Housing in DGSE Models: Findings and New Directions

Matteo Iacoviello

1 Introduction

To understand the renewed interest of academics and policy makers in the housing market, I will start with a quote that summarizes how little interest there was in the topic only nine years ago:

> *This paper focuses on a small niche – the housing market – with limited evidence that this market has the significance that is implied for real economic activity. (July 17, 2001)*

This quote is from a well-known economist who has, since then, written papers on the housing market himself, probably in light of the fact that the housing market is not such a niche anymore. This quote was the justification that the economist, as editor-in-charge at a macro field journal, gave to reject a paper written by the author of this chapter. In sum, the paper was okay, but the topic – housing and the credit channel of monetary policy – was boring.

Nine years later, the research on the housing market and the macroeconomy has finally become mainstream. One of the keys to this shift of ideas has been the observation that movements in housing markets are not just the consequence of wider macroeconomic developments, but also can be important impulses to business fluctuations. For instance, in his introductory remarks at a conference on Housing and Mortgage Markets, Federal Reserve Chairman Ben Bernanke (2008) noted:

> *Housing and housing finance played a central role in precipitating the current crisis.*

To summarize, while only ten years ago "housing" was not part of mainstream economic research, and was confined to a subfield of economics named "real estate

M. Iacoviello
Federal Reserve Board - Division of International Finance.

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economics," it is fair to say that, today, things have changed. Yet even now many popular undergraduate and graduate macroeconomic textbooks devote little space to housing. For instance, the word "housing" only appears once in Carl Walsh's latest edition of the book "Monetary Theory and Policy" (in the context of a discussion of tax deductibility of nominal mortgage payments). It never appears in the Ljungqvist and Sargent or in Woodford's books. The goal of this chapter is to make the case that it is time for macroeconomists to restore the imbalance between the practical and empirical relevance of housing for macroeconomics on the one hand, and the treatment that macroeconomic models devote to housing on the other.

My comments will mostly touch upon the role of housing within the class of macroeconomic models that have become known as dynamic, stochastic, general equilibrium (DSGE) models (see Woodford, 2009, and Fernández-Villaverde, 2009, for recent surveys). The cost of confining my attention to DSGE models is that the chapter will not cover the growing literature that links housing with search models, with models of urban economics, or with asset pricing models, unless this research has used elements of DSGE models. The benefit is that a large portion of modern macro research – especially in central banks and international financial institutions – uses DSGE models for forecasting and for policy advice, as an alternative or as a complement to large scale non-structural macroeconomic models. My hope is that users of DSGE models who are not familiar with housing research will find this review useful.

2 Seven Facts about Housing and the Macroeconomy

There are several interesting dimensions that matter as far as housing prices, housing investment and housing wealth are concerned. To illustrate their importance, I will focus on seven interesting facts about housing. These facts are not new, and have been noted by other authors – including myself – before. I just want to put them together in order to organize my discussion.

1. Housing wealth (the market value of all residential capital stock, whether rented or owned) is an important component of national wealth. In fact, it accounts for almost half of household wealth in most developed economies. Figure 1 illustrates this case for the United States, using data (in billions of 2005$) from 1952 to 2008.[1]
2. Housing wealth is larger than GDP, and fluctuates considerably over time. Figure 2 plots the ratio of nominal housing wealth to nominal GDP for the United States.[2] The ratio of housing wealth to GDP has averaged around 1.5 between

[1] The data source for housing wealth are the Flow of Funds Accounts of the United States. The details of data construction can be found in Iacoviello (forthcoming).

[2] Most of the fluctuations in nominal housing wealth reflect movements in the price of housing, rather than movements in the stock.

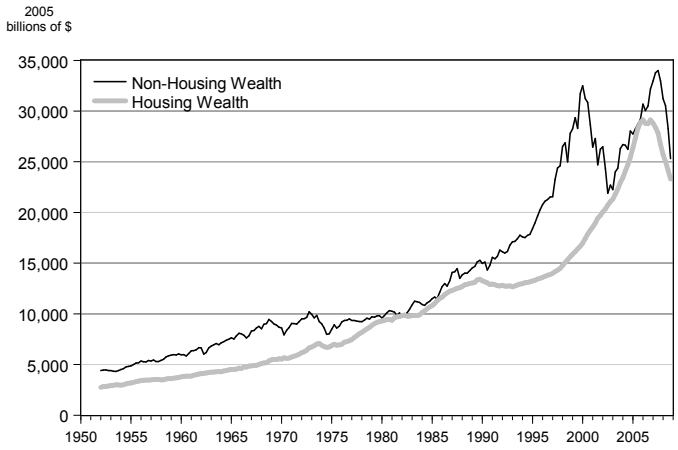

Fig. 1 Housing Wealth and Non-Housing Wealth in the United States - Both variables have been deflated with the deflator for Personal Consumption Expenditures

1952 and 2008. However, it has moved dramatically throughout this period: it was equal to 1.27 at the beginning of the sample period; it was as low as 1.20 in 1962; and reached a value of 2.26 at the end of the 2005, at the peak of the recent housing boom.

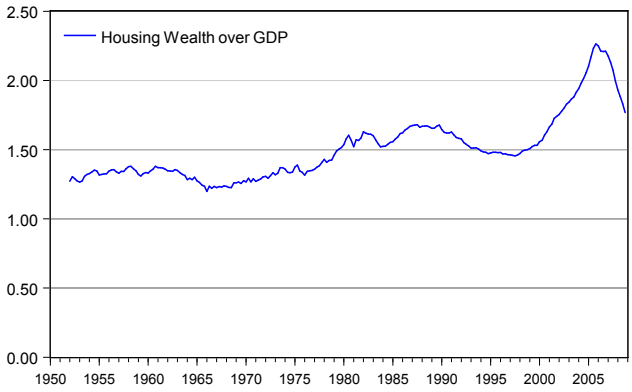

Fig. 2 Ratio of Housing Wealth to GDP - Both numerator and denominator are expressed in dollar terms

3. Housing wealth and aggregate consumption expenditures tend to move together in post-World War II U.S. history. Over the 1952–2008 period, their contemporaneous correlation is 0.47 (using year-on-year real growth rates). Figure 3 illustrates the joint comovement between the two variables. This correlation is larger than the correlation between consumption and the residual components of household wealth: for instance, the contemporaneous correlation between changes in inflation-adjusted financial wealth and changes in consumption equals 0.38.[3]

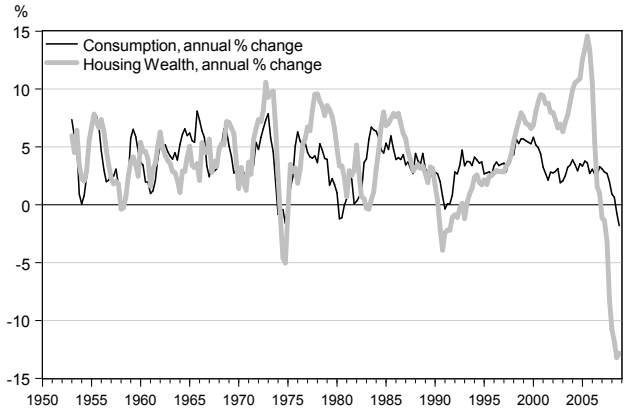

Fig. 3 Changes in Housing Wealth and Changes in Consumption Expenditures - Both variables are expressed in year-on-year growth rates and have been deflated with the deflator for Personal Consumption Expenditures

4. Movements in housing wealth are typically accompanied by large movements in housing investment in the same direction.[4] These movements in housing investment, in turn, substantially affect aggregate GDP and employment, even if the share of housing investment in GDP is relatively small.[5] For instance, since its 2005 peak, the share of housing investment in GDP fell in half, from about 6 percent to 3 percent in about three years (see Figure 4): simple back-of-the-envelope

[3] It is this observation that had led many, in my view, to study the so-called housing wealth effect: see Iacoviello and Neri (2010) and Iacoviello (forthcoming) for further discussion of this topic and for additional references.

[4] Part of this comovement reflect the simple fact that, by adding to the stock, an increase in housing investment will necessarily lead to an increase in housing wealth, holding prices constant. However, a larger fraction of this comovement might reflect the endogenous response of housing investment to exogenous changes in housing demand that jointly affect both the price and the quantity of housing: Iacoviello and Neri (2010) present a DSGE model that captures this mechanism.

[5] The share of housing investment in GDP has been constant around 5 percent throughout the 1952-2008 period. The constant of this share reflects two offsetting forces: while real residential investment has not rises as fast as GDP over time, the price of residential investment has risen relative to the GDP deflator. See Iacoviello and Neri (2010) and Fisher (2007) for further discussion.

economics suggests that this reduction has subtracted several percentage points from GDP growth throughout the same period.

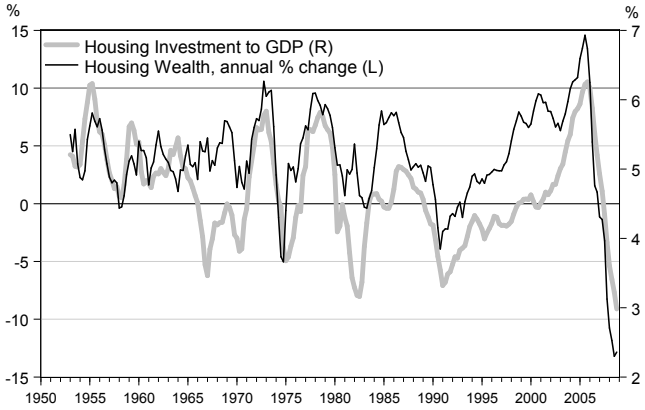

Fig. 4 Changes in Housing Wealth and Ratio of Housing Investment to GDP - Housing Wealth has been deflated with the deflator for Personal Consumption Expenditures and is expressed in year-on-year growth rate. The Housing Investment to GDP ratio is the ratio of the two variables, both expressed in dollar terms

5. Movements in the price of housing are only loosely connected to movements in other prices.[6] Figure 5 plots consumer price inflation alongside two measures of house price inflation, the Census Price Index of new homes sold and the Freddie Mac Conventional Mortgage House Price Index.[7] The contemporaneous correlation between quarter-on-quarter changes in consumer prices and house prices is in the 0.3–0.4 range, depending on the time period and the house price measure used. If anything, housing price inflation leads consumer price inflation by approximately two to three quarters, and this tendency is more pronounced in the last decades. In addition, house price inflation is more volatile than consumer price inflation: for instance, the standard deviation of quarter-on-quarter house price inflation (using the Freddie Mac Conventional Mortgage House Price index) from 1970 to 2008 is 1.19%. The corresponding number for consumer price inflation is 0.67%. This result also holds if one uses less noisy measures (such as year-on-year growth rates) of inflation.

[6] My emphasis here is on unconditional correlations. It is possible that, once some other variables or exogenous shocks are factored in, conditional correlations might be larger.

[7] The Census series starts in 1963. The Freddie Mac series starts in 1970. For this reason, I restrict my attention to observations from 1970 onwards only. See Rappaport (2007) for a survey of the differences between different house price measures for the U.S.

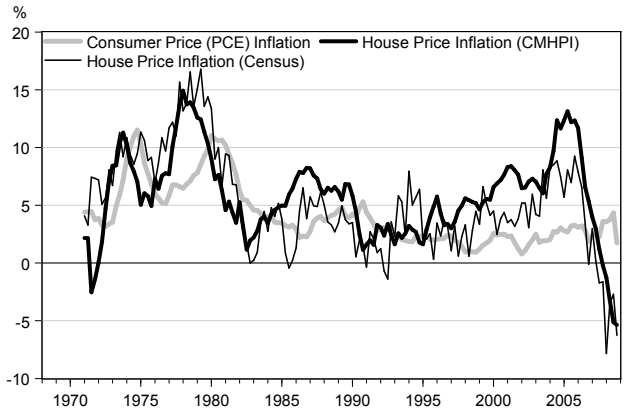

Fig. 5 House Price Inflation and Consumer Price Inflation - All variables are expressed in year-on-year growth rates

6. Housing (Residential Fixed) investment leads nonhousing (Nonresidential Fixed) investment, and is more volatile. This pattern can be seen in Figure 6.[8] Peaks and troughs in housing investment generally precede peaks and troughs in business investment. This observation has led to the now-famous quote by Ed Leamer that "housing is the business cycle".

7. In U.S. data over the last 45 years, inflation-adjusted house prices display an upward trend, even after controlling for the boom and bust in prices of the last decade. Figure 7 illustrates this pattern. See Davis and Heathcote (2005) and Iacoviello and Neri (2010) for additional discussion on these issues.

These facts should be considered as an important yardstick to measure the success of macroeconomic models of housing. My experience with referees, discussants and colleagues tells me that, depending on tastes (as well as intellectual capital spent on each particular question), everyone has his own ranking of these facts. I do not want to take a stance here, and might have omitted other interesting facts about housing that some economist might regard as equally important.[9]

[8] Fisher (2007) documents this result in detail and offers a DSGE model of housing that can explain this result. See also Davis and Heathcote (2005) for a related model.

[9] I will mention here some additional facts that did not make the cut in the list above: (a) The production of housing services can be thought of as the combination of housing structures and land (Davis and Heathcote, 2005). (b) The purchase of a house is typically financed with a downpayment, with a mortgage making up for the difference between the purchase price and the downpayment. (c) Housing services can be either purchased or rented, depending on preferences, life-cycle motives, and institutional arrangements. (d) Finally, contrary to what many seem to believe, the ratio of consumption expenditures to housing expenditures tends to fall over the life cycle: in other words, old people consume relatively more housing than young people (see Yang, 2009).

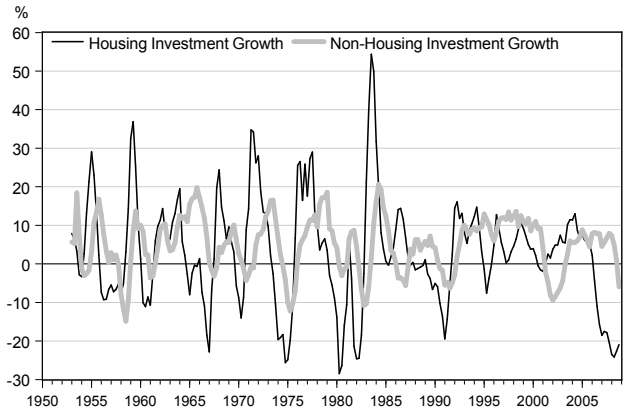

Fig. 6 Housing Investment and Nonhousing Investment - Both variables are chain-weighted and expressed in year-on-year growth rates

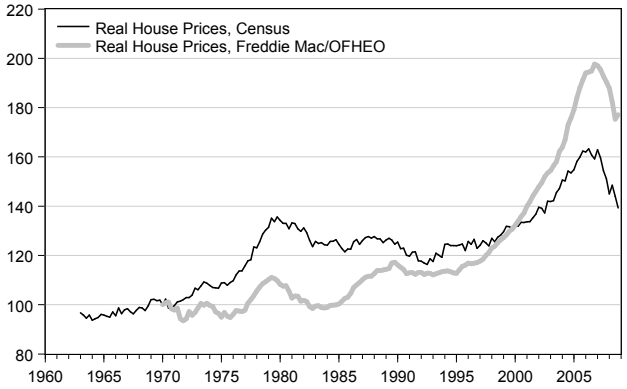

Fig. 7 Real House Price Indices - Both Indices have been normalized to 100 in 1970Q1. Both series have been deflated with the deflator for Personal Consumption Expenditures

3 A DSGE Model of Housing

Iacoviello and Neri (2010) add a rich housing sector to a framework that is increasingly used in quantitative monetary policy analysis. Their paper develops and estimates a DSGE model of the housing market that captures two important features of housing: on the supply side, sectoral heterogeneity allows capturing the different trend and cyclical properties of housing prices and housing investment relative to other prices and to other forms of demand; on the demand side, collateral effects

of housing prices on borrowing allow for spillovers from the housing market to consumer spending. Versions of this model have been used at Riksbank (Sellin and Walentin, 2010), Norges Bank (Brubak, Elekdag and Maih, 2007), ECB (Lombardo and McAdam, 2008), European Commission (Roeger and in 't Veld, 2009), Bank of Canada (Christensen, Corrigan, Mendicino and Nishiyama, 2009), Central Bank of Colombia (López Enciso and Salamanca Lugo, 2009), IMF (Kannan, Rabanal and Scott, 2009), and elsewhere.

In this section, I will briefly review the main elements of the Iacoviello and Neri model.

Let me start with the production side of the economy. Iacoviello and Neri assume that the economy is best approximated by multiple sectors with different rates of technological progress. The non-housing sector produces consumption, business investment, intermediate goods (using capital and labor). The housing sector produces new homes, which add to the existing stock, using capital, labor, land, and intermediate goods. Following the lead of most of the DSGE literature, Iacoviello and Neri allow for nominal wage rigidity in both the non-housing and housing sector and allow for price rigidity in the non-housing sector. The multi-sector structure is meant to capture two important observations about the housing market: first, there is a long-run upward trend in the relative price of housing in post-world-war-II U.S. data, which is – at least in part – due to heterogeneous trend technological progress between housing and other sectors of the economy. Second, the production of housing is land intensive: hence, the assumption that the same production mix is used to produce houses and other goods is too restrictive.

On the demand side, Iacoviello and Neri split households into two types: patient (lenders) and impatient (borrowers). Patient households work, consume and accumulate housing: they own the productive capital of the economy, and supply funds to firms on the one hand, and to impatient households on the other. Impatient households work, consume and accumulate housing: because of their high impatience, they accumulate only the required net worth to finance the down payment on their home and are up against their housing collateral constraint in equilibrium. Along the equilibrium path, in turn, fluctuations in housing values affect borrowing and spending capacity of constrained households.

Iacoviello and Neri use U.S. time series to estimate the model structural parameters and to ask a series of questions concerning the macroeconomic importance of housing market spillovers.

Their main findings are:

- The slow rate of technological progress in housing construction explains the upward trend in real housing prices of the last decades. Part of the trend growth reflects supply constraints from land, but their contribution is small (10% of the total trend increase in house prices). The remainder reflects different rates of technological progress.
- The wage share of credit constrained households is estimated at around 20 percent. The credit constrained households are those who suffer (benefit) the most from drops (increases) in housing values. At the aggregate level, this fraction is

large enough to amplify effects on consumption from fluctuations in housing values (especially for high values of the loan-to-value ratio). The presence of credit constrained households also reinforces the correlation between movements in consumption and movements in housing wealth.[10]
- Wage rigidity in the housing sector is crucial to explain important features of the data, in particular the large sensitivity of residential investment to changes in short-term interest rates: with flexible house prices, wage rigidity is important in making housing investment very sensitive to monetary shocks, something that is apparent in the data.

The Iacoviello and Neri model can be used to assess sources of fluctuations in housing prices and quantities, can be used to quantify macroeconomic consequences of housing market shocks, and can be used to think about optimal responses to asset prices. In what follows, however, I will mainly indicate some directions in which I think and hope this setup can be extended to address topical questions in macroeconomics.

4 New Directions

4.1 The Role of Financial Intermediation

The Iacoviello and Neri model is silent about the role of financial intermediation. In the model, financial intermediation occurs without frictions, since patient households can costlessly transform savings into loans using a constant returns to scale technology. This assumption, which is implicit in the neoclassical growth model, is equivalent to treating the financial sector as a veil. When thinking about the 2008 financial crisis, however, it is hard not to notice that one important effect of fluctuations in housing prices is linked to the potential effect of house prices movements on the balance sheet of financial intermediaries. In the Iacoviello and Neri model, it is only the borrowers who are hurt from declines in housing values: the model's implicit assumption, in fact, is that borrowers will always honor their debts. As a consequence, lenders are virtually insulated from movements in housing wealth. Consider, instead, a financial crisis episode: reductions in house prices may lead to smaller repayments on part of the borrowers (some borrowers walk away from their obligations when the collateral is worth less than the face value of debt). The smaller repayments, in turn, may lead to reductions in the net worth of financial intermediaries. If financial intermediaries are able to absorb these losses raising capital elsewhere, the lack of repayment should be equivalent to a redistributive shock that should not generate large aggregate effects. Suppose, instead, that financial intermediaries themselves face credit constraints. In other words, assume that patient

[10] This effect occurs over and above the comovement coming from common shocks moving the two variables in the same direction.

households lend resources to bankers, and that bankers lend resources to impatient households. If bankers face credit constraints (for instance, they need to satisfy some minimum capital requirement), a negative repayment shock can cause a loss for the lenders which, in turn, may cause an aggregate credit crunch.

In ongoing work (Iacoviello, 2010), I develop a model along the lines developed above in order to study the role of bank in the transmission of financial shocks. This work complements the excellent work of many others who have developed models of banking and credit frictions in a general equilibrium context. A non-exhaustive list includes Gertler and Karadi (2009), Gerali, Neri, Sessa and Signoretti (2009), Angeloni and Faia (2009), Gertler and Kiyotaki (2009), Meh and Moran (2004), and Dib (2009).

4.2 The Determinants of Housing Prices

One important finding of the Iacoviello and Neri model is that a good part of the cyclical fluctuations in housing prices are viewed by the model as the outcome of "exogenous" preference shifts towards housing (the trend in house prices in U.S. data, as explained above, can be captured by heterogeneous rates of technological progress, namely slow technological progress in the housing sector relative to the consumption and business fixed investment sectors). This result holds even after regressing the estimated innovations to housing preferences against a large set of potential explanatory variables for housing demand that we do not explicitly incorporate in the model (such as population or mortgage origination fees or share of subprime mortgages in total mortgages). As with every shock, the issue of whether preference shocks are spontaneous, primitive and interpretable remains an open one: in the paper, we report the results of a search of newspapers' articles for the period 1965-2006 trying to relate, from an informal standpoint, our estimated "preference" shocks to stories about the national housing market. Articles in the press often explain movements in the housing market with changes in housing demand that they could not immediately attribute to changes in fundamentals such as inflation, incomes and interest rates. To give a few examples, they refer to shifts in the housing market as coming from the "increased needs for privacy", to "changes in tastes", to the "desire to buy more housing than necessary", to "faith in real estate as an investment". Obviously, these explanations are only meant to be suggestive. It goes without saying that digging more in detail into the structural determinants of these shocks is an important topic for future research.

4.3 The Time-Series Properties of Housing Price Inflation

Most microfounded DSGE models that incorporate asset prices (including house prices) generate – as an optimality condition of the model – an asset price equa-

tion which is purely forward looking in nature. This is true even for consumer price inflation: the baseline new-Keynesian model, for instance, predicts that inflation is a weighted average of current and future expected real marginal costs. As a by-product of this result, house and consumer price inflation share one common – and somewhat undesirable – property: they are too forward looking relative to the data. In the data, there is a high degree of serial correlation in consumer price inflation (see for instance the survey paper by Fuhrer in the forthcoming Handbook of Monetary Economics). There are not many studies (that I know of) that have looked at the persistence properties of house price inflation, but, as Figure 5 shows, there is evidence of serial correlation in house price inflation. House price inflation persistence is slightly smaller than consumer price inflation persistence, but is present both in the Freddie Mac and in the Census measures of house prices. The Freddie Mac measure has a serial autocorrelation of 0.5. The Census measure is not serially correlated with its first lag, but has a positive correlation (around 0.25) with lags greater than the first.

Why is house price inflation persistent, at least for some measures? As anybody who has bought or sold a house knows, there exist a variety of institutional features and social norms in the housing market that, at least in part, can explain sluggishness in house prices. To give some examples, one yardstick that sellers and their agent use when they first put homes on the market are "comparables": the first listing price of a property is often based on the price of similar nearby properties sold up to 6 months before. Likewise, lenders will often commit to a mortgage that does not exceed the minimum between contract price and appraised price: to the extent that appraisers base their estimates on previous sales, lending criteria and ability to offer will depend on the past. In other words, there seems to be in the real estate practice lots of backward looking behavior: moreover, the potential for backward looking behavior is even larger in periods when the housing market is slow, since the decline in the number of transactions that is typical of housing slowdowns forces appraisers and real estate agents to go back further in time in an attempt to find the "right" price for a property. I am sure we would learn a lot if some of these insights could be incorporated in future DSGE models with housing.

4.4 How to Stabilize House Prices

In earlier work (Iacoviello, 2005), I have found that monetary policy shocks affect house prices more than consumer prices: this result would suggest that, at least in principle, monetary authorities have the tools to mitigate fluctuations in housing prices. However, given the large fluctuations in house prices that are observed in the data, it is not clear whether interest rate policies only can successfully stabilize house prices, or, provided that they can do so, that they can stabilize house prices without causing excessive volatility in other macroeconomic variables.

The above observation leads to an obvious question: are there policy instruments that can be quantitatively successful in stabilizing house prices? Can tax credits

(such as, for instance, the Worker, Homeownership, and Business Assistance Act of 2009) significantly affect housing demand and prices? Do "macroprudential" supervisory tools – such as those used by the Hong Kong Monetary Authority imposing caps on maximum loan-to-value ratios – work? Digging more into these issues – using DSGE models – seems to me a sensible way to address these questions.

4.5 Housing and the Labor Market

The efficient functioning an economy requires that factors of production are allocated where their marginal product is highest. This observation is especially true for the labor market in the United States, which, by most measures, features one of most dynamic labor markets in the world. However, it is possible that, when house prices fall, people are less willing to capitalize a loss on the property they own even if a better job opportunity arises elsewhere. If this argument holds, declines in house prices should impede labor mobility, and less labor mobility could have an impact on productivity. These arguments are fascinating, and one would like to see DSGE models that tackle this intuition more formally (see Head and Lloyd-Ellis, 2008, for a stylized model of housing and labor market search, and Sterk, 2010).

5 Conclusions

As the recent housing turmoil has shown, a better understanding of the workings of the housing market holds the key to a better understanding of macroeconomic fluctuations in general. My hope is that the next generation of DSGE models will devote increasing attention to modeling the housing market. Housing, for better or worse, is no small niche anymore.

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