oates (1969), is the natural complement to the Tiebout article. It is essentially an empirical test, if not of the Tiebout model, then of whether the world is consistent with some Tiebout processes taking place. The starting point is that logically the incentive to move jurisdictions – or to select a particular jurisdiction if moving – is the discounted net difference

in the flow of expected future tax payments compared to the discounted value flow of services from local public goods. It is an early empirical study of capitalisation effects before access to powerful computing and large micro data sets was readily available. Reflecting this limit on computing power it analyses mean values for a cross-section of 53 suburban jurisdictions of the New York metro region. The author is aware of what would now be called the problems of endogeneity and uses a Two Stage Least Squares (instrumental variable) approach to offset for bias. The conclusion is that indeed higher property taxes are negatively capitalised and that better quality local public services – crudely proxied by expenditure per pupil in local schools – are positively capitalised. Indeed the impact of better local public goods on the value of houses likely exceeds that of the increase in local property taxes necessary to pay for the improvement.

A few studies that followed up on Oates' seminal paper are particularly noteworthy as they have critical implications for empirical research. In particular, Brueckner (1979, 1982 [Reading 32] and 1983), in a series of articles, developed a bid-rent framework of property value determination, which considers a world that is not in perfect Tiebout-equilibrium. In Brueckner's framework, local governments finance the provision of local public services from a local property tax, with the aim of maximising the value of the local housing stock. Households are assumed to be freely mobile between locations, have homogenous tastes but heterogeneous incomes. Hence, they bid for units until the utility is the same everywhere. As a result, both a household's marginal willingness to pay for local public services and the local property tax are fully capitalised into house prices. In such a setting local governments should set the level of public expenditures such that the capitalised tax needed to finance a further rise in services just offsets the capitalised willingness to pay for them. If this condition is met, then the public expenditure level is efficient in that it satisfies the Samuelson condition, which states that at the margin, the aggregate willingness to pay for additional services equals the cost of providing them.

Reading [32], Brueckner (1982), builds on this proposition, to derive an empirical test for Pareto-efficiency. The idea is as follows: suppose that for some reason spending on public services is below the level which maximises the value of the aggregate housing stock. This could be for example because of institutional constraints such as property tax limits. In this case, the capitalised willingness to pay for an increase in expenditure exceeds the capitalised tax required to pay for it. Put differently, an increase in expenditure capitalises 'more than fully' into house prices. The converse is true for the case of overspending, which leads to less than full capitalisation. Illustrated graphically; aggregate property values of a local jurisdiction are an inverted U-shaped function of the level of public good provision. Brueckner, in his 1982 paper, also provides empirical evidence, using cross-sectional data, for a sample of Massachusetts communities. Employing an equation that omits local taxes, a negative coefficient on local spending can be interpreted as over-provision, while a positive coefficient implies under-provision. Brueckner find coefficients for education and non-education

spending that are not statistically different from zero, implying no systematic tendency to either under- or overprovide local public goods. Bradbury *et al.* (2001) and Hilber and Mayer (2009) provide more refined empirical analyses in the same spirit, also looking at Massachusetts but exploiting panel data and exogenous variation arising from the property tax limit 'Proposition 2½', finding under-provision of local public good provision.

One shortcoming of Brueckner's framework is that it builds on some restrictive assumptions, perhaps most critically; costless mobility, homogeneity of tastes and perfect substitutability of locations. Reading [33], Arnott and Stiglitz (1979), provide an early theoretical discussion of a theoretical framework that incorporates heterogeneous tastes—the key element of the Tiebout (1956) model. In section 3.3 of their paper they consider the case "in which individuals differ solely in terms of their valuation of an amenity resource such as the quality of a beach". If places are inherently different (some offer access to a beach; others don't) and households vary in their appreciation for these differences, intercommunity differences in land rents will no longer capture inframarginal benefits. This has important consequences for the interpretation of capitalisation studies: "When individuals are not identical, differences in land rents between communities systematically underestimate the value of their differences in amenities, and systematically overestimate the cost of their differences in disamenities." Arnott and Stiglitz provide an intuitive example for the case of a public bad such as noise. For noise, intercommunity differences in land rents provide a consistent overestimate of costs. This is because the cost of noise to the marginal individual is larger than the cost to inframarginal individuals in the noisy community, who through self-selection are those who are not particularly bothered by noise. Another implication of heterogeneity in tastes is that it makes the demand curve for living in a certain place become downward sloping (in contrast to the hedonic model or the Rosen (1974)-Roback (1982) framework, which implicitly assume a perfectly elastic demand curve). Downward sloping demand also introduces a role for supply conditions because capitalisation can be expected to be stronger in locations where housing supply is less elastic.

The treatment of heterogeneous tastes is only one aspect of the seminal paper by Arnott and Stiglitz (1979), which more broadly explores the relationship between aggregate land rents and public expenditure in a residential urban economy and the generality of the Henry George Theorem (HGT). The HGT suggests that in a spatial economy where (i) spatial concentration of economic activity is due to a pure local public good and (ii) population size is optimal, aggregate land rents equal the expenditure on the public good. It implies that a confiscatory tax on land rents is not only efficient but also the 'single tax' necessary to finance the public good. Arnott and Stiglitz demonstrate that the theorem is more robust than had been previously thought but is still far from completely general.

Another important contribution of Arnott and Stiglitz's paper is that they discuss two sources of market failure – not previously treated in the literature – that drive a wedge into the prediction by Tiebout (1956) that preference revelation results in a spatial distribution of

population that would be Pareto-optimal. Specifically, they point out that if local residents (i) do not face or (ii) misperceive the social benefits or costs of an in-migrant, a Pareto-efficient solution is not competitively sustainable.

Most previous tests of the Tiebout model can be described as indirect or implicit; their focus is on deductive implications of the model. Examples are Readings [31] and [32]. Direct tests of Tiebout's 'voting with the feet' mechanism – actual migratory responses to local public good provision – have been rare. The last reading in this volume, Reading [34], by Banzhaf and Walsh (2008) provides such a direct test – perhaps the most rigorous empirical test to date of the 'voting with the feet' mechanism. Banzhaf and Walsh first derive a locational equilibrium model that makes two key predictions: (i) relative increases in population density for neighbourhoods that experience exogenous improvements in local public goods and (ii) for large improvements, also increased relative mean incomes. The authors use a state of the art difference-in-difference strategy to identify the impact of entry and exit of facilities that are required to report their releases of chemicals for the Toxics Release Inventory (TRI), as well as actual changes in air quality (toxicity-weighted emission levels). They provide strong support for the proposition that households vote with their feet for local environmental quality: migration is strongly correlated with TRI facility emissions and their arrival to or exit from a community – defined by half-mile diameter circles rather than local jurisdictions. Moreover, Banzhaf and Walsh find that TRI facilities caused the community to become poorer over time, as predicted by their model and consistent with 'voting with their feet'.

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