INTRODUCTION:

Recent Developments in the Economics of Housing

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Contents

1 Introduction

Housing is about shelter and related services that individuals throughout the world value greatly and on which they spend a large share of their resources. Based on data provided by the Organization for Economic Cooperation and Development (OECD)[2] rental housing accounts for as much as 32% of disposable income in such high-income countries like Norway; its share does not fall below 15% of disposable income for most of the European Union and OECD countries.

Homeownership allows the production of services from an owned and bulky and durable asset. Its services as a shelter are complemented by services from the neighborhood and community in which it lies. The net equity held in owner-occupied housing is an important component of net worth. For the United States, housing net worth as a share of the value of residential real estate was nearly 80% in 1952, and has fluctuated around 60% up until the onset of the Great Recession of 2007-2009. Since then, it declined precipitously by more than 10% before starting to rise as the aggregate economy recovered. By 2016, the value of US residential real estate rose to nearly 30 trillion dollars, when US GDP was nearly 19 trillion dollars.

Because housing is a bulky asset, households typically borrow to finance its purchase by means of mortgage loans using the property as collateral. The resulting financial obligations for principal repayment and interest can also amount to a large share of disposable income. For example, the median mortgage burden as a share of disposable income was nearly 30% in France and Luxembourg in 2014[3], while it averaged around 20% for European Union and OECD countries [OECD (2017)]. While mortgage burdens are substantial, they do allow for households to accumulate wealth in the form of home equity and thus make it possible for individuals to participate in the asset markets.

Another aspect of housing that has been increasingly recognized as important is that it provides access to amenities available in the community where it is located. Houses are key

[2]OECD Affordable Housing Database. Updated January 2017. http://www.oecd.org/social/affordable-housing-database.htm

[3]http://www.oecd.org/els/family/HC1-2-Housing-costs-over-income.pdf

constituents of neighborhoods which, in turn, make up communities. Thriving communities contribute to the appreciation of housing. In countries with local control of schools, households pay for the associated amenities, like schools, public services and recreation facilities, via local, typically property-value based, annual taxes.

Housing as a subject of economic research has established itself even more firmly in the twenty years since the volumes edited by John Quigley appeared in 1997 [Quigley (1997)]. While traditionally treated as a subarea of urban and regional economics, as is attested by the JEL classification codes, housing has become a critical area of inquiry well beyond the confines of urban economics with a specialized literature of high quality. Several factors have contributed to this development. Some are due in part to how policy priorities have motivated renewed research in the economics of housing tenure choice.

Another factor is increased research interest in urban neighborhoods themselves. This has been motivated by interest in policies aimed at urban revitalization in the US as well as in other countries. Researchers now increasingly recognize the multifaceted roles of neighborhoods in influencing individuals' personal and social development. Therefore, it is important to have a firm understanding of the structure and dynamics of neighborhoods especially when contemplating the design of policy. Therefore, there has been a lot of research interest in attaining a deeper understanding of how individuals are affected by their neighborhoods.

Individuals are affected by a multitude of neighborhood contexts. One could be by their immediate residential neighborhoods, which are of course not trivial to define empirically. A particular approach could be the neighborhood clusters in the American Housing Survey.

Ioannides and Zabel (2008), which is included in this volume, have utilized them along with other data sets as sources of contextual information. Influences from broader senses of communities within urban areas, such as municipalities, are also important. Therefore, an understanding of the demand for housing requires understanding how the demand for shelter interacts with the demand for services provided by the community in which individuals wish to live. And, of course, in many ways, neighborhoods are shaped by individuals, not only through their choice of housing, but by adapting to the physical and social space that defines the neighborhood.

Economists have also increasingly sought a better understanding of the supply of housing, for which the supply of buildable land and local land use regulations and zoning are critical. The latter is subject to a multitude of controls by national and local governments throughout the world. A natural issue taken up by this literature is the extent to which local land use regulations are responsible for the large differences in the cost of housing facing households in different urban areas within the same country.

Understanding the structure of urban housing prices is also an important objective of housing economics research, like understanding what are the principal determinants and drivers of their dynamics. The economics of real estate, a relatively new field that has borrowed extensively from the economics of finance, and it has sought to clarify the hedonic pricing of housing assets both in cross-sectional and time-series settings.

Volume I encompasses housing demand and supply, housing markets and their interface with real estate valuations, and the interactions between homeownership and wealth decisions. Volume II encompasses neighborhood dynamics, the dynamics of housing prices where prices are measured at a fairly high level of aggregation, macroeconomic aspects of housing, and a number of topics that emphasize specific aspects of housing markets and their modeling, which have attracted particular policy interest, such as rent control. The volume concludes with a thorough look at recent analyses of housing markets via a lens that emphasizes the importance of frictions, namely the Diamond-Mortensen-Pissarides (DMP) model.

2 Volume I

2.1 Housing Demand, Neighborhood Interactions and Neighborhood Choice

Dusansky and Wilson (1993) provide an elegant reconsideration from a theoretical perspective of the consumption versus investment demand for housing. Unlike the contributions by Henderson and Ioannides (1983) and Fu (1991), this paper casts the problem in a multiperiod

setting, which allows the authors to examine conditions under which seeming anomalies such as upward sloping demand curves can be rigorously justified.

Ioannides and Zabel (2008) offer the first fully identified empirical treatment of the neighborhood component of housing demand, jointly with the quantity of housing demanded, where the full battery of social effects are accounted for. Using a special supplement to the American Housing Survey, the authors consider the impact of the characteristics of households residing in the immediate "micro" neighborhood, comprised of eight to twelve dwellings, the characteristics of broader neighborhoods, defined by the US Census tracts within which the primary dwelling units are located, and the characteristics of their respective US metropolitan areas.

Glaeser, Kahn and Rappaport (2008) aim at a deeper understanding of why more than 19 percent of residents in American central cities are poor, while in suburbs, just 7.5 percent of residents live in poverty. They argue that access to public transportation is important for the concentration of the poor in central cities. As for the rich, their demand elasticity for land is not sufficiently high to explain why they tend to live in the suburbs, but their decisions may be explained by their preference for living in houses (relative to apartments) and their aversion for urban ills. Consequently, improvements in urban transportation will likely affect these patterns. Brueckner and Rosenthal (2009), discussed below, is closely related to this article.

Bayer, McMillan, Murphy and Timmins (2016) develop a dynamic model of neighborhood choice and an associated innovative estimation technique. They address a key issue, namely that it is not only observed but also unobserved characteristics of household preferences which need to be accounted for in studying neighborhood choice in flexible ways. Their estimations utilize a newly assembled data set that encompasses the universe of housing transactions in the San Francisco Bay Area from 1994 to 2004. Because many neighborhood characteristics (such as neighborhood air pollution, violent crime, and racial composition) are not directly marketed, the estimates obtained by these authors of individuals' willingness to pay for such amenities are novel and particularly interesting since they differ from those obtained when a static version of the model is employed, as in Bayer *et al.* (2007). This

article is closely related to Ioannides and Zabel (2008), discussed above.

In contrast to several studies that emphasize demographic features of neighborhoods, Lee and Lin (2017) highlight the role of such natural amenities as coastlines and hills in neighborhood dynamics, suburbanization, and variation across cities in the persistence of the spatial distribution of income. By using a novel database of consistent-boundary neighborhoods in U.S. metropolitan areas, 1880-2010, they show that areas with attractive natural amenities, and heterogeneities in those amenities, have persistently been occupied by high income households over time. In contrast, downtown neighborhoods in coastal cities which were less susceptible to the widespread decentralization of income in the mid-20th century have been more susceptible to gentrification, and experienced an increase in income more quickly after 1980. This highlights coastal locations as valued amenities, but more generally, the versatility of housing markets in responding to changing demands for shelter as well as for neighborhood.

Rossi-Hansberg, Sarte and Owens III (2010) explore the role housing externalities, that is where individuals value, as in Ioannides and Zabel (2008), the housing consumption of their neighbors along with their own. Their model, which "prices" such externalities, yields testable predictions for housing consumption and values, which the authors employ to test with data from a neighborhood revitalization experiment in Richmond, Virginia. The model predicts, *inter alia,* spatial attenuation of residential externalities. The data confirm it at a rate of one-half per one thousand feet. Their results allow for a substantial rate of return to investment, as measured by gains in land values which rose by 2-5 percent in targeted neighborhoods relative to a control neighborhood. Interestingly, urban renewals projects in US cities in the 1950s and the 1960s were predicated on such externalities, but the underlying externalities had not been clarified prior to the modern research discussed here.

Wong (2013) explores the use of ethnic housing quotas in Singapore in estimating individuals' taste for living near own-ethnic group neighbors. The author uses data from the implementation of ethnic quotas in 1989, that were aimed at encouraging residential desegregation in multi-unit public housing estates in Singapore. The quotas take the form of upper limits on the proportions of Ethnic Chinese, Malays and Indians at each location. Identifying

individuals' taste for living near other homoethnics is important because of self-selection, but the quotas can serve as exogenous controls. In other words, this setting can be viewed as a natural experiment, which is rare in housing research. Wong finds that individuals of all ethnic groups, relevant to the Singapore setting, want to live near others of their own ethnic group, but only up to a point. After a threshold reached, they would rather have members of other ethnic groups join them as neighbors. Interestingly, Ioannides and Zabel (2008) also find that individuals value living near others like themselves, although by means of a different approach for controlling for self-selection.

2.2 Housing Production and Supply

Unlike other capital goods, the quantity and price for housing units are not directly observed. Instead, it is their product, expenditure on housing or housing values, that is observed. Individuals, either renters or owners, directly value the consumption of housing services. For homeowners, the value of their homes is also a component of their wealth portfolios. Furthermore, housing structures are particularly durable, and this also helps define the character of the urban unit they belong to, while at the same time contributing to an urban unit's development prospects.

Epple, Gordon, and Sieg (2010) propose a novel flexible duality-based approach for estimating the housing production function. It treats such unobservables as housing quantities and prices as latent variables and utilizes the value of housing per unit of land, which is observable. The housing production function is recovered via the corresponding profit function (the duality element in the approach). Differentiating out the (unobservable) price of housing leads to a differential equation for the supply function per unit of land in terms of observables only. This allows the authors to estimate the production function via a translog indirect profit function. The estimation implies a Cobb-Douglas production function with a land share of about 0.15. Epple *et al.*'s estimates are based on a comprehensive database of recently built properties in Allegheny County, Pennsylvania. The main insight behind their approach is that the observed variation in land prices and housing values per unit of land

is sufficient to identify the housing supply function per unit of land. Thus, the article gets around data unavailability by ingenious combination of theory and available data.

The availability of land suitable for urban development depends on the physical and geological characteristics of different areas within each country, such as terrain elevation and its slope and the presence of water bodies along with land use regulations. Saiz (2010) accounts for such features by utilizing satellite-generated data in order to precisely estimate the amount of developable land in U.S. metropolitan areas. Saiz's findings link the price elasticity of housing supply to land-constraining features of the city's physical landscape as well as land use regulations. Saiz's results are used widely to proxy for geographical variations across US urban areas. They are also used widely as an exogenous measure of the ease of building new housing.

Cities are, of course, made up of structures of all kinds that accommodate residences, businesses, governmental functions and institutions. Their durability[4] moderates the impact of economic shocks upon urban populations. Consequently, housing supply plays an important role in how housing and labor markets perform differently across US cities. Glaeser, Gyourko and Saks (2006) emphasize how a high elasticity of housing supply causes increases in urban productivity to result in bigger cities, whereas a low elasticity will lead to higher paid workers and more expensive homes. Their model integrates the heterogeneity of housing supply into urban development and is confirmed by their empirical analysis.

2.3 Housing Markets and Real Estate Valuations

Much of the functioning of housing markets relies substantially on the services provided by realtors. Real estate is an industry that is firmly embedded in the housing market and also interacts closely with the labor market. Real estate valuations are an important input for real estate transactions. Important research in this area is included in this volume because real estate valuations have undergone revolutionary changes over the last few decades. With a lot of information accessible freely on the web, many market participants, realtors and de-

[4]For the consequences of durability see Glaeser and Gyourko (2005).

velopers cater to the needs of consumers who are contemplating housing moves, relocations, purchases and sales. Firms, too, in the housing and urban development industry need to have a good sense of valuations as they plan expansions and redevelopments. The widespread adoption of web-based information technologies has facilitated important developments in the way of grounding real estate valuations using modern economics and thus directly influencing the housing market. The articles included in the volume involve methodological issues associated with the design of local real estate indices, which rely on conventional as well as unconventional statistical techniques.

Clapp (2004) proposes a semi-parametric method for estimating local house price indices by building on spatial autoregressive hedonic models that utilize house prices in neighboring areas in preceding periods, known as spatial and temporal autoregressive (STAR) models. Neighboring properties and valuations in earlier periods include a lot of information. The Local Regression Model proposed by Clapp (2004) complements these approaches by means of a semi-parametric approach which allows for the identification of space-time asymmetries missed by other models. When estimated with data from 49,511 sales in Fairfax County, Virginia, during 1972Q1-1991Q2, Clapp's method displays a lot of variation over neighborhoods. It also addresses an overlooked problem common to all local price indices, namely how to evaluate the amount of noise in the estimates and thus improve out-of-sample prediction. An important problem with valuations is obtaining reliable measures of current house values. These are essential for calculating returns to housing assets which underlie the illiquidity of mortgage-backed securities, an important contributor to the deepening of the sub-prime crisis at the heart of the Great Recession of 2007-2009 in the US [Geanakoplos and Koniak (2009)].

Caplin, Chopra, Leahy, LeCun, and Thampy (2008) use machine learning techniques with data on housing transactions in Los Angeles to investigate the spatial structure of house prices and returns on housing assets. They show that the very popular repeat sales methodology used to produce house price indices is prone to producing systematic errors. Typically, such indices under-predict sales prices of less expensive homes, and over-predict prices of more expensive homes. For recent periods, the resulting errors are not only unprece-

dentedly large in absolute value, but highly systematic: after a few years in which the indices under-predicted prices, they now significantly over-predict them. The authors show that new machine learning techniques, borrowed from computer science and increasingly relied upon by economists, produce strikingly better results with prediction errors that have geographic origins. Essentially, they use a local regression model to find nearest neighbors for each home in the test sample and employ suitable spatio-temporal kernel functions to smooth the unobservable price surface. The surface is estimated by minimizing the prediction error.

The aggregate rent-to-price ratio, a fundamental component of the aggregate returns to housing assets, is an indicator of the efficiency of the market pricing of housing assets. For owners of dwelling units, which are rented out, to be compensated for holding wealth in the form of housing capital, the returns received in the form of rentals must be on par with the returns to other capital assets. But unlike typical capital assets traded on the stock market, the rent-to-price ratio at the individual property level exhibits cross-sectional and spatial variation, which is important for property management, as well.

Bracke (2015) examines rents in relation to prices using data for 1,922 properties selected from thousands of real estate transactions in London, England, during its boom years 2006-2012, which were both sold and rented out within a particular six-month period. He finds that maintenance costs, vacancy rates, growth expectations and various risk factors are important determinants of market-based rent-price ratios. This confirms the predictions of the standard user cost of housing model proposed by Poterba (1984) and lends it additional realism.

Do house price data obscure bubbles? If yes, how may they be detected? According to a standard definition, a bubble on a capital asset occurs when its market price exceeds its fundamental value. The latter is the quantity associated with the present value of returns (much like dividend payments) from the asset, discounted at the market rate of interest. Considering a discrete time setting, the linear difference equation that the housing price obeys admits as a general solution the sum of a particular solution, that is, the fundamental value, and of the general solution of the underlying homogeneous part of the equation, which is the bubble component. This is the case of the classic rational bubble. That component

grows continuously at the constant rate of interest. Thus, the present value of the bubble component can be finite.

Giglio, Maggiori, and Stroebel (2016) propose a test for detecting the presence of a bubble via testing whether the present value of payments on housing assets occurring infinitely far in the future is zero. The authors utilize institutional differences between housing markets in the United Kingdom and Singapore, where residential property ownership takes the form of either leaseholds of different maturities, or freeholds. Leaseholds are finite-maturity, pre-paid, and tradeable ownership contracts with maturities often exceeding 700 years. Freeholds are infinite-maturity ownership contracts. For Singapore, their data include all 379,000 arms-length transactions between 1995 and 2013 and involve all private residential housing sales. For the U.K., the authors obtain, from the U.K. Land Registry, transaction-level administrative data on all (about 7.6 million transactions) residential property sales in England and Wales between 1995 and 2013.

Giglio *et al.* (2016) exploit the information in the price difference between leaseholds with extremely-long maturities and freeholds which reflects the present value of a claim to the freehold after leasehold expiration, and is thus a measure of a possible bubble component. They estimate this price difference for otherwise similar properties that are held by means of different leases and find no evidence of a bubble component in house prices in both the U.K. and Singapore. Notably, sizable bubbles have been conventionally assumed and have been detected by other techniques during at least some subperiods of the study period. Nonetheless, their approach does not exclude the possibility that behavioral bubbles of finite duration, rather than rational bubbles, could have existed.

2.4 Housing Finance, Homeownership and Housing in Wealth Portfolio Decisions

With housing being the single most important asset in household wealth portfolios, housing-related financial assets are the bedrock of US financial markets, and increasingly, of many economies around the world. That is, households' ability to borrow rest on using the

dwellings they purchase as collateral. By leveraging equity in their own homes, individuals may build up financial wealth. In this connection, it is advantageous for households that most fiscal systems around the world favor housing by not taxing the implicit return in the form of housing services derived from owner-occupancy. At the same time, some countries consider home ownership as an important social objective worthy of subsidizing by, for example, reducing the cost of borrowing.

The central role of collateral at the heart of financial markets which anchors the securitization of housing-related loans has not been well understood. Geanakoplos (1997)[5] examines the role of collateral in general equilibrium, which by allowing trade to take place when agents might be unwilling (or unable) to fulfill their promises improves the functioning of financial markets. Collateral levels are set by the market, anticipating that some promises are unlikely to be fulfilled and posted collateral to be exercised. The presence of collateral allows some individuals to earn higher than normal returns, and, in rational expectations equilibria, the prices of goods used as collateral can be become very volatile. Our experience with the Great Recession of 2007-2009 demonstrates beyond doubt the significance of Geanakoplos' ideas on the importance of collateral, indeed housing-based collateral, and the collateral cycle, during the business cycle, and especially the Great Recession.[6]

Flavin and Yamashita (2002) use a mean-variance efficiency framework to examine the household's optimal portfolio problem when owner-occupied housing is considered as an asset. The paper returns to the standard typology of Henderson and Ioannides (1983), whereby

[5]Geanakoplos motivates the need to understand deeper the role of housing-based mortgages with his own experiences in Wall Street.

[6]Gertler and Gilchrist (2018) examine in depth the several ways in which the decline of house prices in the US, which started in 2006 in the most severely affected US states (Arizona, California, Florida and Nevada), led to the Great Recession of 2007-2009. These include: one, the decline in house prices that weakened household balance sheets and placed downward pressure on consumer spending, much like Case *et al.* (2012) demonstrate; two, poor quality mortgages and financial stress on borrowers caused decline in the values of asset-backed securities, which in turn caused a contraction of the asset-backed commercial paper market; three, the end of the housing boom led to a sharp drop of housing investment. "These factors, along with the disruption of short-term credit markets like asset-backed commercial paper, were sufficient to move the US economy into recession at the end of 2007." *Ibid*, p. 13.

a household's decision of whether to rent or own is determined in terms of a comparison of the quantity of housing stock that satisfies their consumption versus that which satisfies their investment demand for housing. Flavin and Yamashita (2002) see a number of reasons, such as the preferential tax treatment of owner-occupied housing and substantial transactions and agency costs, that effectively constrain households from equating their investment (asset) and consumption demand for housing stock. They establish that this constraint is significant enough to induce a distinct long-term pattern in wealth portfolios, as the share of housing net worth declines relative to shares of stocks and bonds which increase over the life cycle.

Case, Quigley, and Shiller (2012) investigate how households adjust their consumption as they experience changes in the values of their asset holdings, and whether their actions differ for housing vs. non-housing assets. Since households may draw on different ways to access their accumulated housing equity and to rearrange asset holdings, the answer is not obvious. The authors re-examine the links between changes in housing wealth, financial wealth, and consumer spending using a panel of quarterly U.S. state-level data observed during 1975Q1 through 2012Q2. During this period, the US economy experienced significant changes with respect to the values of different assets, with notable regional variation in housing assets. The sustained increase in housing values during 2001-2005 was followed by sustained decreases thereafter, until housing prices recently started growing again. The authors find statistically significant and rather large effects of changes in per capita housing wealth on per capita household consumption, which is consistently larger, typically more than twice as large, than the effect of changes in stock market wealth upon consumption. This underscores that households react differently to the different types of economic risks over the business cycle.

Favilukis, Ludvigson, and Van Nieuwerburgh (2017) use a quantitative general equilibrium model of housing with two previously overlooked elements: aggregate business cycle risk and a highly skewed wealth distribution. The latter is due to the presence of two types of households: a small minority who are born wealthy because of deliberate bequests they receive (and who themselves leave bequests), and a much larger majority who receive small or zero bequests and start their working life with little wealth.

Their investigation of the impact of an economy-wide financial market liberalization, either via relaxation of the collateral constraints or availability of increased foreign capital into the domestic bond market, show that this leads to a large boom in house prices because of a decline in the housing risk premium. Their simulations with US data show that low interest rates following financial market liberalization cannot explain high home values.

The US homeownership rate increased from below 45% in 1940 to above 65% in 1965, fluctuated around that value until 1994 and then exhibited a boom until 2005. Chambers, Garriga, and Schlagenhauf (2009) use a quantitative general equilibrium overlapping-generations model with housing to examine the roles of demographic changes and mortgage innovations in that boom. They find that, in the long-run, mortgage innovation accounts for between 56% and 70% of the increase, whereas demographics account for a much smaller portion. In order to test this result, they consider changes in the US mortgage market since 1940. They find that the introduction of the conventional fixed rate mortgage accounts for at least 50% of the observed increase in homeownership since 1940.

3 VOLUME II

3.1 Neighborhood Dynamics

People sort themselves into different social groups, which might be defined in terms of race, age, ethnic origin, taste, religion, language or even accidents of history. The groups may end up segregated in spatially defined areas, even in transient social gatherings like parties.

Segregation is an age-old phenomenon that Schelling (1969) first sought to understand as the rational behavior of individuals in the presence of social interactions. His two very influential models are known as the self-forming neighborhood model, and the bounded neighborhood model, commonly known as Schelling's neighborhood tipping model. In the former, individuals choose among locations on a lattice based on their preferences for their neighbors' race. Schelling's results understandably attracted attention: he argues that even if people have only a very mild preference for living with neighbors of their own race, much

more pronounced segregation may result in equilibrium. The latter model studies the process of neighborhood dynamics as neighborhood composition "tips" in favor of particular groups and produces clustering of racial groups.

Schelling (1969; 1971) are precursors of the social interactions literature because of their paradigmatic emphasis on the direct impact of characteristics of neighbors on individuals' decisions and their consequences for social outcomes.[7] As Schelling himself put it, this "kind of analysis explores the relationship between the behavior characteristics of the individuals who comprise some social aggregate, and the characteristics of the aggregate." Schelling makes evocative use of such ideas along with the mechanics of self-organization to investigate how unintended social outcomes reflect the magnification of individual preferences.

It took a long time for economists to probe deeper into the possibilities opened by Schelling's research. Hardman and Ioannides (2004) establish some basic facts about the sorting of individuals in US urban neighborhoods, using the same data on "micro" neighborhoods that Ioannides and Zabel (2008) also use. They introduce the concept of Schelling statistics, namely statistics, such as mean, variance or other moments, on a characteristic of one's neighbors conditional on one's own characteristics and measure them empirically. They document both significant income mixing in the majority of US urban micro neighborhoods and the extent of income mixing within neighborhoods of concentrated poverty.

Zhang (2004a; 2004b) provide the first rigorous demonstrations that segregation emerges and persists even if it is not desirable at the individual level. Zhang (2004a) models neighborhood transition as a spatial game played on a lattice graph which allows for the application of stochastic evolutionary game theory. Whereas integrated equilibria are Pareto-optimal, they are also dynamically unstable, as demonstrated by agent-based simulations, and instead segregated equilibria prevail. Zhang (2004b), which is included in Volume II, formulates residential moves explicitly as a spatial game and uses it to study the emergence of segregation in a manner similar to Zhang (2004a). However, in addition, the article also demonstrates the important role that the housing market plays in the dynamics of segregation. People with preferences for like-color neighbors live together and bid up housing prices, which in effect

[7] See Ioannides (2013) for an assessment of this contribution.

deters members of another group to live near them. It also offers predictions about the reversal of housing price and of housing vacancy differentials that are confirmed by the changes in predominately black neighborhoods following the US Fair Housing Act of 1968: housing prices in black relative to white neighborhoods decreased and vacancy rates increased.

Vinkovic and Kirman (2006) explore a physical analogue to the Schelling model by exploring conceptual links with the physics of clustering. In the socioeconomic setting of Schelling, interactions may be understood as taking place on the boundaries of different areas. In the physical setting, cluster dynamics is driven by the surface tension force. The resultant segregated areas can be very large and can behave like spherical liquid droplets or as a collection of static clusters in frozen form. Their careful and rigorous model is an excellent example of how going from a socioeconomic to a physical model and back may provide a useful framework for studying many spatial economic phenomena that involve individuals making location choices as a function of the characteristics and choices of their neighbors.

How do dynamics of actual neighborhoods behave? Brueckner and Rosenthal (2009) and Card, Mas and Rothstein (2008) address two different aspects of neighborhood dynamics. The former looks at how gentrification and neighborhood improvement cycles may change the demographic composition of US urban neighborhoods. The latter examines the dynamics of neighborhood tipping. Brueckner and Rosenthal (2009) emphasize that a key attribute of housing, age of the housing stock, plays an important role in location decisions. High-income households tend to locate in areas of the city where the housing stock is relatively new, namely suburbs. However, gentrification increasingly reduces the effective age of dwellings, making central locations more attractive to such households, reducing the dwelling age differences within cities, and thus narrowing central-city/suburban socioeconomic differences. Therefore, the stark dynamics of the Schelling model may be mitigated once other factors are considered.

Card, Mas and Rothstein (2008) take up the predictions of Schelling (1971), and seek to detect tipping in the dynamics of neighborhood racial composition. Using Census tract data from 1970 through 2000, they find strong evidence of tipping-like behavior in most cities. Minority shares ranging from 5% to 20% induce large white population flows, which is more

prevalent both in the suburbs and near existing minority enclaves. Surprisingly, they find little evidence of nonlinearities in rents or housing prices around the tipping point, which suggests that housing markets price individuals' tastes. Tipping points are higher in cities where whites have more tolerant racial attitudes, which provides qualitative confirmation of Schelling's predictions.

3.2 Dynamics of Housing Prices

In addressing the dynamics of housing prices this part emphasizes the significance of the spatial nature of housing markets. Because individuals move to adjust their consumption and housing equity holdings a complete analysis of housing market fluctuations must account for national economic conditions together with the local aspect of housing markets.

Saks (2008) emphasizes both those forces by looking at changes during 1981-2006 in annual housing stock and prices in US metropolitan housing markets. Saks shows that idiosyncratic characteristics of metropolitan areas explain a large fraction of the variation in annual changes in the housing stock, though not in house prices. Aggregate shocks in construction costs and prices are not that important. However, metropolitan areas with similar characteristics in 1980, such as in the elasticity of housing demand and supply, experienced similar, persistent fluctuations in construction and house prices during the subsequent 25 years. Thus, although housing market outcomes differ considerably across locations, the local factors that explain most of the variation in construction and house prices since 1980 and are highly persistent and do not seem to be correlated with fluctuations in local variables. The co-movement of locations with similar characteristics suggests that national factors cannot be ignored as contributions to the patterns of construction and house prices across US metropolitan areas. All in all, both national and local factors are important influences on metropolitan area housing market dynamics.

Holly, Pesaran and Yamagata (2010) examine real house prices in terms of such fundamentals as real per capita disposable income as well as common shocks to determine the speed of adjustment of real house prices to macroeconomic and local disturbances. Their

econometric model identifies a significant negative effect on changes in real house prices from a net borrowing cost variable, and a significant positive effect for US state level population growth. Using annual US state-level data during 1975-2003, they examine the role of such spatial factors as contiguity and find a significant spatial effect. This is so even after the authors control for state-specific real incomes, and allow for a number of unobserved common factors. Their results show that real house prices have been rising in line with fundamentals (such as real incomes), and there seems little evidence of house price bubbles at the national level. However, they do find evidence of departures from long run equilibrium in the housing markets of some states, like California, New York, Massachusetts, and, to a lesser extent, Connecticut, Rhode Island, Oregon and Washington. This finding could be due to local house price bubbles, or localized effects of technological innovations in media, entertainment, finance, and computers.

Knoll, Shularick and Steger (2017) take a comparative international perspective by studying annual house prices for 14 advanced economies since 1870. They show that real house prices stayed constant from the nineteenth to the mid-twentieth century but rose strongly and with substantial cross-country variation in the second half of the twentieth century. They argue that it is land prices, not construction costs, that are the key to understanding the trajectory of national house prices and the price elasticity of housing supply. Rising land prices explain about 80 percent of the global house price boom that has taken place since World War II. This view implies substantial benefits to land owners and important incentives for increased agglomeration,

3.3 Topics: Housing Indivisibility and Rent Control

Certain characteristics of housing markets require appropriate analytical treatment. Among many possibilities, a particularly notable one is the indivisibility of housing. Whereas price controls as a policy tool are nowadays used infrequently, rent controls seem to persist. This part addresses these two topics.

Kaneko, Ito and Osaga (2006) emphasize the indivisibility of apartments as goods, being

classified into a finite number of categories and traded in a competitive rental market in exchange for a composite commodity, say income. Utilizing duality tools, they present a general approach to obtaining comparative statics. They show that comparative statics are intimately related to the boundary income changes that define the groups demanding different categories of apartments.[8] They demonstrate their approach using data for a rental housing market in the Tokyo metropolitan area.

The consequences of rent control as a housing policy tool have typically been examined in static contexts. Hardman and Ioannides (1999) address it in a dynamic context. The authors develop a two-sector neoclassical growth model in continuous time with an infinite number of overlapping generations which are made up of individuals living for finite lifetimes. The housing sector may clear both via prices, in a free market setting, or via the frequency of moves in the presence of rent control. Housing consumption may be adjusted only by moving which is costly. Rent control that reduces housing rents below Walrasian levels reduce welfare. They may, by discouraging housing investment, increase the steady-state capital-labor ratio in the non-housing consumption-good producing sector. Their model may be used to assess numerous institutional factors, in the context of a growing economy in general equilibrium, which underlie the striking differences in the rates of residential mobility between countries and regions.

Little is known empirically about the impact of lifting rent control restrictions in a particular locale. Autor, Palmer, and Pathak (2014) use the unanticipated lifting of rent controls in 1995 by the City of Cambridge, Massachusetts, as a natural experiment to measure the capitalization of housing market externalities into residential house values. Using data on the universe of assessed values and transacted prices of Cambridge residential properties between 1988 and 2005, they find that rent decontrol generated substantial price appreciation in decontrolled units and nearby never-controlled units. The authors estimate it at a quarter of the $7.8 billion residential property appreciation in Cambridge during this period. Most of this contribution stems from the appreciation of never-controlled properties, which amounts

[8]This is reminiscent of how Epple and Sieg (1999) utilize a single-crossing property to estimate equilibrium sorting of individuals in local jurisdictions.

to significant evidence of neighborhood effects. Residential investment explains only a small fraction of the total.

3.4 Macroeconomic Aspects of Housing

There are several macroeconomic aspects of housing that have received particular attention in the last twenty years or so. While the role of housing in the business cycle has been well known empirically, it has not been fully studied by means of the standard tools of modern macroeconomics. Also, the role of foreign investment in housing markets has notably increased. Even though housing is par excellence a non-tradeable good, claims to it are tradeable.

Englund and Ioannides (1993) provide an international perspective on the dynamics of house prices by means of an overlapping-generations model of a small open economy, where foreign investment in all assets, that is physical capital, land, and housing, is allowed. They show that the openness of the economy increases the likelihood of instability in the standard long-run dynamics, as studied by the usual saddle point property of competitive equilibrium. Englund and Ioannides also show that while a bubble in the asset price of land is possible, that is not the case for the asset price of housing. The authors show, in the context of short-run dynamics, that countries with low residential mobility rates should exhibit higher price volatility.

Davis and Heathcote (2005) employ a standard multisector growth real business cycle (RBC)-dynamic stochastic general equilibrium (DSGE) model of the US economy to calibrate such stylized facts as the standard deviation of residential investment being more than twice that of nonresidential investment and the positive co-movement of GDP, consumption, and of both those types of investment. The model combines construction, manufacturing, and services to produce aggregate consumption, business investment, and residential structures. New housing requires land in addition to new structures. Their calibration shows that hours and output in all industries are positively correlated, and are most volatile in construction.

Iacoviello and Neri (2011) take up the following questions: What is the nature of the

shocks hitting the housing market? And, how big are the spillovers from the housing market to the wider economy? Slower technological progress in the housing sector relative to the rest of economy explains the upward trend in real house prices over the last 40 years. Over the business cycle, housing demand and housing technology shocks explain one-quarter each of the volatility of housing investment and house prices. Monetary factors explain less than 20 percent but have played a bigger role in the housing cycle at the turn of the 21st century. Housing market spillovers via the impact of the collateral effects of housing wealth on non-housing consumption are significant; they increase the reduced-form elasticity of consumption to housing wealth by 2.5 percentage points, from about 0.11 to 0.135. They have become more important over time; housing collateral effects have contributed up to 6 percent of the variance in consumption growth early in the study period, and up to 12 percent of the variance in consumption growth late in the period. Interestingly, while these effects are broadly consistent with those of Case *et al.* (2012), they are obtained by means of a full multi-sector DSGE model.

In dynamic studies of urban economies, spatial equilibrium is modelled by imposing that individuals' equilibrium utility be equalized across all sites. Glaeser, Gyourko, Morales, and Nathanson (2014) find that a dynamic linear rational expectations equilibrium model is consistent with several stylized facts of housing markets. These include: markets are local in nature; construction persistence is fully compatible with mean reversion in prices; and price changes are predictable. Their calibration shows that the volatility in local income processes as reflected in Housing Mortgage Disclosure Act (HMDA) mortgage applicant data can account for much of the observed price and construction volatility, except for the most inelastically supplied local markets. However, the authors are unable to match the strong persistence in high frequency annual price changes.

Since Piketty (2014) drew attention to the recent increase in income and wealth inequality in several advanced economies, several researchers sought to better understand its underpinnings. Notable among them is Rognlie (2015), who criticizes Piketty (2014) by arguing that the share of net income generated by housing has risen, from 3% in 1948 to almost 10% nowadays, with the total net share of capital having fallen and been fluctuating around

20% in the seven large developed economies since data became available; see Rognlie (2015), Fig. 3, p. 12. Thus, a chief culprit in the unequal distribution of capital and wealth is the increase in housing costs. It is observed in large developed economies, and much of it has urban origins, due to land scarcity, land use regulations and the like, as several papers in this volume argue, including notably Glaeser *et al.* (2006) and Saiz (2010). As housing has relatively "dispersed" ownership, it does not conform to the traditional story of "labor versus capital" (with allusions to "class struggle"), nor can its growth be easily explained by many of the explanations commonly proposed for the income split elsewhere in the economy.

3.5 Diamond-Mortensen-Pissarides Models of the Housing Market

In view of the numerous similarities between labor and housing markets, it is somewhat surprising that there have been relatively few housing market applications of the Diamond-Mortensen-Pissarides (DMP) approach to markets with frictions. Other than an early contribution by Ioannides (1975), who models search on both sides of the housing market and studies equilibrium outcomes, among more recent notable contributions Wheaton (1990) stands out. It models the single-family housing market where households that move are both buyers and sellers. Taste shocks induce homeowners to look for a better dwelling and to match randomly with potential buyers, while holding two houses until a buyer of the old residence is found. The vacancy rate determines the expected length of sale and search. It is an input into individuals' search strategies, which take the standard form of reservation prices by buyers and sellers. Transactions prices are determined by bargaining. The model yields a theoretical prediction for the persistence of positive vacancies and an inverse relationship between vacancy and prices. Thus, Wheaton utilizes several of the key concepts of DMP theory in analyzing the housing market.

Piazzesi and Schneider (2009) use survey evidence of beliefs about the evolution of prices and associated housing market decisions during the housing boom leading up to the crash of 2007. During 2002-2003, an increasing fraction of households believed the time was good for

buying a house because of favorable credit conditions and the likelihood of further price increases. Then, during 2004-2005, overall enthusiasm waned, with houses increasingly viewed as too expensive. The size of this "momentum" cluster strongly increased toward the end of the boom. These authors use these facts to motivate a simple search model to show how a small number of optimistic investors can have a large effect on prices without buying a large share of the housing stock. This argument is analogous to the role of momentum investors in the stock market where they can push up prices in the presence of short-sales constraints. Their simple model highlights the fact that when transactions prices are set via bargaining, the optimism of relatively few purchasers can push up prices. Because of search costs, beliefs do not affect market volatility.

Head and Lloyd-Ellis (2012) propose a joint model of housing markets for ownership and renting, where the ownership segment is subject to frictions, whereas the rental segment is frictionless. The model determines geographical mobility, unemployment, and homeownership in an economy with heterogeneous locations and endogenous construction. Houses are illiquid because they may not be sold at will, due to frictions. Homeowners accept job offers from other cities at a lower rate than do renters, which generates a link between homeownership and unemployment both at the city level and in the aggregate. A calibration with aggregate U.S. statistics on mobility, housing, and labor flows predicts that the effect of homeownership on aggregate unemployment is small.

Han and Genesove (2012) apply a random matching model to unique multi-year, multi-market survey data on both buyers and sellers to examine how demand affects housing market liquidity. They find that buyer time on the market, the number of homes that buyers visit, and especially seller time on the market all decrease with demand, with a much greater sensitivity to demand growth than its level. This is consistent with a straightforward matching model with a lag in seller response.

Albrecht, Gautier, and Vroman (2016) develop a directed search model of the housing market with a pricing mechanism that reflects the way houses are bought and sold in the United States. Their model is consistent with the observation that houses are sometimes sold above, sometimes below, and sometimes at the asking price. They characterize the

equilibrium of the game played by buyers and sellers and it is a new way to look at the housing market from a search-theoretic perspective. They contribute to the directed search literature by considering a model in which the asking price entails only limited commitment and has the potential to signal seller type.

Ioannides and Zabel (2018) extend Head and Lloyd-Ellis (2012) by treating decisions about housing and labor supply as joint decisions of individuals, articulating how both the renting and owner segments of housing markets adjust through turnover flows and highlighting the transitions across different discrete states in those markets, that is owner-to-owner, owner-to-renter, renter-to-owner, and renter-to-renter by unemployed or employed workers. Both segments of the housing market and the labor market are modeled as being subject to frictions. By allowing for frictions in agents' transition between the two segments of the housing market they are able to introduce a novel concept of "unemployment" in housing markets. That concept allows them to define and estimate Beveridge curves for housing markets. Using data from the Panel Study of Income Dynamics for 1969-2015, the paper offers a novel view of the interactions between housing and labor markets via the empirics of transitions across discrete states for owners and renters, and their cyclical properties.

4 Conclusion

Nearly a generation since Quigley (1997), it behooves this collection of recent developments in the economics of housing to reflect the state-of-the-art of what has happened to mainstream economics since the late 1990s. The profession has become very empirical and employs both estimation and simulation techniques. Indeed, it is quite rare for purely theoretical approaches to be well received, especially on matters that bear on policy design. Empirical approaches sometimes take the form of econometric estimations of purely ad hoc models; at other times they comprise empirical tests of theories, and still at other times they motivate theories. Leading figures in the profession as well as journal editors emphasize the importance of empirics, and newly minted professional economists are rarely comfortable without at least a modicum of empirical research.

It is hoped that a complete picture of the state-of-the-art in the economics of housing is given by the entire portfolio of articles in this collection. Overlaps in coverage were minimized to the extent possible. It is hoped that the collection will advance the frontier in the economics of housing and also substantiate the complementary role that housing research has played in exploring several important concerns of contemporary economics. Notable among them are: housing and the macroeconomy (including international aspects and especially since the critical role that mortgage-related assets played in the emergence of the Great Recession of 2007-2009 in the US); neighborhood dynamics; neighborhood, or more generally, social interactions and housing demand; geography, housing supply and the spatial distribution of income.

While the volumes have not devoted space to housing policy per se, several articles are key to elucidating critical issues in long-standing policy questions. Here are a few examples. Rossi-Hansberg *et al.* (2010) provide the fundamentals for the reconsideration of urban renewal interventions. Wong (2013) offers critical input for understanding the effectiveness of mixed housing policies. Brueckner and Rosenthal (2009) inform the role of gentrification, and Glaeser *et al.* (2008) clarify the role of public transportation for income stratification of US cities. Lee and Lin (2018) and Saiz (2010) open up the richness of links with geography and how geographical features of cities are intimately linked with the spatial distribution of income. Social interactions, as they have been introduced into the economics literature by Schelling (1969; 1971) and taken up by many scholars[9] are amply represented in the collection. The contributions by Zhang (2004b) and Card *et al.* (2008), which are included in Volume II and by many other scholars are critical for understanding urban dynamics and urban policy interventions.

Giglio *et al.* (2016) and Holly *et al.* (2010) improve our understanding of the feasibility and likelihood of housing price bubbles. Clapp (2004), Caplin *et al.* (2008), Bracke (2015), on the one hand, and Geanakoplos (1997), on the other, allow for a deeper understanding of the role of mortgage-based securities in the functioning of asset markets. A better understanding of the critical role of housing in macroeconomic equilibrium is provided by

[9]For an emphasis on urban applications, see Ioannides (2013).

Davis and Heathcote (2005), Iacoviello and Neri (2010), Saks *et al.* (2008), and Glaeser *et al.* (2014), with the last underscoring that the different local housing markets in large economies are interconnected in profound ways.

Understanding frictions in housing market are likely to be increasingly relied when studying housing markets worldwide. They are indispensable for both local housing market issues as well as for macroeconomic issues, and the DMP-type models included in Volume II provide many essential modeling tools and empirical findings that are likely to open up new avenues of housing research.

International aspects of housing markets are dealt with in a number of ways. The example in Kaneko *et al.* (2006) provides a glimpse of the Tokyo housing market. The use of comparative international data by Giglio *et al.* (2016), the historical perspective on global housing prices in Knoll *et al.* (2017), and the role of housing in small open economies in Englund and Ioannides (1993) give a novel understanding of housing in a international context.

If one compares Quigley (1997) with the present collection of articles, it would be irresistible not to speculate that the next such collection will look very different! Some of the methodological innovations will come to dominate thinking about housing, while others will be forgotten. Rigorously established facts will, however, persist and will likely continue in the future to motivate high quality research in the economics of housing.

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