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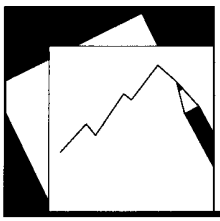

IMF Working Paper

Global Housing Cycles

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Abstract

Housing cycles and their impact on the financial system and the macroeconomy have become the center of attention following the global financial crisis. This paper documents the characteristics of housing cycles in a large set of countries, and examines the determinants of house price movements. Empirical analysis shows that house price dynamics are mostly driven by income and demographics but fluctuations in these fundamentals and credit conditions can create deviations from the implied equilibrium path. We conclude with a discussion of the macroeconomic implications of house price corrections.

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I. INTRODUCTION

After the tech bubble burst in 2000, rising property prices, which in retrospect appear to be an unsustainable boom, helped to prop the global economy. Never before had real house prices risen so fast, for so long, and in so many countries at the same time (Figure 1). With the exception of Germany and Japan, real house prices in all OECD countries increased, in most cases, substantially, from 2000 to 2006. A similar yet not as striking increase, with a few exceptions, was recorded in developing countries. House prices rose 50 percent in real terms in the median advanced economy during this period while they were up by almost 30 percent in the median developing country. Nevertheless, as some had been predicting for quite some time, what went up had to come down. When the global housing boom turned into a housing bust during 2007 in almost all countries except the United States, where a housing correction has been under way since 2006, the world economy found itself in what many label as the biggest crisis of the post-World War II era (Figure 2).

This paper documents the magnitude and characteristics of this global housing boom-bust and examines the impact of house price corrections on the overall economy. The analysis is conducted in an international sample covering both developed and developing countries and complemented by exercises at the sub-national level using data for the United States. To give a sense of the usefulness of the analyses in real time, the data cut-off is applied at end-2009.

The findings suggest that long-run price dynamics are mostly driven by local fundamentals such as income and population growth. The effect of more globally connected factors such as interest rates appears to be less strong. Credit market conditions may cause short-run deviations from long-run equilibrium and, ultimately, when the correction starts, as it did in the most recent episode, financial stability and the overall economy bear important consequences in terms of credit institutions coming under stress and slowing real economic activity. The severity of the ultimate impact depends on various factors including structural characteristics of housing and mortgage markets.

If past is prologue, the ongoing house price corrections could average about 23 percent and be spread out over a period of 4-4.5 years from peak to trough. This assessment is in line with those stemming from inspection of valuation ratios and econometric models. Past evidence also suggests that cross-country differences in the impact of these corrections on economic activity are likely to depend on the characteristics of the housing finance systems, particularly the ease with which households have been able to access mortgage credit in recent years.

A major obstacle in conducting formal analysis of global housing cycles and their implications is the lack of data. Efforts should be concentrated on increasing the availability of consistent and reliable data on housing and real estate financing markets. Then, future research can aim to look into these macro-financial linkages more closely to better understand the consequences of housing boom-bust episodes.

The paper is organized as follows. Section II discusses the data, with particular attention paid to the discrepancies that result from using different sources, the effects of seasonal adjustment, and issues that may be masked by use of national series because of variation in sub-national movements. Section III presents the empirical findings. Section IV concludes.

II. DATA

We gather information from various national sources on housing market indicators and demographic factors. We combine this information with macroeconomic variables from the *IMF International Financial Statistics* and the Organization for Economic Cooperation and Development (OECD). A full list of the variables used in the analysis is in the Appendix.

Measuring house prices is a hard task given the opaqueness and infrequency of transactions and the heterogeneity of the product not only cross-sectionally but also through time because of repairs and improvements that alter the value of a property. Despite calls for production of comprehensive and detailed data on housing and mortgage markets that have gained momentum following the global financial crisis, reliable and long time series of house price indices are hard to come by, especially for non-advanced countries. Data availability severely limits the number of the countries that we can include in the study, constraining most of the formal econometric analysis to 22 advanced countries. It should be noted that aggregating information at the national level might mask important regional differences within a country. In order to complement the analysis further and to accentuate these regional differences, we also combine data from the U.S. national statistical sources to conduct a sub-national analysis of house price cycles and economic consequences of price corrections. The series we use in our analysis of the international sample are gathered by the OECD, the Bank for International Settlements (BIS), and Global Property Guide, a private company. These are put together based on commonly-used national sources and are seasonally adjusted. For the sub-national part of the analysis, the data come from national sources: the Federal Housing Finance Agency (FHFA)[2], the Bureau of Economic Analysis (BEA), and the Bureau of Labor Statistics (BLS). The Appendix also includes a table with more information on the house price data series we use.

Given the complications in measuring house prices, it is common to have multiple series for the same country or region constructed using similar but not identical methodologies. Often, an index is constructed based on actual transactions from tax or land registries. In addition to the fact that institutional quality may affect the extent the transaction value is reported truthfully, this method does not take into account the potential differences between the set of properties that change hands at different points in time. For example, developers may have a tendency to release new properties to the market in fall (completing construction in the summer) while existing home owners put their properties in the market in spring. A methodology that aims to solve this problem concentrates on existing home sales and follows the same property over time as it changes hands (the repeat-sales methodology). A problem that still remains is that repairs and improvements (or lack thereof) by occupants and developments in the urban landscape around the property (e.g. infrastructure projects, gentrification) can alter the value of a property

[2] FHFA was created on July 30, 2008, when President George W. Bush signed into law the Housing and Economic Recovery Act of 2008. The Act combined the staffs of the Office of Federal Housing Enterprise Oversight (OFHEO), the Federal Housing Finance Board (FHFB), and the government-sponsored enterprises mission office at the Department of Housing and Urban Development (HUD).

over time. But even when the methodologies are the same, coverage (geographical and/or type of property) and computation techniques may still differ.[3]

To illustrate how different sources of data lead to discrepancies, Figure 3 shows several house price indices for the United States. Although both OFHEO and S&P Case-Shiller indices concentrate on single-family homes and use the repeat-sales methodology, major differences in data coverage and computation remain leading to a discrepancy.[4] Most importantly, OFHEO's national index has a broader geographical coverage than the Case-Shiller national home price index. Also, OFHEO basic index includes refinance appraisals while Case-Shiller considers purchases only. Even when only purchases are considered, OFHEO index is based on conforming mortgage loans, and hence, does not take into account jumbo and (most of) non-prime loans. Moreover, OFHEO gives equal weight to each home valuation while Case-Shiller applies a weighting system in which a home's effect on the index is proportional to its value. Recalculating the OFHEO national index using each state's share of mortgage originations as weights brings this index closer to Case-Shiller. Similarly, internationally-comparable house price data from different sources, while they all tell broadly the same story, differ slightly due to coverage and seasonal adjustment or interpolation techniques when the series are not reported at the same frequency. These data issues should be remembered when findings of different studies are compared to each other.

Another important measurement issue is the aggregation of regional trends into a single national index. As Figure 4 shows there generally is a non-negligible amount of variation in the magnitude of house price changes, if not the direction, in different geographical areas, often defined in rather granular terms. For instance, house prices in Northern Ireland were almost flat in the late 1980s while strong house price appreciation in London area pushed the national index up. Similar patterns are supported by data from China, Hong Kong SAR, India, Korea, the Netherlands, and the United States. To account for such heterogeneity in housing markets, we conduct parts of our analysis using sub-national data for the U.S.

Finally, the frequency at which our data are reported is quarterly, giving us a sharper edge than annual data can to analyze the cyclicality in housing markets. As we use data at quarterly frequency, it is crucial to seasonally adjust the series. House prices exhibit strong seasonal patterns, due to intrinsic features of these markets, e.g., most households choose to wait for warmer temperatures to look for a house and move. All data series we use are seasonally adjusted to get rid of these patterns using the X-12 procedure in E-Views. Again, the technique used can lead to small discrepancies in comparison of different studies.

Our empirical analysis on house price cycles consists of three parts. First, we demonstrate the cyclical movement in housing markets. Then, we make inferences on the extent of ongoing global correction in house prices based on the characteristics of past housing cycles and use

[3] For a more detailed account of issues related to measurement of house prices and construction of house price indices, see Silver (2011) and Silver (2012).

[4] The OFHEO index is now referred to as the FHFA index.

nonparametric techniques to estimate the size of the gap between current and *equilibrium* house price levels. Finally, we estimate a regression model that aims to capture the long-term relationship between house prices and their key macroeconomic determinants. The analysis then moves onto the consequences of house price corrections, with particular focus on consumption, investment, financial distress and overall impact on GDP.

III. Empirical Analysis

A. Housing Cycles

Housing markets, due to certain distinctive features, e.g., rigid supply, infrequent trades, opaqueness, short-term financing for construction together with long-term financing for occupancy, are intrinsically prone to boom-bust cycles. While empirical studies documenting the cyclical behavior of housing market developments abound, there is a relative scarcity of theoretical models of real estate cycles. Most of these rely on supply rigidity and uncertainty about long-term returns on housing to generate strong and persistent cyclical movements. Among the recent research efforts, Chinloy (1996) represents the apartment rental rate as a function of vacancies and space absorption expectations. Empirical application of his model shows rent expectations and construction lags as significant determinants of real estate cycles. Abraham and Hendershott (1996) develop a model that describes real house price appreciation in terms of two groups of determinants: changes in the equilibrium price and the adjustment mechanism in the equilibrium price process. Dokko et al. (1999) attempt to model the relationship between real estate rent cycles and value cycles. Their model links economic fundamentals to real estate income and value cycles from the basic relationship for property value, namely, the capitalization of expected future rents. Edelstein and Tsang (2007) employ an interactive two-equation system where the first equation, housing demand, relates rent, property values, and capitalization rates with demand fundamentals and the second equation, housing supply, relates housing investment and property values with supply fundamentals. Overall, the general approach is to model real estate price and quantity changes to certain demand and supply factors.

An interesting feature of housing cycles is that prices and quantities tend to move in the same direction. For instance, U.S. new home sales and new home prices has a correlation of 0.61 based on data covering the period from the early 1960s to the present (Figure 5). This pattern indicates a supply response by developers increasing construction as they observe/anticipate higher prices. Yet, a similar, and actually stronger, pattern carries over to the market segment for existing homes. In other countries, the comovement also displays itself, albeit the strength of the relationship varies. For example, in Hong Kong SAR prices and the number of sales contracts also move in tandem with a correlation coefficient of 0.4 while in the Netherlands there is a positive relationship between regional house price changes and the turnover of housing stock, calculated as the number of houses that exchange hands divided by the total number of houses in the region, but the correlation coefficient stands at a more modest 0.27 (Figure 6).

The positive relation between house prices and transactions can be explained by the underlying supply-demand structure. Economic thinking treats housing like other goods, as such, house prices and the volume of houses that exchange hands are determined by a multitude of supply

and demand factors. Supply factors such as land availability and zoning restrictions are generally assumed to be rather inelastic in the short run, and hence, the supply curve slopes upward.[5] Demand factors, e.g. demography, credit availability, and income, are assumed to be subject to non-stationary shocks. As a result, house prices are not stationary either and, in this simple supply-demand framework, house prices and demand-side factors would be in a cointegration relationship the exact characteristics of which would depend on the elasticities of supply and demand.

All in all, the widespread approach is to model housing cycles in a demand-supply framework and treat supply more or less as a constant. Before moving onto modeling house prices as a function of various demand and supply factors and empirically estimating this relationship, we present the descriptive characteristics of housing cycles for 55 countries for which price data are available.

Dating Housing Cycles

As price data are more readily available than quantity data are, we use seasonally-adjusted national house price series at quarterly frequency from 1970 to 2010, when available, to date the cycles in housing markets of 55 countries covering a fair number of advanced economies as well as emerging markets. For long-enough time series (those that start in 1986 or earlier), we adopt the dating procedure described in Harding (2003) with a minimum duration of six quarters. For shorter series that do not allow an application of formal econometric dating procedures, we employ a simpler approach that treats four or more consecutive quarters of decline (rise) as a downturn (upturn). Results of this exercise are summarized in Table 1.

Although cyclical movement is a common feature of housing markets in different locations, the duration and amplitude of these cycles may vary widely across geographical areas as well as through time reflecting differences in supply-demand conditions in the local housing market, characteristics of housing finance, and the nature of linkages between housing and the overall economy. A first glance confirms the existence of considerable variation in durations and amplitudes of housing cycles both across countries and through time. A typical cycle, defined by the median sample values, is asymmetric: upturns tend to last 16 quarters over which house prices record a trough-to-peak increase of 37 percent while downturns are shorter with duration equal to 11 quarters and amplitude equal to -17 percent. Yet, upturns can last as long as 99 quarters as in the case of Belgium with prices more than quadrupling as in the case of Ukraine while downturns can extend to 76 quarters as in the case of Japan and prices can decline as much as 76 percent as in the case of Latvia.

Through time, housing cycle characteristics still vary from one country to the next, yet there appears to be a pattern that the timing of phases has been converging. In other words, housing cycles have become more *global* as upturns and downturns across countries overlap more now

[5] In our international sample, for instance, housing construction measures, e.g. permits, starts, completions, have a correlation coefficient of 0.6, on average, with house price changes.

than they used to (Figure 7). Plotting the proportion of countries whose housing markets are in an upturn at any point given in the sample period also confirms this (Figure 8).

An immediate question is whether carrying out the dating procedure only from the price perspective and ignoring quantities makes a significant difference. As mentioned before and shown based on housing starts and transactions data in a handful of countries, prices and quantities tend to move together. Although the number of transactions in the residential housing markets or new housing starts are not that widely available, an alternative measure of quantity in housing is private residential investment. Information on private residential investment volume provided by OECD broadly confirms the contemporaneous comovement of price and quantity in housing markets (Figure 9). For 17 of 21 countries for which the data are available, the correlation between house prices and residential investment exceeds 0.6.[6] Therefore, dating the cycles by relying on price data alone should not create a major robustness issue.

Modeling Housing Cycles

Numerous studies have investigated the relationship between house prices and several demand- and supply-side factors, paying particular attention to the possibility of house price bubbles. For instance, Case and Shiller (2003) look at state-level house prices in relation to the underlying "fundamentals" in the U.S. while Kalra, Mihaljek, and Duenwald (2000) do not reject the existence of a speculative bubble in the Hong Kong property market in the late 1990s. Other studies have analyzed house price dynamics in a more general framework using error correction mechanisms to underscore long-term trends and highlight short-run deviations from equilibrium. For example, Malpezzi (1999) and Capozza et al. (2002) analyze the impact of supply and demand factors on the path of house price adjustments. Most studies conclude that some locations may be more prone to house price bubbles owing, in particular, to rigid supply conditions delaying response to demand-side shocks.

Data limitations are a major obstacle in applying any model of housing in a large set of countries. Hence, our approach in the following analysis is rather pragmatic in letting availability of data to determine the sample size and the level of aggregation. We first use the characteristics of past housing cycles to infer the potential outcome of the ongoing correction. Then, we look into some common yardsticks with little data requirements that could help assess misalignment in house prices. At the end, we adopt a formal framework to model house price changes at the expense of severely constraining the country coverage.

Nonparametric Estimates

In this subsection, we present the results of nonparametric, history-dependent analysis examining housing cycle characteristics and valuation ratios putting house prices in perspective

[6] The countries for which data are available are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, and United States. The correlation coefficient is negative in the cases of Germany and Korea while it is positive but less than 0.5 for Sweden and Switzerland.

of developments in several key economic variables to evaluate the recent global housing downturn.

Past Cycles versus Present Cycle

If the past can serve as any indicator for the present, one can compare the current cycle to the other cycles to predict the direction and size of house price movements going forward. In particular, assuming that housing cycles are driven by the same dynamics through time, the duration and amplitude of current cycles should resemble the duration and amplitude of past cycles.

As noted in the Introduction, the last upturn in house prices was characterized by an extraordinarily long duration and extraordinarily large amplitude (Table 2). It is striking to notice that across countries, on average, the last upturn lasted almost twice as long as the average cycle in the past. In addition, prices during the current cycle increased more than double the amount they had increased in the past cycles. Simply comparing the duration of the ongoing downturn to the duration of downturns in the past, one would expect, as of 2010Q1, the current downturn to continue another 3 quarters and subside by the end of the year. Yet, from Table 1, longer upturns tend to be followed by longer downturns. Hence, one could argue that the downturn will also last almost twice as long as the average downturn in the past as did the upturn and house prices might continue their decline as far as 3 years down the road. The magnitude of house price falls is likely to amount to half of the steep climb that took place since the mid-1990s, averaging slightly more than 60 percent around the globe. By these accounts, the ongoing downturn is far from complete.

Once again, it is important to note that there is considerable variation across countries. For instance, housing markets in Ireland or Ukraine, where a sharp downturn started relatively earlier, are likely to be closer to reaching the bottom than those in Poland. Moreover, the correspondence between the housing downturn and the financial crisis has urged many governments to implement stimulus plans, often including measures targeted at housing, at the end of 2008 and in 2009. Arguably, the downturn in many countries was superficially brought to an end. The ongoing effects of these plans make it hard to judge the potential for further house price correction. Preliminary assessments suggest that these effects are likely to be short-lived as, following the expiration of the policy measures, house prices in some countries start declining again failing to continue their brief rebounds and giving up to the broader market forces.

Valuation Ratios

A simple way of putting the demand-supply framework described at the beginning of this section into work is to construct ratios of prices to key determinants of house prices. Accordingly, a common yardstick to assess housing market developments relies on the supposed cointegration relationship between income and house prices and analyzes the long-term trends in price-to-income ratio (PIR). Most households spend a constant portion of their income on housing and their demand for housing increases as their income does so. If house

prices exceed the income earned by a typical household more than the *historically* observed ratio, this can be interpreted as an indicator of overvaluation in the housing market.

Figure 10 shows the deviation of the ratio of house prices to per capita income from its historical average for the 55 countries included in our global sample, also in relation to the observed change in house prices.[7] First, potential misalignment indicated by PIR as of 2009Q4 is displayed in the upper panel. The countries placed towards right, mostly composed of advanced countries, are the most likely candidates to experience further decline in house prices. Taking off an out-of-sample exercise, the lower panel shows the deviations as of 2006Q4 against the realized changes in house prices since that date. There is a rather strong negative relationship between the two: the larger the overvaluation at the end of 2006, the larger the drop in house prices in the recent downturn.

These give support to employing PIR as a useful yardstick. In countries where fast house price appreciation appear to have gotten out of whack against income growth dynamics, such as Denmark, Estonia, Iceland, Ireland, Latvia, Lithuania, Spain, Ukraine, and the U.S., the downturn has been harsh. A somewhat worrisome observation is that potential misalignment still remains in Denmark and Spain as well as in a handful of countries where the downturn has so far been milder.

A further step in the PIR approach takes into account the impact of credit market conditions and, based on mortgage loan terms and interest rates, calculates a housing affordability index (HAI). HAI measures whether or not a typical family could qualify for a traditional mortgage loan on a typical home. A typical family is one that earns the median family income in their state. A typical home is defined as the one that is priced at the median home value in the same state.

Due to demanding data requirements, we calculate HAI at the sub-national level within the U.S. Using information on both the median family income and the median home value come from the Bureau of the Census and the prevailing mortgage interest rate as reported by the Federal Reserve Board, we ask whether a family earning the median household income can qualify for a mortgage on a typical home. The calculation assumes a down payment of 20 percent of the home price and underwriting standards that require a qualifying ratio of 25 percent. That means that the monthly principal and interest payment cannot exceed 25 percent of the median family monthly income, adhering to a rule-of-thumb frequently quoted by practitioners. When interpreting the index, a value of 100 means that a family with the median income has exactly enough income to qualify for a mortgage on a median-priced home. An index above 100 signifies that family earning the median income has more than enough income to qualify for a mortgage loan on a median-priced home, assuming a 20 percent down payment. For example, 130 means a family earning the median family income has 30 percent more than the income necessary to qualify for a traditional loan covering 80 percent of a median-priced home while

[7] Household disposable income is a more accurate measure to be used in the construction of this ratio, yet it is less widely available than per capita income.

70 means that this family is not able to afford mortgage to buy a median-priced home in their area.

Figure 11shows the HAI as of 2009Q4 in different states while Figure 12 compares the index in 2009 to its level in 1990. Hawaii, District of Columbia, California, Massachusetts, New Jersey, Arizona, New York, Oregon, and Washington lead the nation as states with the least affordable homes. Affordability has deteriorated across the board with the exception of Northeast Corridor (Connecticut, Maine, Massachusetts, New Hampshire, and Rhode Island). Yet this exception could be explained by the fact that 1990 may not be a good benchmark in these states due to the burst of the New England real estate bubble. Indeed, affordability in these states has also deteriorated compared to its level in 2000. Overall, affordability ratios remain above their historical levels, calculated using data from 1960 to 2004, in 3 out of 5 states.

These figures confirm heterogeneity not only across countries but also within a country. This is an issue that perhaps deserves further attention in formulation of policy responses to real estate bubbles since over-the-board measures, e.g. monetary tightening, may have more unintended consequences than often assumed.

A related strand of literature on house prices borrows on the asset pricing models and posits that the price of real estate, as an asset, should be in line with returns, revealed as market rent. It is widely argued that, if a house is an asset, its return should be in line with its price, as it is assumed to be for any other asset. Looking at the price-to-rent ratio (PRR), then, could provide some guidance to the extent of overvaluation in the housing market. Akin to price-to-dividend ratio in the stock market, PRR asserts that changes in the cost of owning versus renting a house could be used to predict house price movements. When house prices are too high relative to rents, potential buyers find it more advantageous to rent, which should in turn exert downward pressure on house prices.

Once again, we exploit sub-national U.S. data to depict the use of PRR.[8] We gather data on median house prices, from the National Association of Realtors, and ongoing market rental rates, from the Department of Housing and Urban Development, in metropolitan statistical areas to calculate the PRR and document its evolution through time. **Error! Reference source not ound.**Table 3 summarizes the descriptive statistics for the adjustment of PRR to its historical benchmarks and Figure 13 shows the distribution across the United States. Revisions of these estimates reveal that the adjustment has been under way with PRR going down from 23.17 in 2008Q2 to 19.97 in 2009Q4, yet the latest values still remain slightly above historical norms.

One of the main messages that emerge from this exercise is that the adjustment in the U.S. housing market is still far from over and this adjustment process is likely to keep on affecting the rest of the economy. This message is in line with the one that has emerged from examination of HAI at the state level. Repeated once more is the message that there can be considerable variation within a country on the severity of the house price adjustment problem. For instance,

[8] Some data on market rents are available for a subset of advanced countries to calculate the PRR. These calculations reveal a picture similar to the one portrayed in Figure 10.

while there is no obvious adjustment necessary in parts of Pennsylvania and Indiana, areas such as Ocean City, NJ, San Jose, CA, and Barnstable Town, MA could be facing further drops in house prices over the course of next 5 years. This fact points to the importance of local factors in house price corrections and should be taken into account for policy recommendations aimed at limiting the spillovers to local economic activity and encouraging the recovery.

PRR has allure in detecting valuation discrepancies in the housing market. The simple PRR, though, does not fully consider the costs associated with being a home owner. Obviously, home ownership involves costs such as maintenance and property taxes. On the other hand, homeowners enjoy tax advantages and potential capital gains. Hence, PRR should be assessed against the evolution of the user cost of home ownership, which takes into account the financial returns associated with owner-occupied housing, as well as differences in risk, tax benefits, property taxes, depreciation and maintenance costs, and any anticipated capital gains from owning the house. Equilibrium in the housing market occurs when the expected cost of owning a house equals that of renting, implying that overvaluation is defined by the actual PRR being greater than that calculated with the user cost.

In order to calculate the user cost of owner-occupied housing and compare to the actual PRR, we follow Poterba (1992). To put it specifically, user cost of housing is given as

$$UC = P[(1 - \tau_m)(i + \tau_p) + \beta + m + d - \pi]$$

where τ_m is the marginal tax rate, i is the nominal mortgage interest rate, and τ_p is the property tax rate on owner-occupied houses. i measures the cost of foregone interest that the homeowner could have earned on an alternative investment. β, d, and m are the recurring holding costs consisting of the risk premium on residential property, depreciation, and maintenance. π is the expected capital gains (or loss). P is the house price index. In equilibrium, economic agents would be indifferent between owning and renting so that the expected cost of owning a house should equal the cost of renting. This implies that the user cost should equal rent and rearranging reveals a relationship between the actual price-to-rent ratio and the features of the user cost such as interest rates and taxes:

$$P/R = 1/[(1 - \tau_m)(i + \tau_p) + \beta + m + d - \pi]$$

We gather information on tax rates and deductions of property taxes and mortgage interest paid from the Internal Revenue Service and the NBER.[9] Data on nominal mortgage interest rates come from the Federal Reserve Board and the Federal Housing Finance Board. House price information comes from the Office of Federal Housing Enterprise Oversight and the rent information comes from the Bureau of Labor Statistics. The sum of the parameter values for risk premium, maintenance, and depreciation ($\beta + m + d$) is assumed to be constant at 4 percent and π is proxied by a moving average of the consumer price inflation following Poterba (1992) and using data from the Bureau of Labor Statistics. In the calculations presented here the moving average is calculated over an eight-year window.

[9] Based on Feenberg and Coutts (1993), these data are available at http://www.nber.org/taxsim.

A first look at the data gathered shows that, while the top marginal federal income tax rates have declined significantly from 1960 to 2008, the average marginal tax rate has remained almost flat. Tax benefits from property tax and mortgage interest deductions declined until 2003 and, while the benefit from property tax deduction declined further in 2008, the benefit from deductibility of mortgage interest paid somewhat increased between 2004 and 2008. This trend in tax benefits are likely to be explained partly by the decline in top marginal tax rates and partly by the changes in the tax code regarding deductibility restrictions.

The calculations reveal that PRR, at 24.84, lies above the "equilibrium" level, around 15.2, as of 2008Q2 (Figure 14). Historically, however, PRR has exceeded the (inverse of) user cost by 5.15, on average. Hence, one could argue that equilibrium in housing market would be reached once PRR goes down to this historical average discrepancy. Holding all other things constant including the rent, this would translate into an almost 26 percent drop in nominal house prices. Assuming a 4 percent increase in rental rates, the drop would be around 21 percent.

Not surprisingly, the estimates are particularly sensitive to expected capital gains on housing. For instance, if one assumes that the potential buyers form their expectations of house price movements on the basis of changes during the past three years but update their expectations downwards when the average change over the past three years exceeds the historical annual increase in house prices, PRR and the (inverse of) user cost move more closely.

Parametric Estimates

The nonparametric estimates, while quite parsimonious and functional, consider only one or two demand factors. A more sophisticated way of looking at the equilibrium level of house prices is to model and estimate the main driving sources of house prices over the long term and calculate the gap between the actual house prices and their predicted values based on this model. To this end, we model real house price changes as a function of changes in disposable income, working-age population, equity prices, credit, and the level of short- and long-term interest rates. To put it more precisely, we estimate the following regressions:

$$\Delta hp_t = \alpha + \beta_1 A_{t-1} + \beta_2 \Delta YPC_t + \beta_3 \Delta WAP_t + \beta_4 \Delta sp_t + \beta_5 \Delta C_t + \beta_6 i_t^s + \beta_7 i_t^l + \varepsilon_t$$

where Δhp_t is the change in real house prices over the last quarter, ΔYPC_t is the change in real income per capita over the last quarter, ΔWAP_t is the change in working-age population over the past year, Δsp_t is the change in stock prices over the year before last, and ΔC_t is the change in bank credit to the private sector over the past year.[10] The periods over which the changes are calculated are chosen such that the transmission of changes in these variables would have enough time to have an impact on house prices. i_t^s and i_t^l are short-term and long-term interest rates, respectively. A_{t-1} is affordability level of housing in the previous period, measured by (the log of) the ratio of house prices to income per capita.

[10] In robustness checks, we use several different lags and find that the results are not particularly sensitive to the exact choice of lag as long as longer lags are maintained for working-age population and bank credit to the private sector.

The choice of these variables stems from the desire to capture major demand factors. Assuming housing is a normal good, demand for it would be increasing with income gains. Yet, depending on how sluggish the supply response is, an income shock can push prices too far in the sense that housing affordability deteriorates. In the end, demand would have to subside so that house prices come back in line with income. In other words, affordability acts as an anchor for any unsustainable deviation from the equilibrium level of house prices to correct itself over the long run.[11]

This could be interpreted as an *error correction* mechanism, and it reflects the concept of a long-run equilibrium level of house prices determined by economic fundamentals such as income growth and demographic dynamics and credit availability while short-term deviations can occur due to financial market conditions and/or policy interventions. The sensitivity of house prices to these demand factors would depend on the supply conditions in each country. Therefore, pooling the data may not be the best option in order to analyze short-run fluctuations but pooled estimates could give hints about which determinants are more important in the longer run once supply response to demand shocks is complete by compiling information under different supply elasticities.

The regression equation is estimated using ordinary least squares (OLS). Since data series are not long enough for many countries in the global sample, we constrain the sample in this part to 22 advanced economies for which we have long-enough series of quarterly data.[12] An apparent question is why not estimate using a vector error correction model (VECM). The answer is a technical one: Johansen cointegration tests confirm the existence of at least one cointegrating relation only for one out of three countries. Hence, VECM estimations do not have well-behaved time series properties, compelling us to use OLS instead. Due to the inclusion of the affordability variable, our model still encompasses an error correction component. The estimation is carried out both for each country in the sample separately and for the whole sample by pooling the observations. Table 4 shows the results of country-by-country regressions while Table 5 displays the results obtained in pooled regressions.

Overall, the estimated coefficients have the expected signs. Affordability is negatively related to the change in prices for 82 percent of the countries in the sample and change in income per capita enters the equation with a positive sign in all cases except for the U.S.[13] The coefficients

[11] Note that affordability here is akin to the PIR discussed above. Results from the regression analysis does not change much when the PRR is used as the long-term anchor instead.

[12] The list of countries is: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, Norway, New Zealand, Portugal, Sweden, Switzerland, Spain, the U.K., and the U.S.

[13] The estimated coefficient on per-capita income growth is negative but not statistically significant for the U.S. One explanation why we obtain a negative coefficient in this case could be the related to the case made by Leamer (2007) in arguing that housing *is* the business cycle in the U.S. In the post-war era, declines in house prices and housing investment have preceded decline in other economic activities, acting like a recession indicator, and revival of housing markets has frequently pulled the economy out of recession episodes. So, it is possible that even as per-capita income declines as the recession wears out, house prices start increasing reflecting the role of the

(continued…)

on affordability and income per capita with the expected signs are also statistically significant most of the time. There is also a positive relation between house price changes and population growth in 86 percent of the cases, accompanied with statistical significance about a third of the time. These results suggest that, for the majority of the countries, increases in income and population push house prices up but there is a tendency for the increase in prices to slow down as house price appreciation outpaces income growth and affordability deteriorates. Given the sluggishness with which demographic changes tend to take place, it appears to be harder to pin down the relationship between population growth and house prices in a statistically significant manner than it is to establish the relationship between income and house prices.

The next variable that has the expected sign for an overwhelming majority of the countries is bank credit to the private sector. Better credit availability appears to promote higher house price appreciation for 91 percent of the countries. These results are also quite significant with 64 percent of the countries delivering a correctly-signed statistically-significant coefficient on credit growth.[14]

In contrast, the signs of the coefficients for interest rates are not as consistent across countries: the correct sign (negative, potentially reflecting the higher cost of mortgage loans) is obtained for 50 to 64 percent of the countries and a correct *and* significant sign for 27 to 41 percent. Note that a positive relationship between interest rates and house prices may emerge if higher rates are an indication of tighter monetary policy stance as a response to overheating in the economy. A similar situation applies to the estimated coefficients on stock prices, with 68 percent of the cases delivering a positive coefficient and only 36 percent registering a statistically significant positive relationship. A straightforward interpretation of the positive relationship would emphasize e.g. the forward-looking feature of stock prices: optimism about the prospects of the economy and expectations of higher income in the future may stimulate housing markets. A negative relationship, on the other hand, would highlight e.g. the potential substitutability among asset classes: chasing past returns in the stock market, households may be tempted to shift the composition of their assets from real estate toward stocks.

To summarize, heterogeneity across countries reveals itself once more this time regarding the coefficients on certain variables as well as the fit of the regression model. Not only the subset of variables that are significant varies across countries but also the sign of the coefficients change from one country to another. Furthermore, the R-squared stands at 0.33 on average across countries, yet the model fit is very poor for Australia, Canada, and Italy.[15] On the other hand, the

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housing sector to jump start the economy. It should be noted that, in extending Leamer's analysis to other countries, we do not find the same strong relationship between housing and business cycles.

[14] It should, however, be noted that this does not imply a causal relationship running from credit to house prices. Real estate plays an important collateral role and lenders tend to become more willing to extend loans when collateral values increase, boosting perceived borrower quality. We refrain from interpreting the positive correlation between credit growth and house price appreciation as causation and leave establishment of such a causal link for further research.

[15] Several country-specific demand-supply characteristics not captured by the model could explain the poor fit for these countries. For instance, both in Australia and Canada, the differences between urban and rural areas tend to

(continued…)

fit for Norway and Spain, and, to a lesser extent, for Finland, Japan, and the U.K. proves to be rather good.

While it may be true that the cross-country differences are too large to justify imposing common coefficient restrictions, it is also possible that short time span at the country-by-country case prevents identification of stable long-run relationships. Hence, there may be some value added from running pooled regressions, which could also allow introduction of additional variables as it increases the number of observations. Indeed, the pooled regression results deliver rather sensible results (Table 5, Column 1). Lower levels of affordability entail less house price appreciation, acting like a circuit breaker on the positive relationship between increases in per-capita income and house price appreciation. An enlarging working-age population and increasing stock prices are associated with increases in house prices. Growth in bank credit to the private sector also displays a positive relationship with house price appreciation. Rising short-term interest rates are linked to negative price changes but a similar negative relationship for long-term interest rates is not statistically significant. All in all, the bottom line emerges as important roles played by income and population dynamics in the determination of house prices with credit market conditions taking on a quantitatively smaller role.

To verify the robustness of these findings, we run pooled regressions by adding additional variables to the right-hand side. In Table 5, Column 2, the square of lagged affordability level is included. This variable has the same sign on the estimated coefficient as affordability itself, implying that the larger the deviation between income growth rate and house price appreciation rate, the more the downward pressure for house price appreciation to abate. We introduce a new variable, namely, the change in construction costs in Table 5, Column 3. This new variable aims to bring in a supply factor, which could act as an added longer-run anchor, to the analysis. As anticipated, higher construction costs are linked to increases in house prices. Finally, Table 5, Column 4 presents the results with the change in commodity (fuel and nonfuel) prices. This is to capture the "global" nature of business cycle fluctuations that could explain the unprecedented synchronization in house price movements prior to the global financial crisis. In unreported regressions, we also split this new variable into fuel and nonfuel commodities only, without any major changes in the results. In all extensions, the coefficients on the original set of variables are virtually unaltered from the values they attain in the baseline regression.

Having identified some of the key determinants of house prices, we move on to examine their implications for misalignment in housing markets. Recall that the house price variable we have is expressed as an index and, hence, our regression analysis utilizes house price changes rather the levels. In order to arrive at an estimate of overvaluation, we need to translate our findings so that they pertain to some hypothetical equilibrium level for house prices. Our approach is to assume that house prices were at this equilibrium level at an arbitrarily-assigned date and set the house price index to 100. Then, using the predicted house price changes from the regression

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be larger than in other countries, potentially skewing the house price index at the national level. Moreover, sizeable immigration and somewhat lax natural land supply constraints could also affect house price dynamics. In the case of Italy, a declining domestic population is juxtaposed with foreign demand for Italian real estate, which remains in limited supply.

analysis, we compute the index values from that date onward. In the end, we compare the actual index value to the predicted one and label the difference between the two values as the estimated price gap. One concern, of course, is that the date chosen to be the one when house prices are at their equilibrium level implied by fundamentals is arbitrary and the estimated price gap would be sensitive to the choice of this date. In order to address this concern and ensure robustness, we repeat the computation of predicted house price indices at several dates and state the average of estimated price gaps.

Using the same set of variables as in the regression analysis in Table 4, we estimate the deviation from the predicted equilibrium level of house prices and report the results in Table 6 in the form of a heat map.[16] House prices are assumed to be at their equilibrium level at five different dates (the fourth quarters of 1997, 1998, 1999, 2000, and 2001) and the average of estimated gaps is reported as the point estimate. Colors closer to the red end of the spectrum indicate a larger point estimate of the price gap, and, arguably, greater possibility of a house price correction. Once again, there is considerable variation across countries in terms of estimated house price misalignment. Nonetheless, the analysis insinuates an 'overheating' in housing markets at the end of 2006 and 2007, as to be anticipated based on the recount of the recent global housing boom in the Introduction and supported by Figures 1 and 2 and Table 1. The misalignment detected by our analysis has been unwinding reducing the 'heat' in 2008 and 2004; still, large price gaps remain in a handful of countries, in line with the earlier assessment that the ongoing housing downturn has more way to go.

A question that naturally follows is how good the model is in predicting the actual path of house prices. Note that, by construction, point estimates are obtained based on the estimated coefficients using data only up to the 'as of' date. This backward-looking property is essential to use the model in real time and assess its predictive power. Also note that the analysis tells us the extent of possible house price drop should a correction in housing markets start, but it does not convey any information on when such a correction would start and how long it would last. This makes it challenging to compare the predicted price changes against the realized values because it is not clear over what time frame the comparison should be.

One instinctive option is to get the prediction at or close to the peak of a cycle and calculate the actual change in house prices from that point forward. In the most recent episode, the global housing cycle reached its peak and entered the downward phase at the end of 2007. Thus, to see how well the predicted house price changes fit the actual path, we calculate the predicted correction as the estimated price gap as of 2007Q, multiplied by -1, and put it side by side with the actual change in real house prices since that date.

As shown in Figure 15, there is a strong positive correlation between the predicted and actual changes. In a few cases, the estimates fall short of predicting the severity of the house price correction, notably, in Ireland, Denmark, and the U.S. In several others, the downturn has been less severe than predicted, most conspicuously for Australia and Canada. On average, though, the match-up looks quite well: the model predicts an average decline of 9 percent for this group

[16] We do not disclose the point estimates to avoid any speculation that may be caused by such information.

of countries against a realized decline of 5 percent. The discrepancy may be attributed to the policy-induced rebound that has happened in some countries, or to the fact that the correction is still continuing and an additional 4 percent decline on average may be expected over the next few years.

B. Macroeconomic Consequences

Relatively less attention has been paid in the literature to the consequences of the kind of house price corrections analyzed in Section III. A. Claessens, Kose, and Terrones (2008) find that recessions in advanced economies that coincide with house price busts and credit crunches tend to be longer and deeper than those that do not. Strikingly, unemployment increases notably more and for longer in recessions with housing busts. In terms of output components, impact on investment tends to be more clear-cut than the effect on consumption. Changes in house prices are generally considered to have an effect on individual consumption through their impact on household wealth and access to finance via relaxation of collateral constraints. Buiter (2008) points out that wealth effects across households are likely to cancel each other out and the net effect on aggregate wealth would be minimal while relaxation of collateral constraints is likely to generate a positive impact on individual consumption. Muelbauer (2008), in line with this prediction, finds that changes in house prices have a medium-run liquidity effect on consumption in the U.K. and U.S., especially through increased access to housing collateral. Benito (2007) documents that, for U.K. households, it is much more common for mortgage equity withdrawal to be used for residential investment rather than for consumption. This supports the evidence on the impact of house price cycles on investment: Claessens, Kose, and Terrones (2008) find that investment falls more sharply during recessions associated with housing busts and credit crunches than in recessions that are not.

Adding to this literature, we conduct a vector auto-regression (VAR) analysis to assess the vulnerability of key macroeconomic variables such as GDP, consumption, and residential investment to house price corrections. Data availability once again constrains the sample, this time to 20 advanced economies.[17]

Assessing Macroeconomic Vulnerabilities to House Price Corrections

To study the dynamic effects of shocks in the housing market and quantify the spillovers from the housing market to the rest of the economy, we employ a standard VAR.[18] The baseline model includes six variables: GDP, private consumption, residential investment, CPI, short-term interest rate, and house prices. In unreported robustness checks, we also estimate variations of this by adding government consumption to the list and dropping private consumption or residential investment but the main results are not altered drastically.

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[17] The list of countries is: Australia, Austria, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Korea, Netherlands, Norway, New Zealand, Sweden, Switzerland, Spain, the U.K., and the U.S. We have to drop Belgium and Portugal from the subset used in the previous section because residential investment breakdowns are not available for these two countries.

[18] Recent applications of this methodology include Jarocinski and Smets (2008), IMF (2008), and Cardarelli et al. (2009).

We identify house price shocks through a Cholesky decomposition of the variance-covariance matrix of the reduced-form residuals. Similar to the literature on identification of monetary policy shocks, the ordering puts the variables of interest, namely, GDP, consumption and residential investment first. CPI and interest rate follow to control for endogenous monetary policy response to inflation shocks. Therefore, macroeconomic variables are affected by monetary policy only with a lag while monetary policy responds contemporaneously to changes in all the variables in the system (Christiano, Eichenbaum, and Evans, 2005). House prices come last allowing them to respond contemporaneously to changes in macroeconomic variables and monetary policy, reflecting the forward-looking nature of asset prices (Goodhart and Hofmann, 2008).

The shocks identified through this ordering are labeled as housing demand shocks, in line with the discussion in the previous section, where short-run movement in house prices would be driven by changes in demand factors since supply is fixed. In practice, these demand shocks lead to a strong positive comovement between house prices and residential investment, as observed in descriptive statistics presented in the previous section, confirming the labeling.[19]

The sample period runs from the first quarter of 1986 to the first quarter of 2010.[20] All variables are transformed for estimation into log levels, except the CPI, for which we take log first differences (i.e. the inflation rate), and the short-term interest rate, which enters in levels without transformation. Estimating the model in levels incorporates any cointegrating relationships without the need to specify a VECM. Moreover, examining the stationarity of impulse response functions reveals that the responses go back to the steady-state values. Hence, estimating the model without first-differencing is acceptable.[21, 22] Based on standard lag length criteria, we choose 1 to 2 lags of each variable.

Table 7 presents the effects on key macroeconomic variables of a housing demand shock as identified in this framework. In the first three columns, the shock is normalized such that the

[19] It is, of course, possible that the housing demand shock affects the residential investment equation (quantity) rather than or as well as the house price equation (price). In most cases, shocks to the former equation are found to be associated with housing supply shocks with negative or no comovement between quantities and prices.

[20] In robustness checks, we include the 1970s and early 1980s and typically find a smaller impact of housing demand shocks compared to the results obtained in the shorter sample. This is consistent with larger financial accelerator effects and increasing importance of macro-financial linkages due to financial deregulation and deepening of mortgage markets. Iacoviello and Neri (2010) provide some evidence along these lines for the United States.

[21] Cardarelli et al. (2009) also do the estimation in levels. Jarocinski and Smets (2008) estimate their model both in levels and in first differences. In the latter case, they need to impose additional restrictions on the growth rate of some variables to ensure that certain long-run properties are preserved. The impulse responses to a housing demand shock are similar under both specifications.

[22] Ireland is an exception: we cannot reject unit roots in GDP and house price growth rates. So, we first-difference the Irish data.

initial house price response is a decline of 10 percent but we also consider the case where the shock is defined as a decline equal to two standard deviations of the quarterly house price change over the sample period. Bearing in mind the country-specific distribution of house price changes, the latter case gives a sense of outcomes that are likely to materialize in a particular country. The maximum impact on GDP, consumption, and residential investment are shown for both cases.

These results, with a an average impact of -1.87 percent on GDP in the case of a 10 percent house price decline, are in the ballpark of the results reported elsewhere in the literature. For instance, Cardarelli et al. (2009) report that the average response of real GDP to a 10 percent house price shock is about -2 percent across OECD countries while Goodhart and Hoffman (2008) estimate stands at about -1 percent. The results are also in accordance with estimates of Claessens, Kose and Terrones (2008), who use an alternative approach by computing the changes in macroeconomic variables during house price busts.

Yet, there is a large degree of heterogeneity in the responses across countries. Looking at the GDP response, we can put countries into three groups. First are the small-impact countries with GDP decline of around or less than ½ percentage points: Austria, Italy, Netherlands, Norway, and Switzerland. At the other end are countries where the likely decline in GDP is close to or more than 1 percentage point: Denmark, Greece, Ireland, Japan, New Zealand, Spain, and the United States. The rest lie in the middle. In some cases, some judgmental adjustment of the estimated macro impact may be necessary. For instance, in a couple of cases (Germany and Japan), the VAR approach gives very high estimates of macro sensitivities, potentially due to distortion caused by the protracted downturn these countries have been experiencing. In other cases, the characteristics of housing and mortgage markets may have changed rapidly in recent years, so the sensitivity of the economy to house price corrections may be higher than the average estimates presented.

Effects on consumption and residential investment are likewise quite heterogeneous across countries. These differences across countries could be a reflection of the channels that transmit house price shocks to household behavior. In particular, lower house prices may be associated with a larger credit tightening response in countries that have deeper financial systems or that allow mortgage equity withdrawal. Hence, the larger multiplier for a given house price decline leads to greater pressure on consumption and investment. Alternatively, economic activity in countries with larger or more labor-intensive construction sectors may suffer more during housing downturns because of the higher negative impact on employment. Next, we round up some evidence on the usual suspects that could be responsible for cross-country differences in sensitivity of the macroeconomy to housing downturns.

Relating Vulnerabilities to Country Characteristics

Obviously, there are significant cross-country differences in the extent economic activity declines following a housing bust, which in principle can depend on a wide range of characteristics of national financial and legal systems. Previous work in the field (e.g., IMF, 2008; Cardarelli et al., 2009) has suggested that mortgage market characteristics defining the ease to access to credit and sensitivity of mortgage contracts to current market conditions could explain why economic activity in some countries may be more vulnerable to declining house

prices. These characteristics include, for instance, typical loan-to-value ratio, standard term on mortgage loans, availability of mortgage equity withdrawal and prepayment options without penalty, and development level of secondary market for loans.

With the serious caveat that we only rely on limited cross-country observations, we can loosely relate the degree of vulnerability to house price corrections to (i) availability of penalty-free prepayment and (ii) equity withdrawal options on mortgage loans, as well as to (iii) loan-to-value ratio (Table 8). More precisely, in countries where borrowers have the ability to prepay a mortgage loan with no or little penalty and refinance, the estimated impact on GDP of a 10 percent decline in house prices is -2.77 percent on average in contrast to an average impact of -1.71 percent in countries where this option is not available. Similarly, if homeowners are allowed to withdraw lines of credit on their home equity, the average estimated impact is -2.27 percent against -1.61 when they are not. Finally, among countries where a typical mortgage loan carries a loan-to-value ratio of less than 80 percent at origination, the average estimated impact stands much lower than when the typical loan-to-value ratio is greater than 80 percent. When outliers (Germany, Japan, Greece, and Netherlands) are excluded, vulnerability also appears to be positively related to the ratio of residential mortgage debt to GDP. On the other hand, correlation with other characteristics of mortgage markets and along structural dimensions such as labor intensity of construction and the share of construction sector in total value added seem to be weaker.

These relationships point to an important dimension determining vulnerability, namely, the ease with which households can access mortgage credit. One reason housing cycles may be more *special* than other asset cycles is the financing system supporting them. Residential real estate and mortgage debt constitute the largest chunk of household balance sheets. If mortgage markets provide opportunities to exploit increases in collateral values more easily, the financial accelerator effect is larger.

Other factors can play a role in explaining the amplitude of the economic cycle following house price corrections. In addition to the characteristics of mortgage markets already discussed, a key feature at the current juncture is the prevalence of mortgages with variable (as opposed to fixed) interest rates. There are differences within Europe in this respect, where Finland, Ireland, and Spain have mostly variable rate mortgages. Higher debt burden (interest payments relative to household disposable income), which responds more to interest rate hikes if rates on mortgage loans are adjustable, has been historically associated with bigger declines in residential investment during housing busts. Countries also differ in terms of legal provisions, such as those that govern residential mortgage lenders' recourse regarding defaulted residential mortgages, which can influence foreclosure rates. In many of the countries, e.g., France, Germany, Ireland, the Netherlands, Spain, and the United Kingdom, debtors are personally liable for the full amount of mortgage debt, thus reducing incentives for foreclosure. In the United States, mortgage foreclosure is regulated at the state level. In six states, lenders have recourse only to the mortgaged property, which they may repossess and sell. In the other states, debtors are also personally liable for the full amount of the debt, but there are differences in the extent to which lenders can recover the difference between the mortgage debt and the foreclosure sale price. In practice, lenders may choose not to seek deficiency judgments mainly because of the time and cost involved.

Another factor that can play a role in explaining the amplitude of the economic cycle following house price corrections is banking sector exposure to the housing sector, which varies across countries as well as across lending institutions within countries. The value of mortgage loans held by banks, expressed as a multiple of their overall market capitalization, gives an indication of their ability to withstand the deterioration of their real estate loan portfolios. This indicator varies from about 4 in Denmark and Germany, less than 3 in Spain, about 1.5 in Canada, Japan, and the United Kingdom, and less than 1 in the United States. Cross-country declines in residential investment during housing cycles have been higher in countries with greater banking sector exposure to mortgage lending, but the effect has not been as strong as that shown earlier with the mortgage-debt-to-GDP ratio. Nevertheless, at the current juncture, with bank balance sheets under renewed stress and bank equity prices low, the potential for an adverse impact on the real economy from banking system exposure to mortgage lending is perhaps greater than in the past.

IV. Conclusion

Many advanced economies as well as emerging markets experienced a house price run-up in recent years that is difficult to account for fully in terms of fundamental driving forces such as income growth and interest rates. The correction in house prices has begun in most of these economies. We document the characteristics of this global housing cycle as well as the previous ones. If past is prologue, these corrections could average about 23 percent and be spread out over a period of 4-4.5 years from peak to trough. This assessment is also in line with those stemming from inspection of valuation ratios and econometric models of house prices. Past evidence also suggests that cross-country differences in the impact of these corrections on the macroeconomy are likely to depend on the characteristics of the housing finance systems, particularly the ease with which households have been able to access mortgage credit in recent years. This feature is likely to be correlated with the extent of investment declines that occur during the house price corrections and could also have a dampening impact on consumption. The pre-crisis exposure of the financial system to housing markets may also affect the extent of the macroeconomic losses and the shape and timing of the recovery. A major obstacle in conducting formal analysis of global housing cycles and their implications is the lack of data. Efforts should be concentrated on increasing the availability of consistent and reliable data on housing and real estate financing markets. Then, future research can aim to look into these macro-financial linkages more closely to better understand the consequences of housing boom-bust episodes.

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Table 1. House Price Cycles by Country

			Downturn		Upturn	
Country	Peak	Trough	Duration	Amplitude	Duration	Amplitude
Argentina	1981Q4^	1984Q3	11	-76.43	11	39.93
	1987Q2	1989Q1	7	-11.41	30	190.58
	1996Q3	2003Q4	29	-25.70	16	58.54
Australia	1974Q1	1978Q4	19	-16.61	12	14.84
	1981Q4	1983Q3	7	-10.29	8	9.49
	1985Q3	1987Q1	6	-4.47	9	36.86
	1989Q2	1991Q1	7	-8.00	14	5.35
	1994Q3	1996Q1	6	-4.18	48	116.53
	2008Q1	2009Q1*	4	-9.08	4	16.80
Austria	1992Q2	2001Q4	38	-27.87	28	21.74
	2008Q4	2009Q4*	4	-3.93	1	5.71
Belgium	1970Q1^	1971Q3	6	-8.40	32	61.25
	1979Q3	1985Q2	23	-38.09	99	186.71
Bulgaria		2005Q3^			12	41.85
	2008Q3		6	-32.85		
Canada	1976Q4	1978Q3	7	-7.10	12	6.50
	1981Q3	1985Q1	14	-20.76	16	67.88
	1989Q1	1998Q3	38	-18.75	37	79.46
	2007Q4	2008Q4*	4	-11.98	5	18.29
China		2006Q1^			7	6.02
	2007Q4	2008Q4*	4	-2.02	5	8.67
Colombia	1990Q1^	1992Q4	11	-13.59	11	22.77
	1995Q3	2004Q3	36	-37.90	21	59.02
Croatia	1999Q4	2003Q4	16	-22.07	18	37.49
	2008Q2		4	-8.57		
Czech Republic	2003Q3	2005Q3	8	-9.36	11	45.25
Denmark	1973Q3	1977Q1	14	-5.87	9	14.51
	1979Q2	1982Q3	13	-34.78	15	58.71
	1986Q2	1993Q2	28	-34.11	55	176.59
	2007Q1		11	-21.30		
Egypt		2004Q4			4	4.53
	2005Q4		12	-25.42		
Estonia		1997Q4			39	419.77
	2007Q3		9	-63.64		
Finland		1972Q2			7	19.31
	1974Q1	1979Q1	20	-28.86	41	115.95
	1989Q2	1993Q1	15	-46.80	58	79.33
	2007Q3	2009Q1*	6	-9.60	4	9.80
France	1980Q4	1984Q4	16	-18.34	26	32.99
	1991Q2	1997Q1	23	-17.59	43	117.85
	2007Q4	2009Q2*	6	-9.60	3	2.93
Germany	1972Q2	1976Q3	17	-7.06	19	14.49
	1981Q2	1989Q2	32	-14.66	21	14.89
	1994Q3		61	-24.11		
Greece	1993Q4^	1995Q2	6	-2.73	47	97.54
	2007Q1		12	-5.27		
Hong Kong	1994Q2	1995Q4	6	-22.35	7	49.55
	1997Q3	2003Q2	23	-59.96	19	94.55
	2008Q1	2009Q1*	4	-15.04	4	27.15

Table 1. House Price Cycles by Country - continued

			Downturn		Upturn	
Country	Peak	Trough	Duration	Amplitude	Duration	Amplitude
Hungary		1998Q1^			27	141.08
	2004Q4		19	-18.60		
Iceland		2000Q1^			31	74.81
	2007Q4		9	-32.33		
India		2001Q4^			27	170.17
	2008Q3		3	-11.57		
Indonesia	trend growth since 1990Q1					
Ireland	1979Q2	1987Q2	32	-27.71	12	26.64
	1990Q2	1994Q4	18	-4.06	47	286.40
	2006Q3		14	-38.08		
Israel	1999Q4	2003Q2	14	-16.65	11	24.88
	2006Q1	2008Q3*	10	-8.17	6	19.80
Italy	1970Q1^	1973Q3	14	-11.10	31	109.04
	1981Q2	1986Q2	20	-35.99	24	58.99
	1992Q2	1997Q3	21	-28.29	40	59.14
	2007Q3		10	-7.61		
Japan	1973Q4	1977Q3	15	-28.94	54	80.61
	1991Q1		76	-43.53		
Korea		1987Q3			15	31.81
	1991Q2	2001Q1	39	-55.39	10	25.75
	2003Q3	2005Q1	6	-6.34	8	14.05
	2007Q1	2009Q2*	11	-2.73	3	0.67
Latvia		2005Q1^			9	84.73
	2007Q2	2009Q3*	9	-76.08	2	15.77
Lithuania	1999Q2	2002Q1	11	-23.47	22	249.81
	2007Q3		10	-45.32		
Luxembourg	2006Q4	2008Q3*	7	-6.06	6	3.28
Malaysia	1997Q2	1999Q3	9	-20.24	22	12.84
	2005Q1	2006Q3	6	-2.43	13	2.97
Malta	1980Q4^	1985Q3	19	-24.84	88	269.86
	2007Q3		5	-7.38		
Netherlands	1978Q2	1985Q1	27	-49.90	93	216.21
	2008Q2		7	-5.18		
New Zealand	1974Q3	1980Q2	23	-40.71	16	33.62
	1984Q2	1986Q4	10	-8.49	6	15.48
	1988Q2	1992Q1	15	-6.83	23	39.62
	1997Q4	2000Q4	12	-6.32	27	98.48
	2007Q3	2009Q1*	6	-15.31	3	6.69
Norway		1972Q4			17	11.41
	1977Q1	1983Q4	27	-11.69	12	57.00
	1986Q4	1993Q1	25	-39.47	58	200.11
	2007Q3	2008Q4*	5	-11.91	5	9.75
Philippines	1996Q3	2004Q3	32	-56.20	13	22.41
	2007Q4		9	-8.56		
Poland	2000Q4^	2004Q2	14	-5.47	16	91.89
	2008Q2		5	-12.07		
Portugal	1992Q2	1996Q3	17	-12.70	17	17.30
	2000Q4	2007Q2	26	-9.71	11	4.03

Table 1. House Price Cycles by Country - concluded

Country	Peak	Trough	Downturn Duration	Downturn Amplitude	Upturn Duration	Upturn Amplitude
Russia		2002Q1^			26	72.28
	2008Q3		4	-19.97		
Serbia	2000Q2	2002Q4	10	-51.68	11	36.37
	2005Q3	2007Q4*	9	-12.96	6	30.39
Singapore	1996Q2	1998Q4	10	-45.71	6	38.82
	2000Q2	2004Q2	16	-22.47	15	45.25
	2008Q1	2009Q2*	8	-4.24	3	28.37
Slovak Republic		2005Q1^			13	65.82
	2008Q2		7	-18.44		
Slovenia	1995Q3	2002Q4	29	-20.58	19	59.21
	2007Q3		7	-11.74		
South Africa	2000Q1^	2000Q4	3	-5.09	27	159.08
	2007Q3	2009Q2*	7	-14.70	2	4.99
Spain	1974Q3	1976Q2	7	-10.59	8	27.91
	1978Q2	1982Q2	16	-35.06	38	145.13
	1991Q4	1996Q3	19	-18.14	44	121.62
	2007Q3		10	-13.80		
Sweden		1974Q2			21	24.93
	1979Q3	1985Q4	25	-38.24	17	40.77
	1990Q1	1996Q1	24	-31.01	47	132.77
	2007Q4	2008Q4*	4	-5.31	5	8.96
Switzerland	1973Q1	1976Q3	14	-29.47	53	74.14
	1989Q4	2000Q1	41	-38.63	40	22.55
Thailand	1991Q3	1996Q4	21	-19.89	5	8.18
	1998Q1	1999Q4	7	-20.10	25	34.55
	2006Q1		16	-39.29		
Trinidad & Tobago	1980Q4^	1992Q1	45	-74.34	59	160.70
	2006Q4		8	-22.36		
Ukraine	2000Q2^	2001Q2	4	-5.36	24	449.73
	2007Q2		11	-52.47		
United Arab Emirates		2007Q1^			4	59.71
	2008Q1	2009Q2*	5	-40.78	3	10.26
United Kingdom	1973Q3	1977Q3	16	-33.31	12	28.44
	1980Q3	1982Q1	6	-12.44	30	95.65
	1989Q3	1996Q2	27	-30.38	46	160.66
	2007Q4	2009Q2*	6	-15.68	3	4.98
United States	1973Q4	1975Q3	7	-4.38	14	19.14
	1979Q1	1982Q4	15	-9.28	28	15.29
	1989Q4	1995Q1	21	-5.54	47	64.31
	2006Q4		13	-16.57		
Uruguay		1999Q2^			2	2.82
	1999Q4	2003Q3	15	-42.84	19	62.19

Notes: Turning points of real house price cycles are based on the cycle-dating procedure as described in Harding (2003), with a minimum duration of six quarters, when the times series is long enough (starting at 1986 or earlier). For shorter series, four or more consecutive quarters of decline (rise) in prices is treated as a donwturn (upturn). Duration is the number of periods from peak (trough) to trough (peak) and is expressed in quarters. Amplitude is the change in real house prices from peak to trough and is expressed in percent. ^ shows the first available observation. * denotes a preliminary assessment of the turning point in the last cycle because of the proximity to the end of the time series.

Table 2. Characteristics of House Price Cycles

Stylized Facts on Duration and Amplitude of House Price Cycles				
	Upturn		Downturn	
	Duration	Amplitude	Duration	Amplitude
Past cycles	20	48	18	-23
Present cycle	38	126	15	-19

Notes: Average values for cycles whose peaks and troughs are both identified across 55 countries are reported. Present cycle downturn is assumed to extend into 2010Q1, the latest data are available for the majority of the countries. Duration is measured in quarters. Amplitude is the percent change in real house prices from trough to peak during the upturn and from peak to trough during the downturn.

Table 3. Price-to-Rent Ratio: Adjustment to Benchmark

		Lower boundary			Upper boundary		
Statistic	Current value	Deviation from trend (percent)	Time to adjustment (years)	Drop necessary (percent	Deviation from trend (percent)	Time to adjustment (years)	Drop necessary (percent
Average	19.97	4.77	2	3.11	14.13	5	14.13
Median	18.69	0.00	2	0.00	12.72	3	12.72
Maximum	53.51	47.80	5	9.27	81.06	15	62.49
Minimum	7.71	0.00	2	0.00	0.00	2	0.00
Standard deviation	7.04	9.72	1	3.25	10.93	4	10.93

Table 4. Modeling House Price Changes: Country-by-Country Regressions

	Dependent variable: House price index, change										
	Australia	Austria	Belgium	Canada	Denmark	Finland	France	Germany	Greece	Ireland	Italy
Affordability, lagged	-0.0144	-0.0914**	-0.0713***	-0.0244	-0.0327**	-0.0400***	-0.0107	0.0031	-0.0905*	-0.0328**	-0.0153
	(0.0131)	(0.0458)	(0.0190)	(0.0207)	(0.0161)	(0.0137)	(0.0082)	(0.0284)	(0.0455)	(0.0163)	(0.0233)
Income per capita, change	0.1590	0.4290	0.2080	0.584**	0.397**	0.418***	0.588***	0.357**	0.1920	0.728***	0.1730
	(0.1650)	(0.8730)	(0.3020)	(0.2950)	(0.1970)	(0.1450)	(0.1640)	(0.1630)	(0.2000)	(0.1790)	(0.3470)
Working-age population, change	0.483*	-0.2490	3.112***	0.0530	0.8080	1.1070	1.742***	0.3530	-1.0540	0.2940	-1.846*
	(0.2800)	(1.3160)	(0.9560)	(0.3330)	(2.0600)	(0.8130)	(0.4900)	(1.4100)	(1.1760)	(0.5990)	(0.9910)
Stock prices, change	0.0061	0.0015	0.0135**	-0.0124	0.0273**	0.0254***	0.00950*	-0.0027	0.0017	0.0203*	-0.0010
	(0.0100)	(0.0223)	(0.0059)	(0.0126)	(0.0116)	(0.0068)	(0.0051)	(0.0039)	(0.0075)	(0.0117)	(0.0086)
Credit, change	0.0480	0.1230	-0.0082	0.0151	-0.0003	0.224***	0.0131	0.0819*	0.0661*	0.0653**	0.0799
	(0.0362)	(0.0902)	(0.0108)	(0.0166)	(0.0049)	(0.0391)	(0.0103)	(0.0469)	(0.0388)	(0.0320)	(0.0625)
Short-term interest rate	-0.00216**	0.00537*	0.0011	0.0010	-0.00461***	-0.00421***	0.0003	0.00252*	0.0003	0.0004	0.00527*
	(0.0011)	(0.0031)	(0.0012)	(0.0016)	(0.0016)	(0.0010)	(0.0008)	(0.0013)	(0.0016)	(0.0012)	(0.0027)
Long-term interest rate	0.0004	0.0033	-0.00266*	-0.00367*	0.0015	0.00450***	-0.00271***	-0.00321*	-0.0015	-0.0026	-0.0049
	(0.0014)	(0.0064)	(0.0015)	(0.0020)	(0.0021)	(0.0017)	(0.0009)	(0.0017)	(0.0016)	(0.0017)	(0.0031)
Constant	-0.0817	-0.588*	-0.419***	-0.1240	-0.249*	-0.250***	-0.0502	0.0178	-0.461*	-0.196*	-0.0783
	(0.0823)	(0.2960)	(0.1170)	(0.1290)	(0.1280)	(0.0841)	(0.0476)	(0.1680)	(0.2360)	(0.1070)	(0.1290)
Observations	155	91	92	155	103	155	147	72	64	131	155
R-squared	0.14	0.21	0.29	0.12	0.29	0.47	0.33	0.35	0.22	0.32	0.11

Notes: Estimation period covers 1970Q1 to 2010Q1 in principle but varies from one country to the next based on data availability. The dependent variable is the log change in the house price index over the last quarter. Affordability is defined as the log of the ratio of house prices to income per capita. Log change in income per capita is calculated as the quarter-on-quarter change in the log level. Log changes in working-age population and bank credit to the private sector are calculated as the year-on-year change in log levels. Log change in stock prices is calculated as the lagged year-on-year change in the log level. All variables are in real terms except short-term and long-term interest rates. Robust standard errors are in parantheses. ***, **, * denote significance at the 1, 5, and 10 percent level, respectively.

Table 4. Modeling House Price Changes: Country-by-Country Regressions - continued

	Dependent variable: House price index, change										
	Japan	Korea	Netherlands	New Zealand	Norway	Portugal	Spain	Sweden	Switzerland	United Kingdom	United States
Affordability, lagged	0.0049	0.0249*	-0.0379***	-0.0123	-0.0816***	-0.124***	-0.0650***	-0.0062	0.0373**	-0.0412***	-0.0071
	(0.0108)	(0.0129)	(0.0099)	(0.0118)	(0.0180)	(0.0317)	(0.0117)	(0.0080)	(0.0178)	(0.0100)	(0.0082)
Income per capita, change	0.319**	0.0347	0.336*	0.203*	0.1730	0.349*	0.0764	0.1910	0.539**	0.877***	-0.0755
	(0.1370)	(0.1490)	(0.1980)	(0.1080)	(0.1280)	(0.1770)	(0.2940)	(0.1510)	(0.2690)	(0.2520)	(0.1030)
Working-age population, change	0.1150	0.0956	0.4230	1.683***	7.420***	0.1780	2.645***	0.0591	0.1340	0.8590	0.531*
	(0.5480)	(0.9910)	(0.6320)	(0.3480)	(1.9450)	(0.6600)	(0.5740)	(0.4400)	(0.3060)	(0.7530)	(0.2800)
Stock prices, change	0.0214***	-0.0005	-0.0020	0.0320***	0.0029	-0.0114**	0.0013	0.0189**	-0.0176**	0.0064	0.0108
	(0.0071)	(0.0060)	(0.0073)	(0.0099)	(0.0081)	(0.0057)	(0.0093)	(0.0076)	(0.0081)	(0.0119)	(0.0070)
Credit, change	0.0331**	0.162***	0.174***	0.0403***	0.0840**	0.0571***	0.159***	0.0525*	0.0432	0.0651***	0.100***
	(0.0163)	(0.0492)	(0.0418)	(0.0105)	(0.0352)	(0.0209)	(0.0383)	(0.0288)	(0.0400)	(0.0167)	(0.0171)
Short-term interest rate	-0.00168*	-0.00326**	-0.00305**	-0.0008	-0.00206**	0.00232**	-0.0006	-0.00167*	0.0011	0.0014	-0.00162***
	(0.0009)	(0.0013)	(0.0014)	(0.0010)	(0.0010)	(0.0012)	(0.0017)	(0.0010)	(0.0012)	(0.0011)	(0.0005)
Long-term interest rate	0.00228*	-0.0010	-0.0022	0.0001	-0.0002	-0.0001	0.0027	-0.0004	-0.0110***	-0.00521***	0.00135*
	(0.0013)	(0.0023)	(0.0022)	(0.0015)	(0.0018)	(0.0009)	(0.0021)	(0.0012)	(0.0029)	(0.0013)	(0.0007)
Constant	0.0451	0.315*	-0.214***	-0.0846	-0.757***	-0.661***	-0.389***	-0.0339	0.282**	-0.206***	-0.0495
	(0.1180)	(0.1640)	(0.0551)	(0.0673)	(0.1770)	(0.1680)	(0.0645)	(0.0660)	(0.1250)	(0.0550)	(0.0546)
Observations	155	95	147	144	76	83	95	149	144	155	155
R-squared	0.41	0.36	0.32	0.36	0.67	0.31	0.56	0.36	0.37	0.42	0.32

Notes: Estimation period covers 1970Q1 to 2010Q1 in principle but varies from one country to the next based on data availability. The dependent variable is the log change in the house price index over the last quarter. Affordability is defined as the log of the ratio of house prices to income per capita. Log change in income per capita is calculated as the quarter-on-quarter change in the log level. Log changes in working-age population and bank credit to the private sector are calculated as the year-on-year change in log levels. Log change in stock prices is calculated as the lagged year-on-year change in the log level. All variables are in real terms except short-term and long-term interest rates. Robust standard errors are in parantheses. ***, **, * denote significance at the 1, 5, and 10 percent level, respectively.

Table 5. Modeling House Price Changes: Pooled Regressions

	Dependent variable: House price index, change			
	1	2	3	4
Affordability, lagged	-0.0130***	-0.0335***	-0.0269***	-0.0268***
	(0.0025)	(0.0081)	(0.0041)	(0.0042)
Income per capita, change	0.415***	0.408***	0.429***	0.4397***
	(0.0474)	(0.0472)	(0.0684)	(0.0948)
Working-age population, change	0.694***	0.641***	0.991***	1.6677***
	(0.1150)	(0.1160)	(0.1980)	(0.3066)
Stock prices, change	0.0136***	0.0129***	0.0048*	0.0087**
	(0.0021)	(0.0021)	(0.0027)	(0.0031)
Credit, change	0.0369***	0.0367***	0.0187***	0.0174**
	(0.0057)	(0.0057)	(0.0052)	(0.0079)
Short-term interest rate	-0.0008**	-0.0007**	-0.0009**	-0.0016**
	(0.0003)	(0.0003)	(0.0004)	(0.0006)
Long-term interest rate	-0.0004	-0.0006	-0.0006	-0.0006
	(0.0004)	(0.0004)	(0.0004)	(0.0008)
Affordability, lagged, squared		-0.0013***		
		(0.0005)		
Construction costs, change			0.127***	
			(0.0365)	
Commodity prices, change				-0.0041
				(0.0067)
Constant	-0.0833***	-0.156***	-0.166***	-0.243***
	(0.0172)	(0.0326)	(0.0266)	(0.0554)
Observations	2718	2718	1297	1521
R-squared	0.16	0.16	0.17	0.27
Number of countries	22	22	17	22

Notes: Estimation period covers 1970Q1 to 2010Q1 in principle but varies from one country to the next based on data availability. The dependent variable is the log change in the house price index over the last quarter. Affordability is defined as the log of the ratio of house prices to income per capita. Log change in income per capita is calculated as the quarter-on-quarter change in the log level. Log changes in working-age population and bank credit to the private sector are calculated as the year-on-year change in log levels. Log change in stock prices is calculated as the lagged year-on-year change in the log level. Log change in construction costs is calculated as the quarter-on-quarter change in the log level. Log change in commodity prices is calculated as the quarter-on-quarter change in the log level of the commodity (fuel and nonfuel) price index. All variables are in real terms except short-term and long-term interest rates. Country fixed effects are included in all columns. Robust standard errors are in parentheses. ***, **, * denote significance at the 1, 5, and 10 percent level, respectively.

Table 6. Misalignment in House Prices: A Heat Map

	Based on point estimate of price gap…			
Country	as of 2006Q4	as of 2007Q4	as of 2008Q4	as of 2009Q4
Australia				
Austria				
Belgium				
Canada				
Denmark				
Finland				
France				
Germany				
Greece				
Ireland				
Italy				
Japan				
Korea				
Netherlands				
New Zealand				
Norway				
Portugal				
Spain				
Sweden				
Switzerland				
United Kingdom				
United States				

Notes: House prices are assumed to be at their equilibrium level at five different dates (1997Q4, 1998Q4, 1999Q4, 2000Q4, and 2001Q4) and the average of estimated gaps is reported as the 'point estimate'. Point estimates are obtained based on the estimated coefficients using data only up to the 'as of' date. Colors closer to the red end of the spectrum indicate a larger point estimate of the price gap.

Table 7. Macroeconomic Impact of House Price Corrections

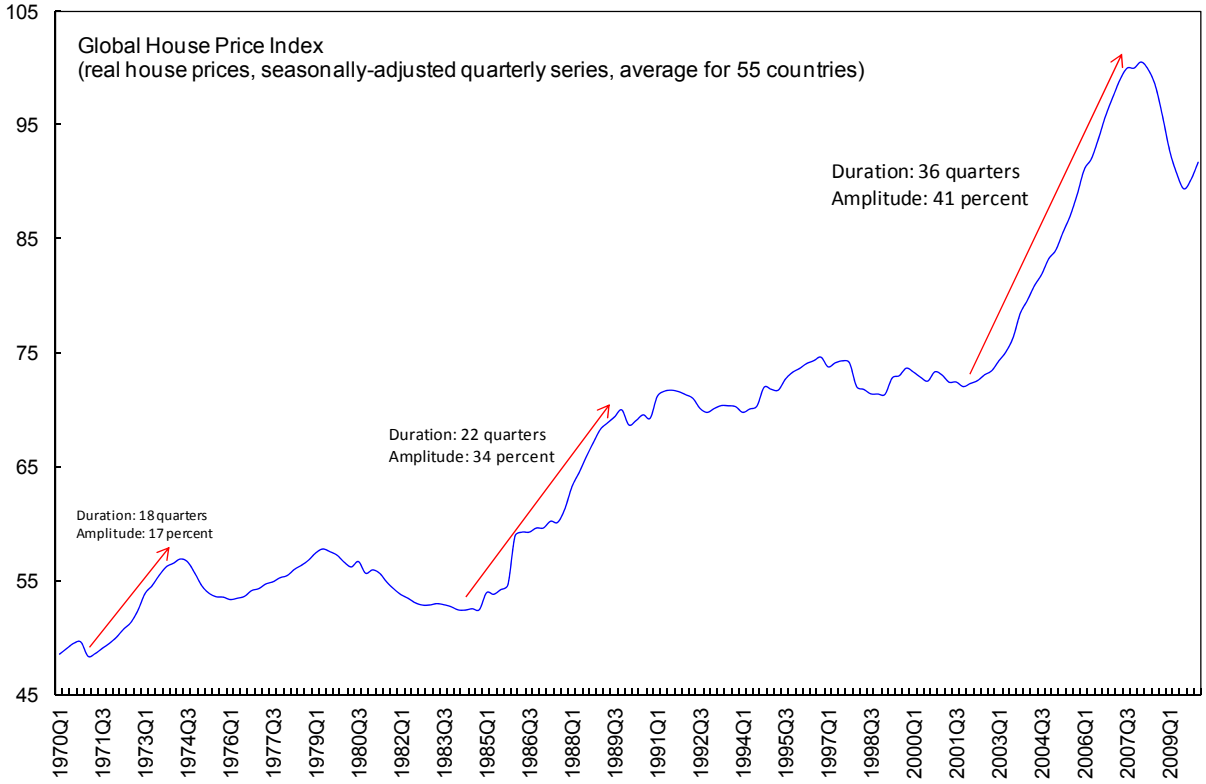
	Maximum Impact of a Negative Shock to House Prices						
	Decline of 10 percent			Decline of 2 standard deviations of the quarterly change in real house price index			
	GDP	Consumption	Residential investment	GDP	Consumption	Residential investment	Shock size
Australia	-0.95	-1.76	-13.12	-0.41	-0.77	-5.74	4.38
Austria	-1.86	-3.87	0.00	-1.44	-3.00	0.00	7.74
Belgium	-1.13	-0.22	-8.35	-0.29	-0.06	-2.16	2.59
Canada	-1.19	-1.31	-2.07	-0.62	-0.68	-1.07	5.20
Denmark	-2.60	-3.60	-13.83	-1.31	-1.82	-7.00	5.06
Finland	-0.88	-2.76	-17.02	-0.53	-1.67	-10.28	6.04
France	-2.07	-1.13	-9.76	-0.62	-0.34	-2.94	3.01
Germany	-4.61	-5.74	-38.45	-0.65	-0.81	-5.42	1.41
Greece	-7.42	-6.23	-13.89	-2.26	-1.90	-4.23	3.04
Ireland	0.00	-0.78	-5.42	0.00	-0.53	-3.68	6.78
Italy	-0.10	-0.50	-9.53	-0.04	-0.19	-3.64	3.82
Japan	-5.49	-3.03	-19.74	-1.21	-0.67	-4.36	2.21
Korea	-0.71	-0.50	-12.98	-0.33	-0.23	-5.93	4.57
Netherlands	0.00	-0.44	-13.39	0.00	-0.13	-3.91	2.92
New Zealand	-4.18	-5.70	-28.76	-1.74	-2.37	-11.95	4.16
Norway	0.00	-0.68	-5.25	0.00	-0.38	-2.92	5.56
Spain	-1.76	-2.50	-7.01	-0.93	-1.32	-3.71	5.29
Sweden	-0.95	-1.27	-39.02	-0.42	-0.55	-17.05	4.37
Switzerland	-0.54	-0.46	-4.22	-0.19	-0.16	-1.47	3.48
United Kingdom	-1.03	-1.40	-12.24	-0.52	-0.71	-6.19	5.06
United States	-1.89	-2.78	-20.20	-0.42	-0.62	-4.48	2.22

Notes: The VARs are estimated for the period from 1986q1 to 2010q1. Identification is through a Cholesky decomposition with ordering of variables as follows: real GDP, real private consumption, real private residential investment, CPI, nominal short-term interest rate, real house prices. For all countries except Ireland, the variables are transformed for estimation into log levels, except the CPI, for which log first differences (i.e. the inflation rate) are used, and the short-term interest rate, which enters in levels without transformation. For Ireland, data series for GDP and house prices are first-differenced.

Table 8. Macroeconomic Impact of House Price Corrections and Country Characteristics

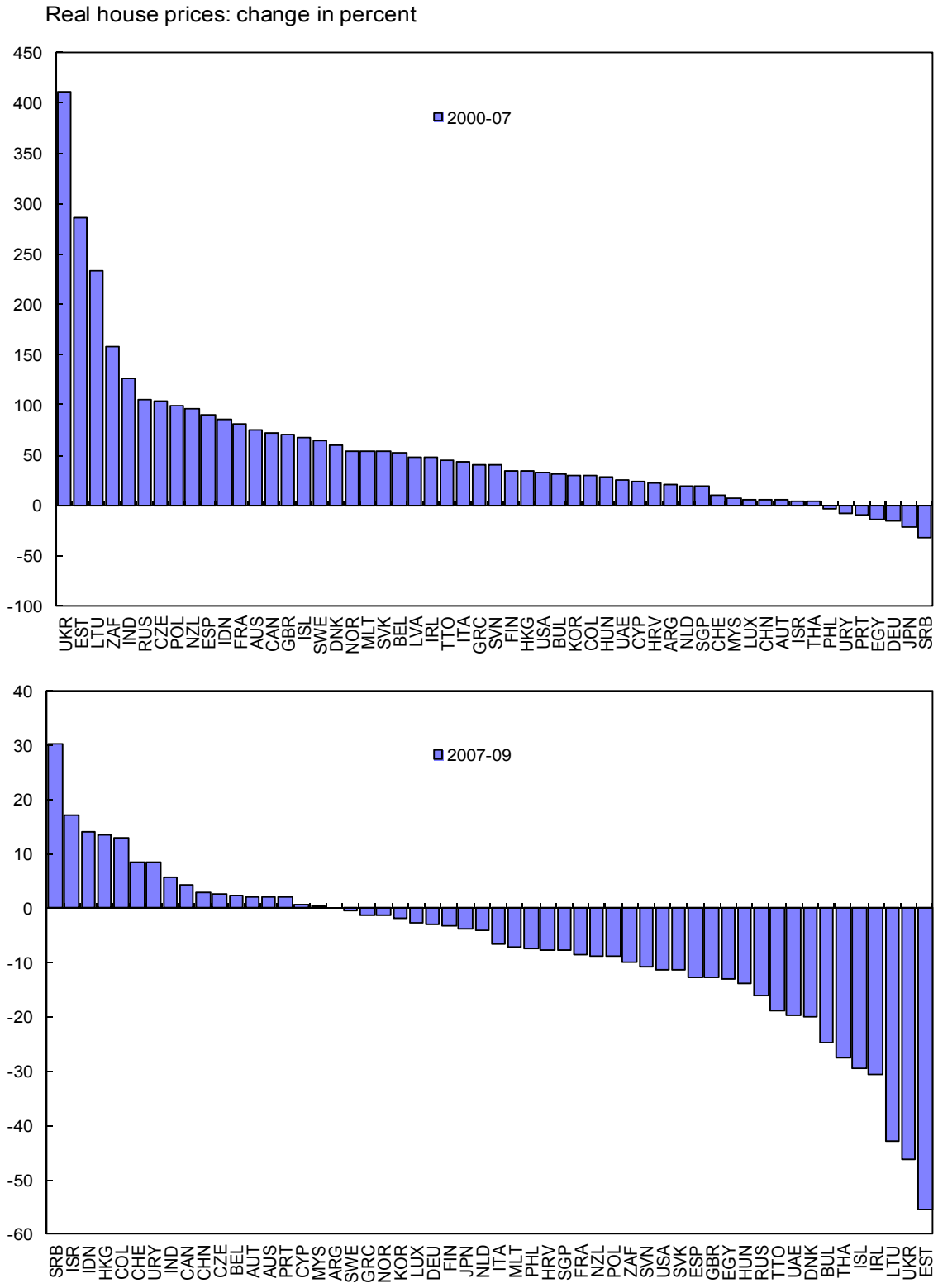
	Average estimated impact on GDP by VAR analysis (in percent)	Countries included in the calculation of average impact
Penalty-fee prepayment and refinancing		
available	-2.77	Australia, Denmark, Japan, United Kingdom, United States
not available	-1.71	Austria, Belgium, Canada, Finland, France, Germany, Greece, Italy, Netherlands, Norway, Spain, Sweden
Option to withdraw mortgage equity		
available	-2.27	Australia, Canada, Denmark, Finland, Greece, Ireland, Japan, Netherlands, Norway, Sweden, United Kingdom, United States
not available	-1.61	Austria, Belgium, France, Germany, Italy, Spain
Typical loan-to-value ratio at origination		
less than or equal to 60 percent	-0.06	Austria, Italy
between 60 and 79 percent	-1.67	Canada, Finland, France, Germany, Norway, Spain, United Kingdom
more than or equal to 80 percent	-2.21	Australia, Belgium, Denmark, Ireland, Japan, Netherlands, Sweden, United States

Figure 1. An Unprecedented Global Housing Boom



Sources: OECD, BIS, Global Property Guide, national sources; authors' calculations.

Figure 2. A Global Housing Boom Turning into a Global Bust



Sources: OECD, BIS, Global Property Guide, national sources; authors' calculations.

Figure 3. Measuring House Prices: Differences in U.S. Indices

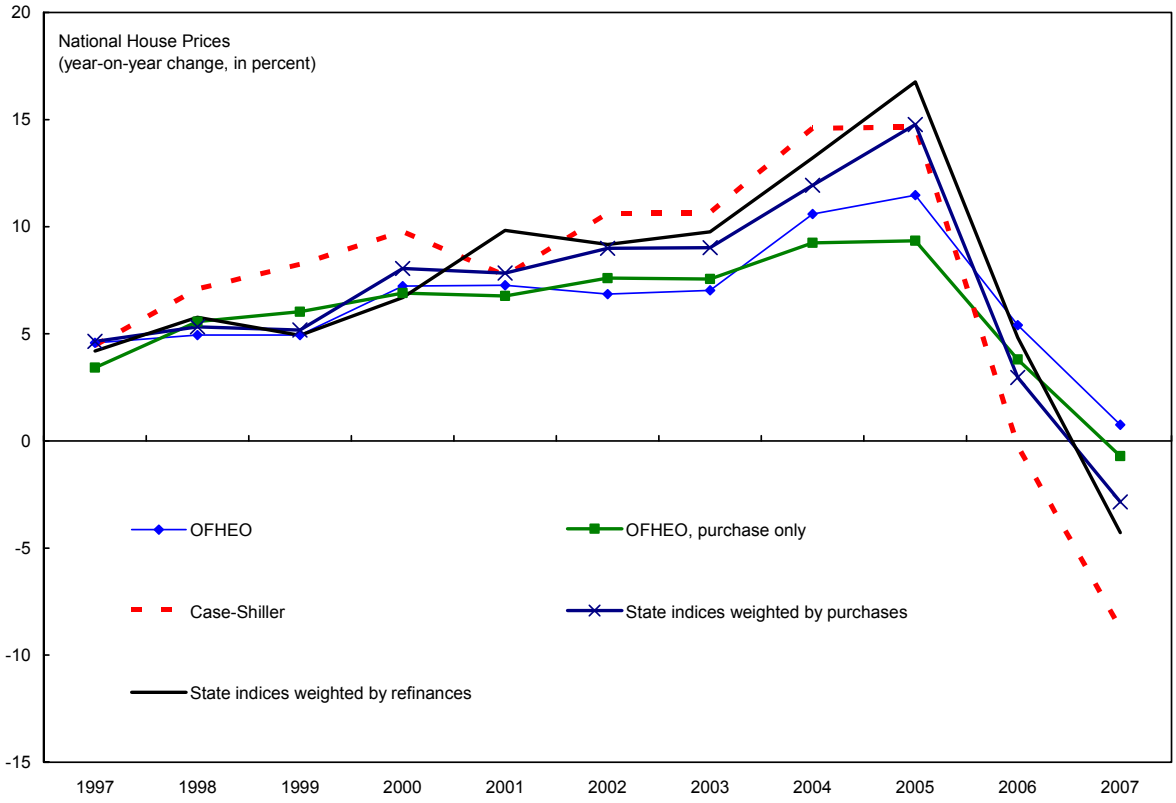


Figure 4. National versus Sub-national Prices: Selected Indices in the U.K.

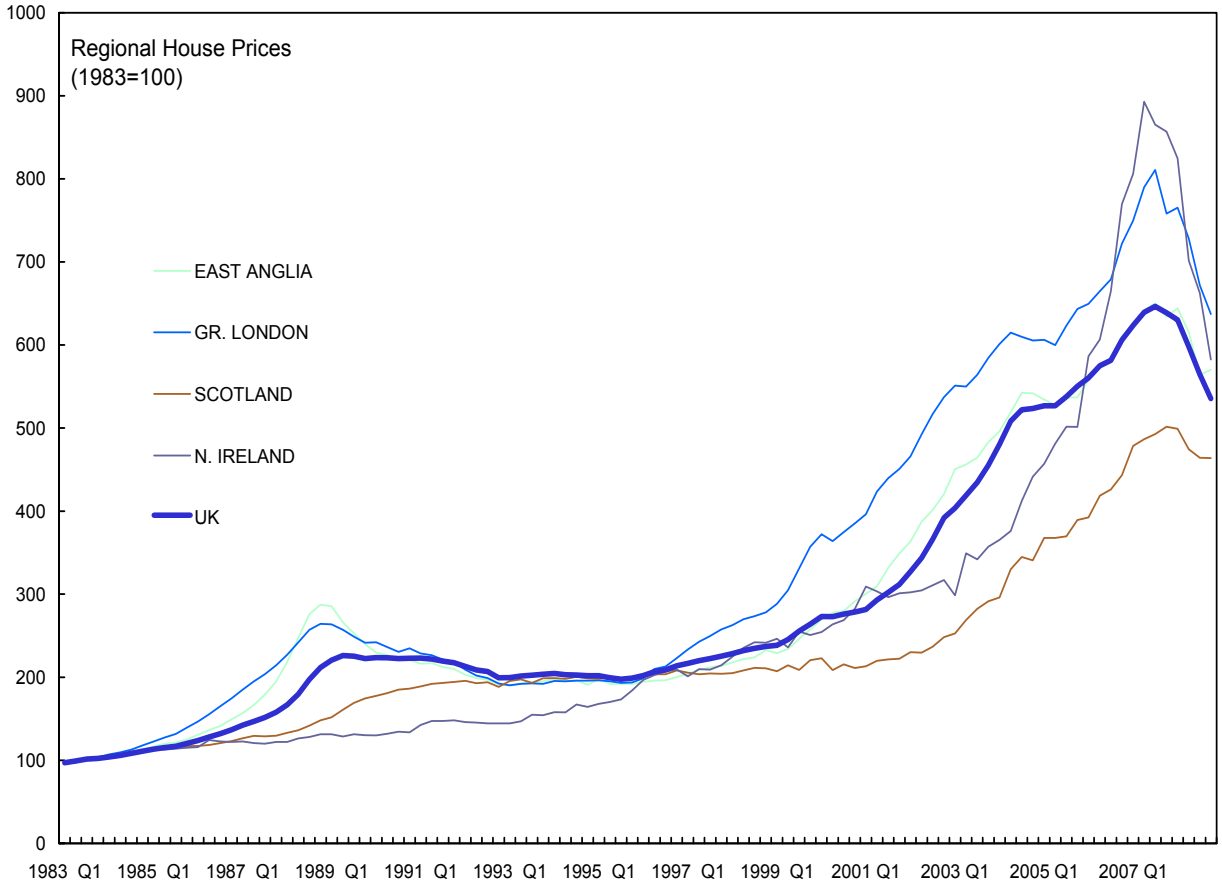
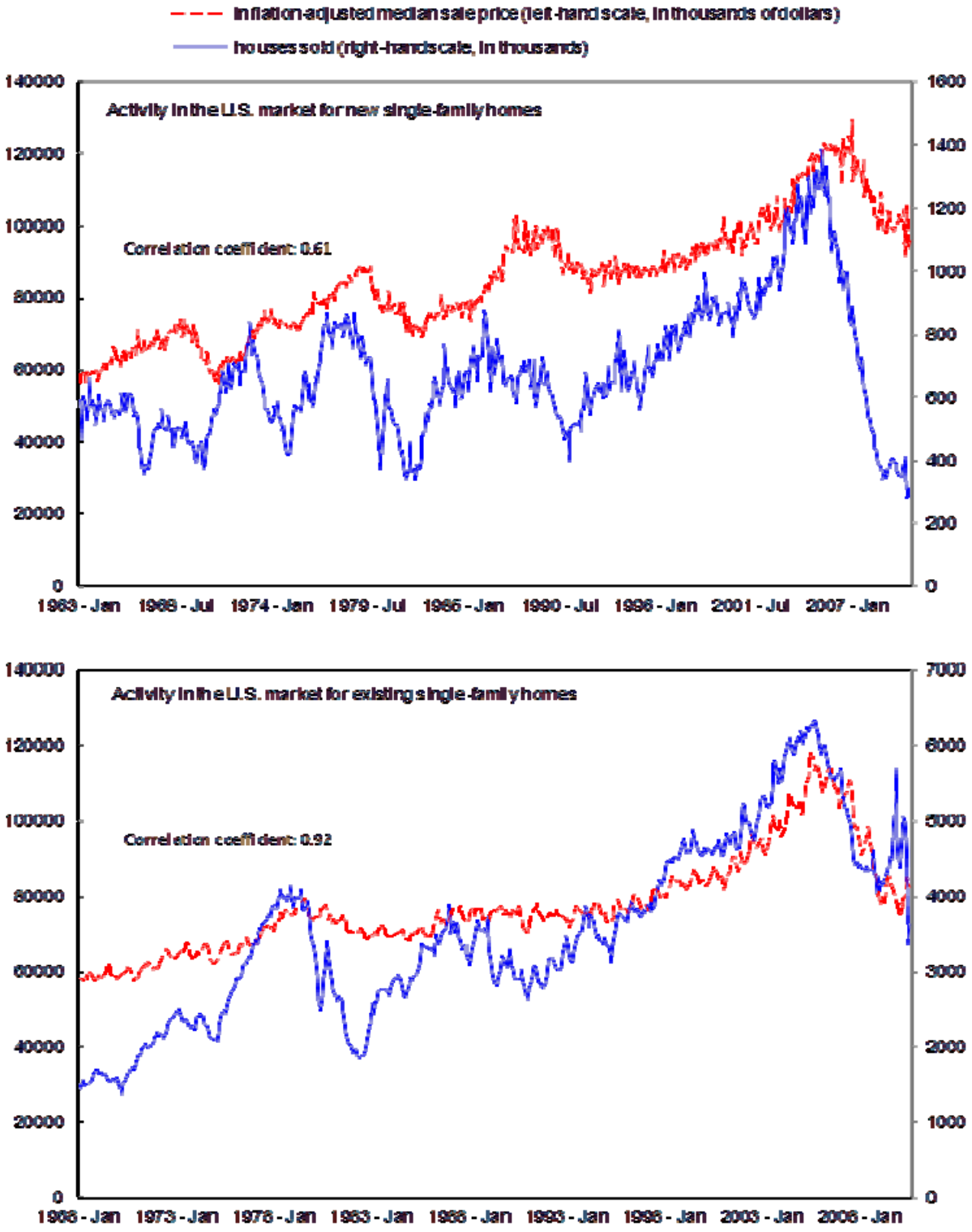
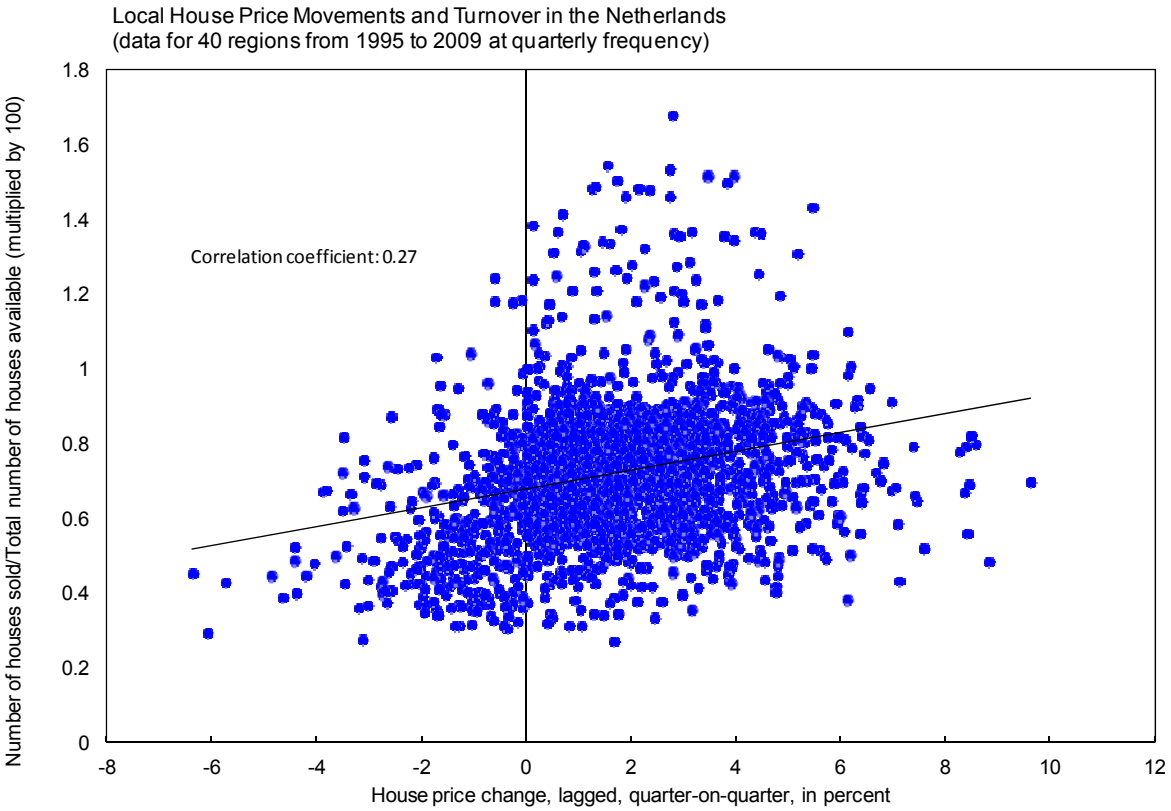


Figure 5. Housing Markets: Price versus Quantity



Source: US Census Bureau, National Association of Realtors.

Figure 6. Regional Housing Markets: Prices versus Activity



Source: Statistics Netherlands.

Figure 7. Global Housing Cycles: Concurrence of Local Markets

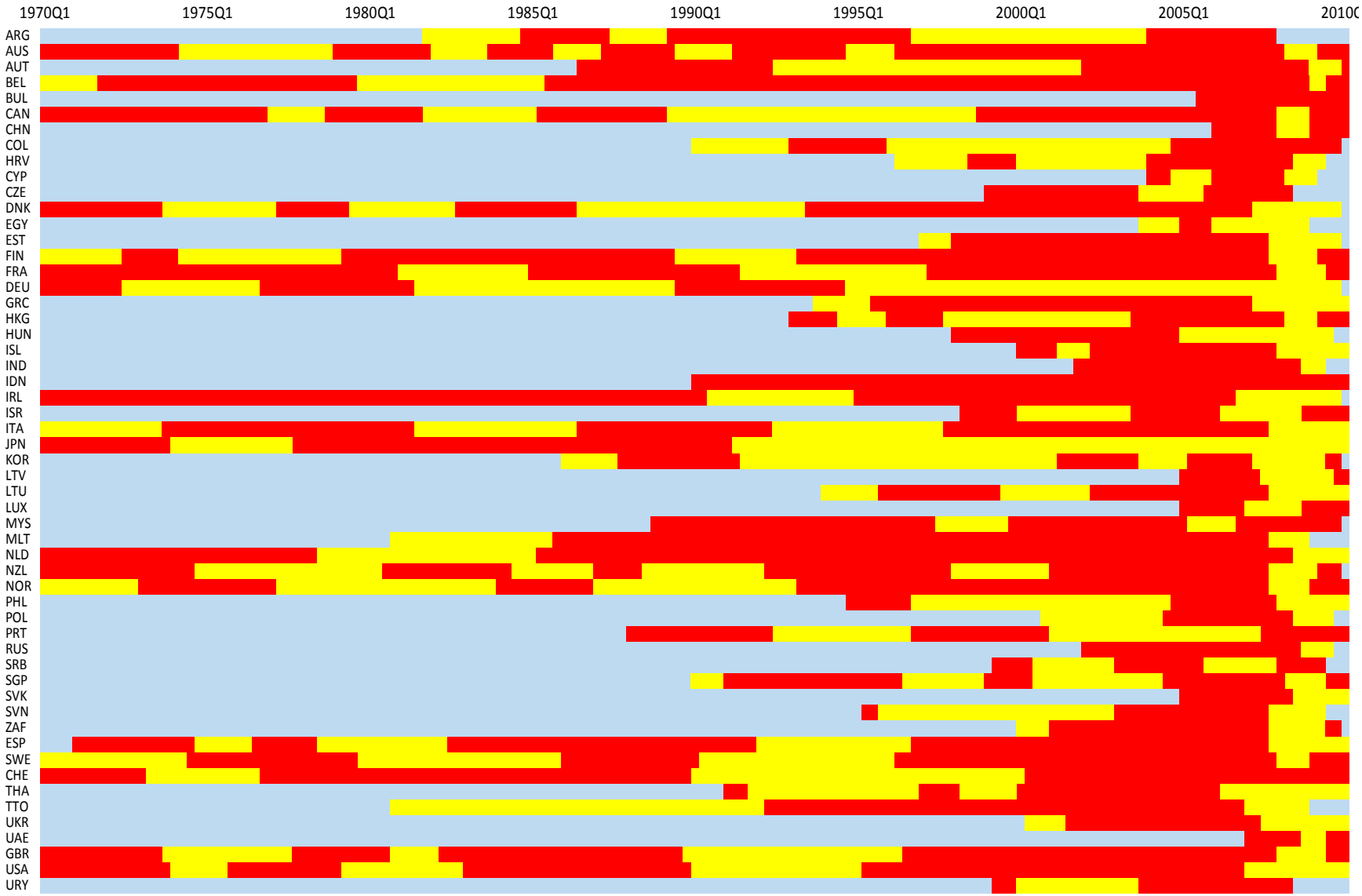
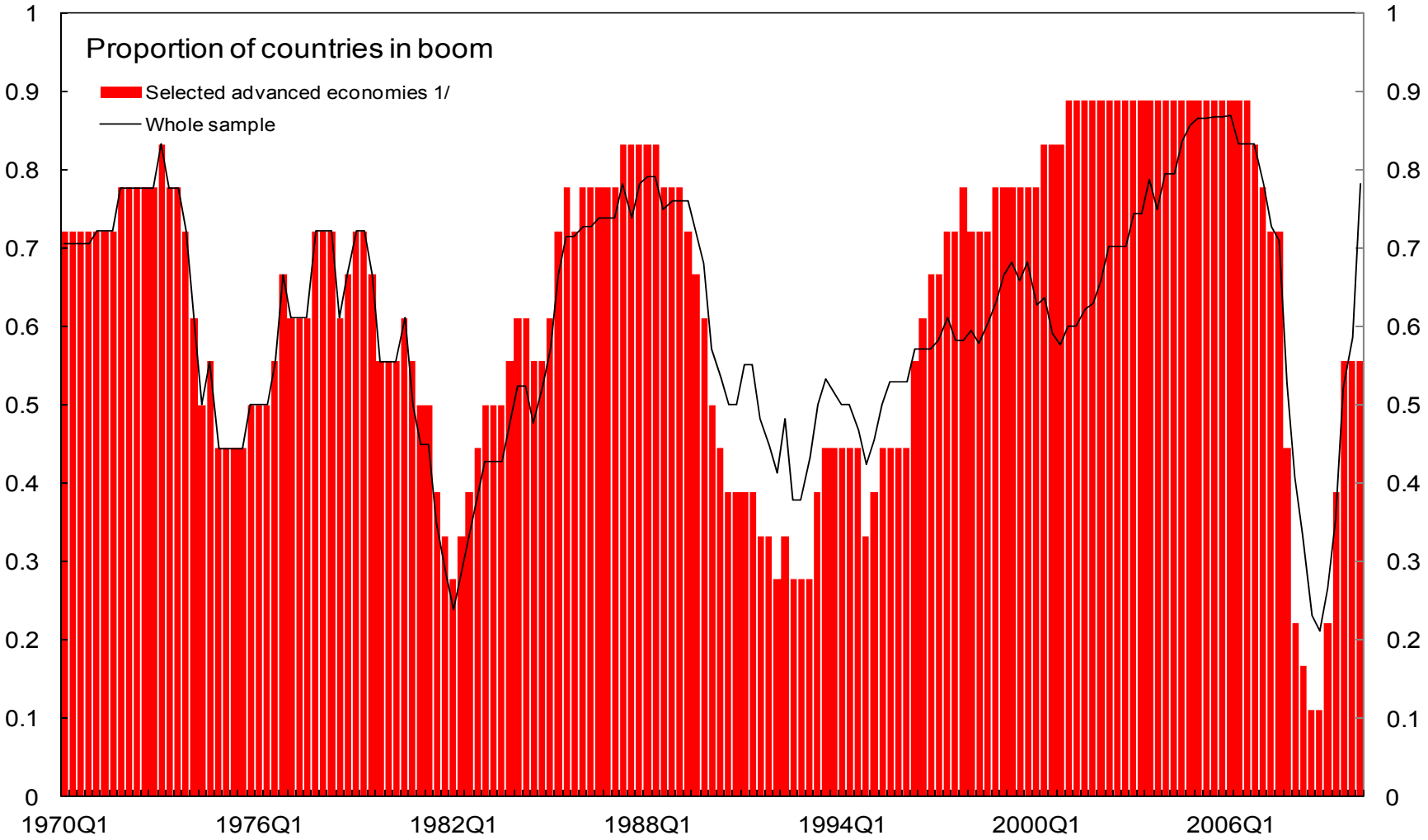


Figure 8. Global Booms and Busts



Sources: OECD, BIS, Global Property Guide, national sources; authors' calculations.
1/ These include Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, United Kingdom, and United States. The selection is imposed by the availability of data for the whole sample period.

Figure 9. House Prices and Residential Investment

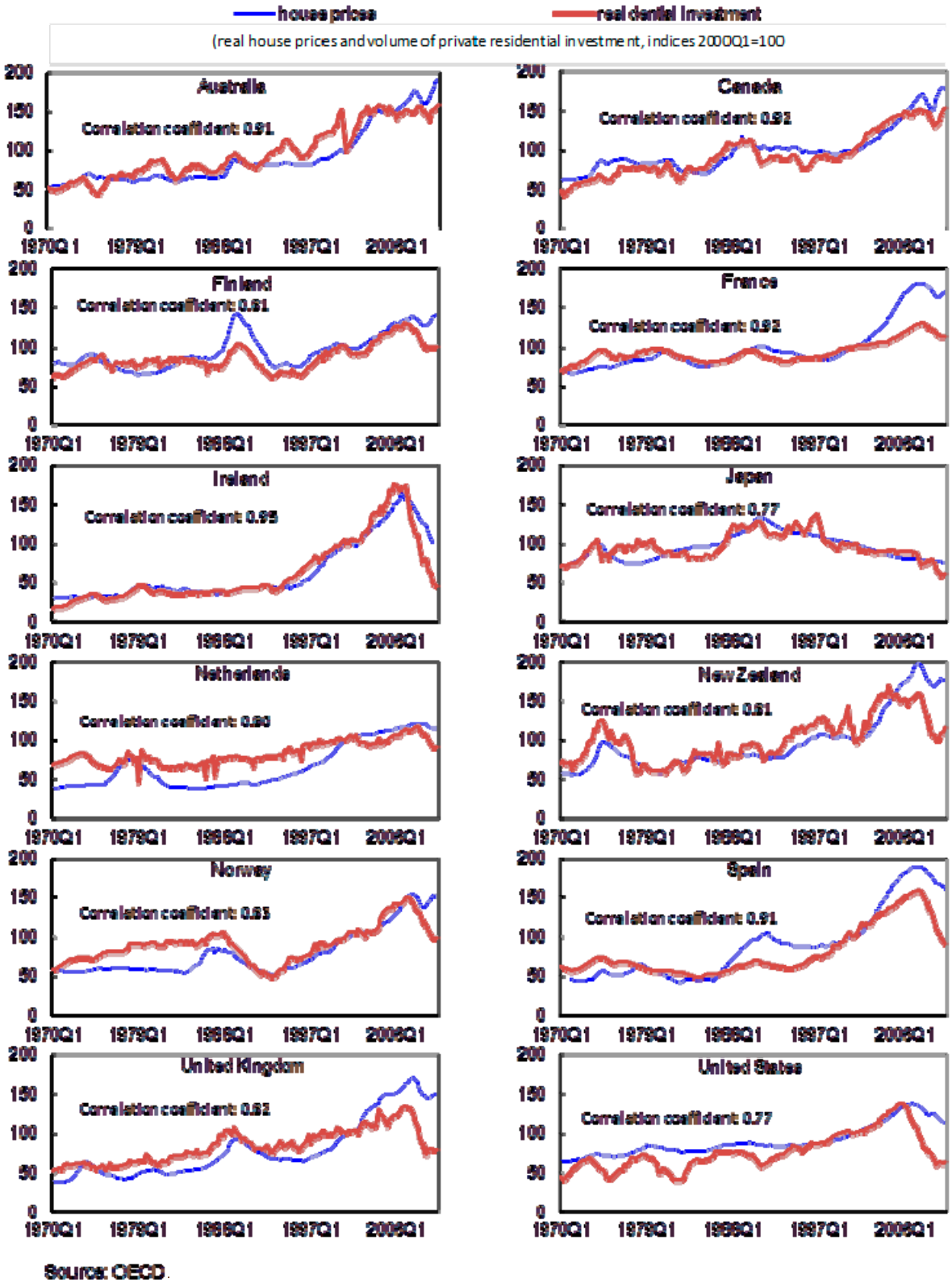
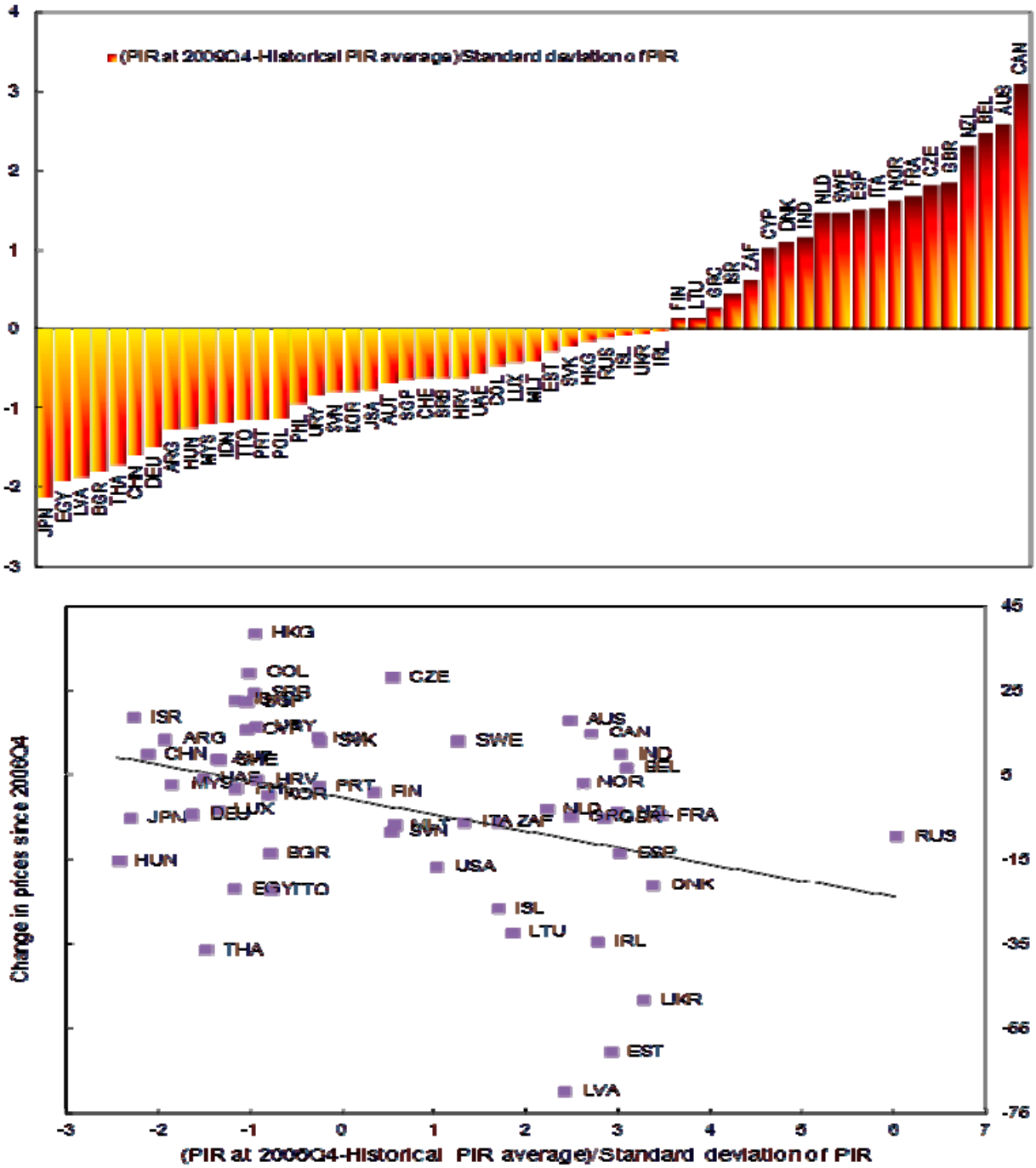


Figure 10. Price-to-Income Ratio by Country



Sources: OECD, BIS, Global Property Guide, national sources; authors' calculations.
Notes: Price-to-income ratio (PIR) is calculated as the ratio of house price index to an index of per capita income with base set to 100 at 2003Q4. Historical PIR average and standard deviation of PIR are calculated using data from the beginning date of the series to 2009Q3 and 2006Q3 in the upper and lower panels, respectively.

Figure 11. Housing Affordability in the U.S.

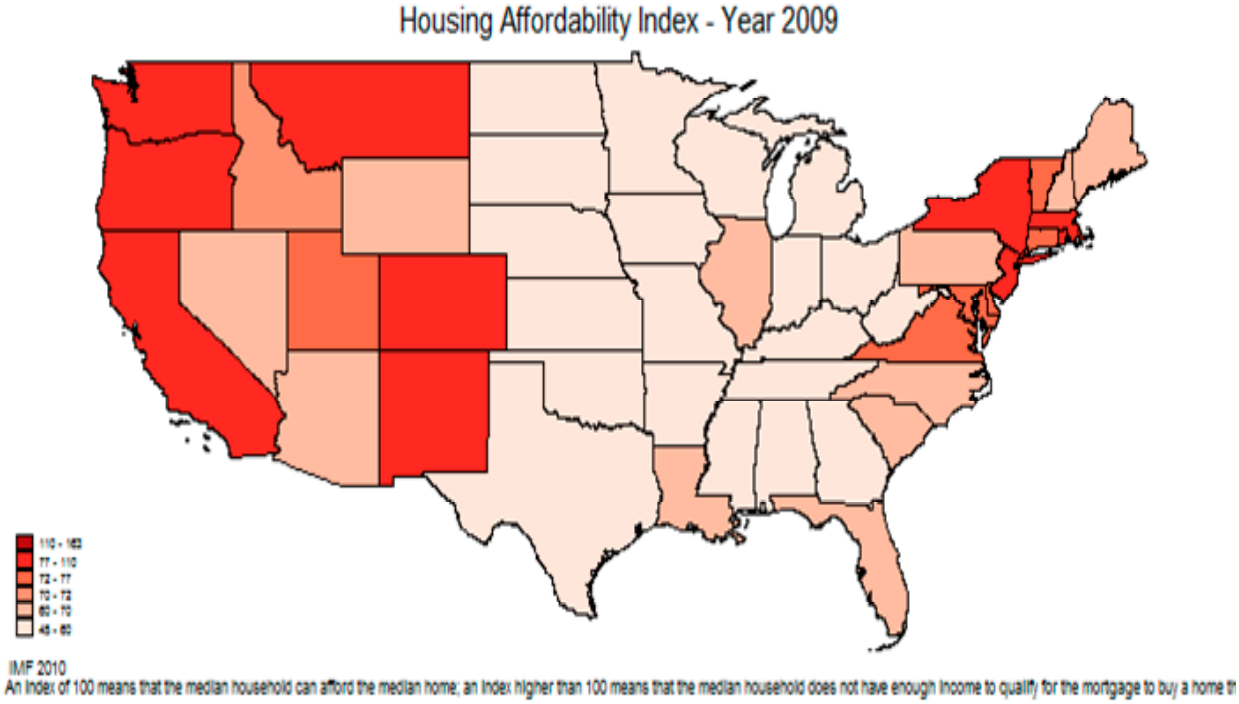


Figure 12. Housing Affordability in the U.S.: Now and Then

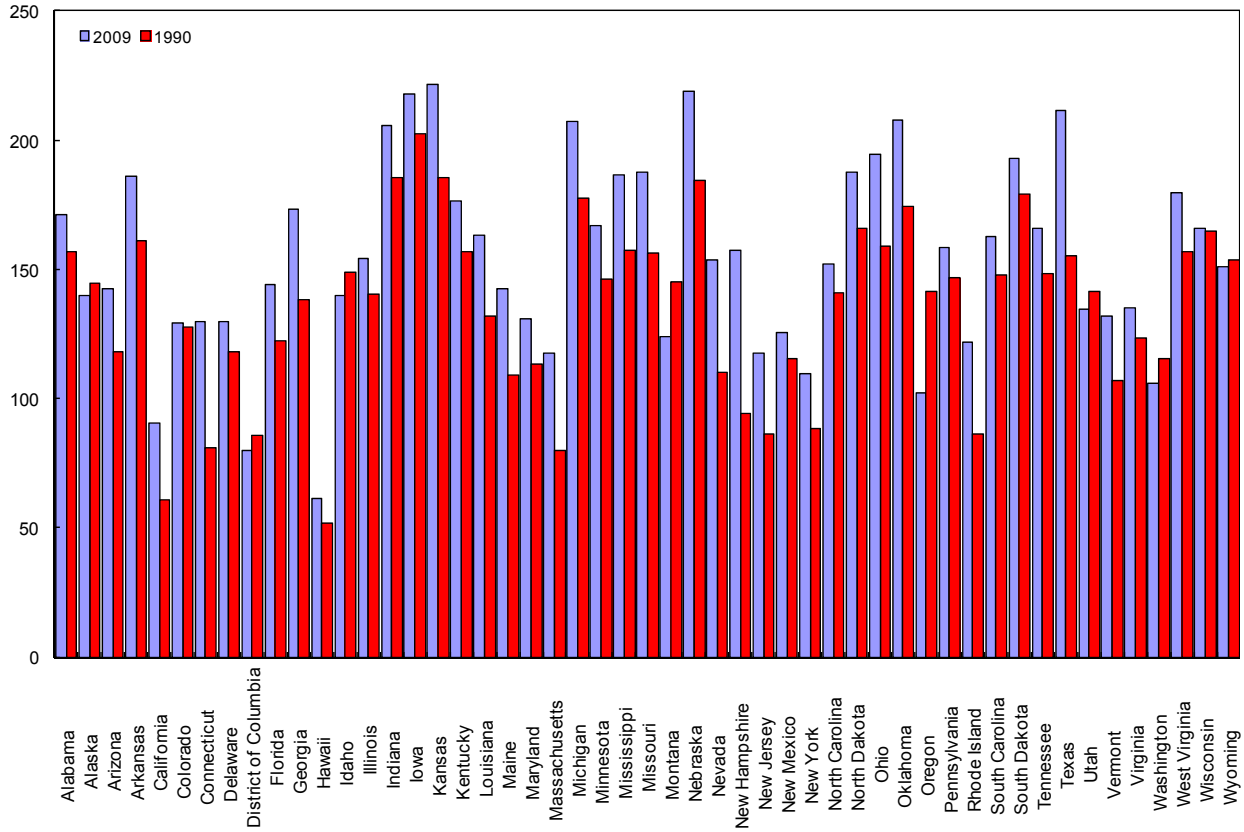


Figure 13. Price-to-Rent Ratio Adjustment in the U.S.

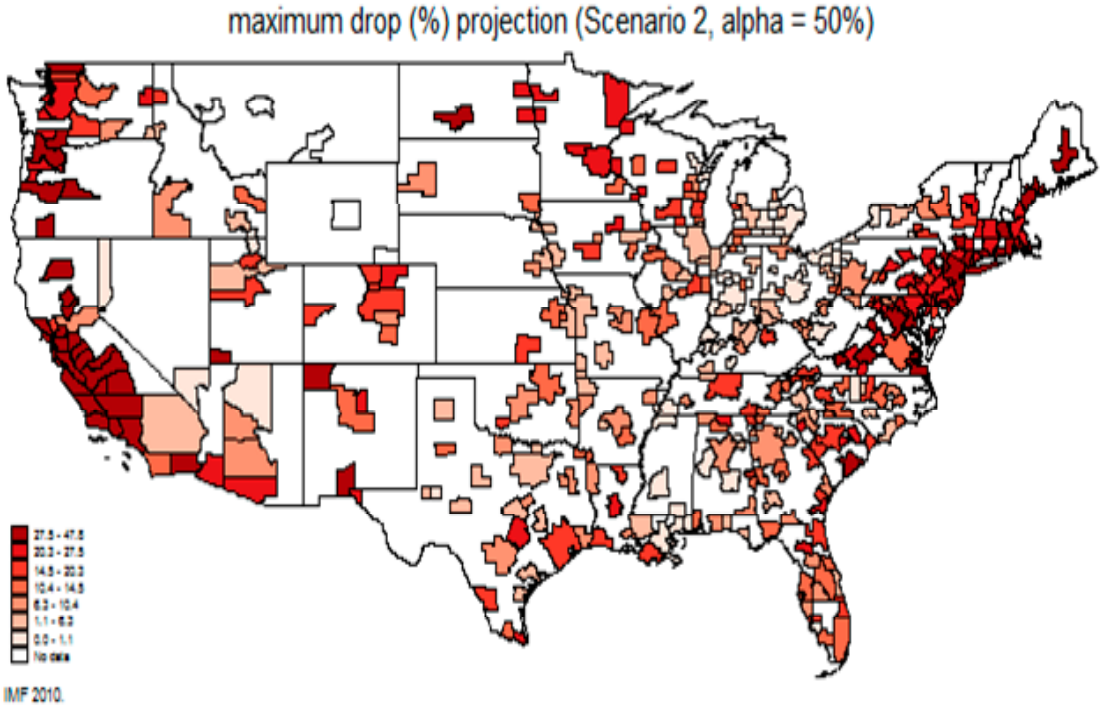


Figure 14. User Cost of Housing in the U.S.

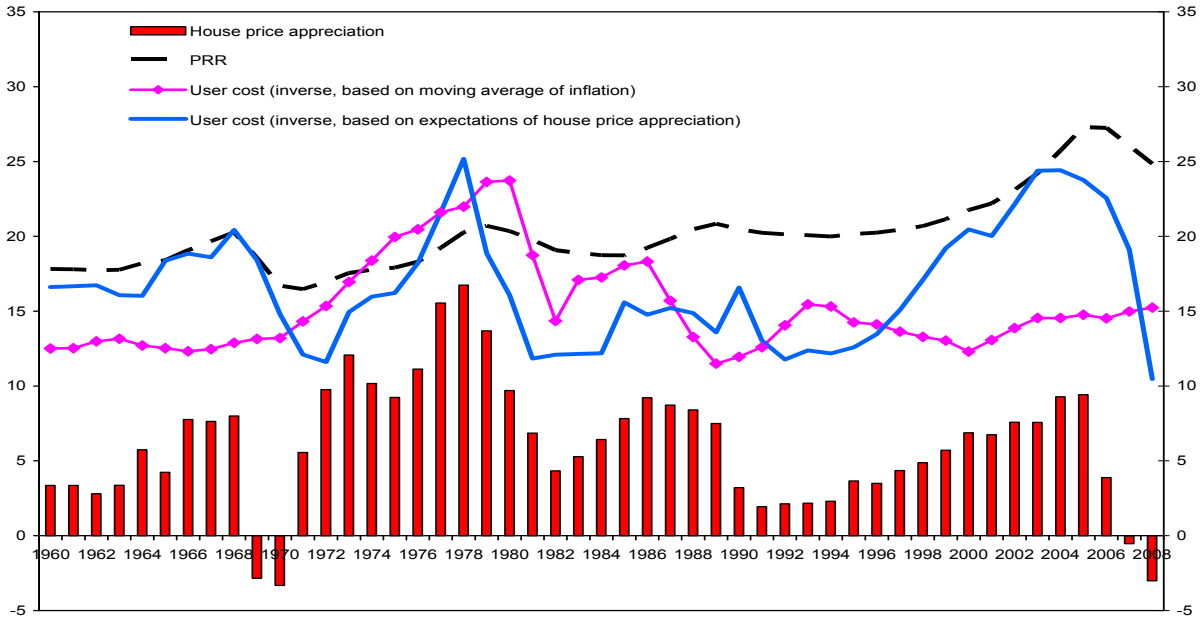
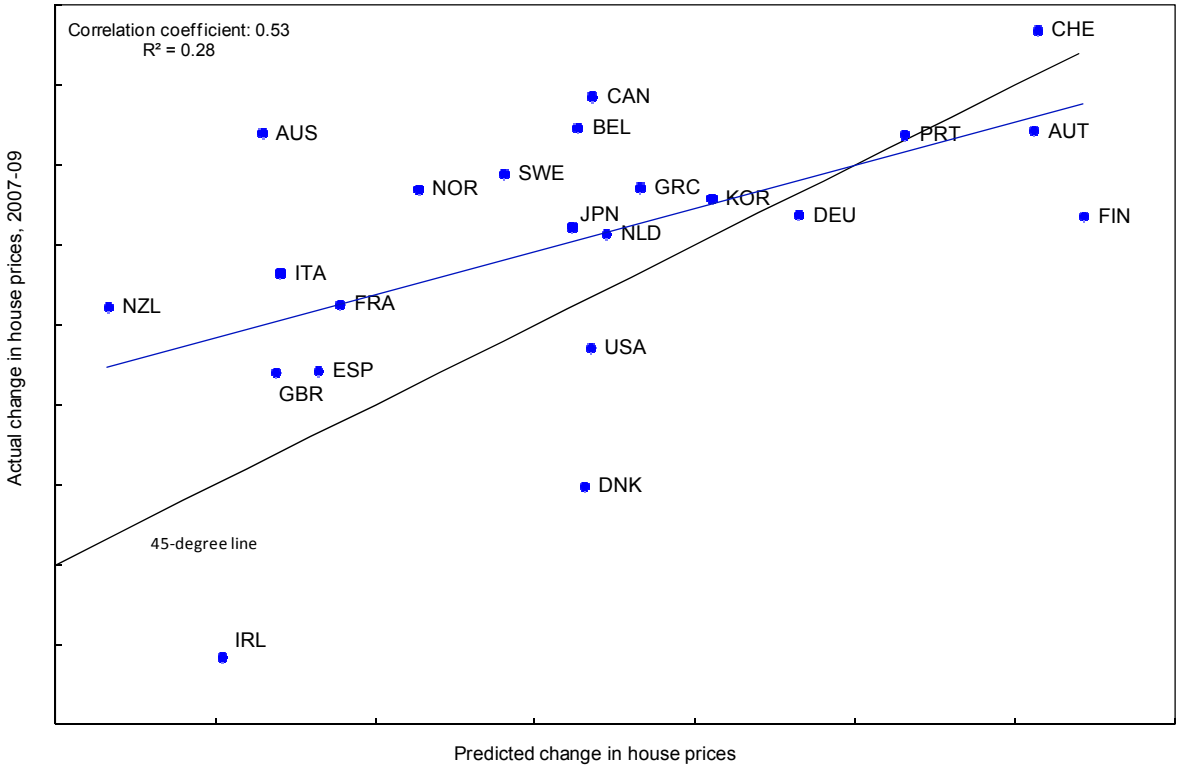


Figure 15. Back to Earth: Predicted and Actual House Price Changes



Sources: Authors' calculations, IMF *International Financial* Statistics, and OECD.
Notes: The predicted change is the estimated price gap multiplied by -1. The estimated price gap is calculated as of 2007Q4 .

Appendix

Details on variables used in the econometric analysis are in Appendix Tables 1 and 2. A brief discussion of the construction of the series in Figure 3 is also included.

Data

Appendix Table 1. List of Variables

Variable	Source
House price index	OECD, BIS, Global Property Guide (compilations of data from private and/or public national sources)
Disposable income	OECD
Working-age population	OECD
Bank credit to the private sector	IMF *International Financial Statistics*
Equity price index	IMF *International Financial Statistics*
Short-term interest rate	IMF *International Financial Statistics*
Long-term interest rate	IMF *International Financial Statistics*
Gross domestic product	IMF *International Financial Statistics*
Private consumption	OECD
Residential investment	OECD
CPI	IMF International Financial Statistics

All variables except population, credit, and interest rates are in real terms.

Appendix Table 2. House Price Data Availability

Country	Definition	Source	Original frequency	Frequency adjustment	Time span
Argentina	Average price of existing apartments, Buenos Aires	Reporte Inmobiliario	biannual	cubic spline interpolation	1981-2007
Australia	Index of a weighted average of 8 capital cities (Adelaide, Brisbane, Canberra, Darwin, Hobart, Melbourne, Perth, Sydney)	Australia Bureau of Statistics	quarterly	not applicable	1970-2010
Austria	Residential property price index, Vienna	Oesterreichische National Bank	quarterly	not applicable	1986-2010
Belgium	Average price of all houses	Statistics Belgium	quarterly	not applicable	1970-2010
Bulgaria	Average price of dwellings	National Statistics Office	quarterly	not applicable	2005-2010
Canada	Multiple listing series, average price	Ministry of Finance	quarterly	not applicable	1970-2010
China	House price index, 70 cities	Ehomeday	monthly	period average	2006-2010
Colombia	Existing house price index for major areas (Bogotá, Medellín, Cali, Soacha, Bello and Envigado e Itaguí)	Departamento Administrativo Nacional de Estadística	quarterly	not applicable	1990-2009
Croatia	Property price index	Croatian Bureau of Statistics	semi-annual	cubic spline interpolation	1996-2009
Cyprus	Buy/Sell house price index	MAP S. Platis	monthly	period average	2004-2009
Czech Republic	Property prices based on tax returns	Czech Statistical Office	quarterly	not applicable	1999-2008
Denmark	Index of one-family houses sold	Statistics Denmark	quarterly	not applicable	1970-2010
Egypt	Average price of a housing unit	Bearing Point, Inc.	annual	cubic spline interpolation	2003-2008
Estonia	Average price per sq.m. of 2-bedroom dwellings, Tallinn	Statistical Office of Estonia	quarterly	not applicable	1997-2009
Finland	Housing prices in metropolitan areas	Bank of Finland	quarterly	not applicable	1970-2010
France	Indice de prix des logements anciens	INSEE	quarterly	not applicable	1970-2010
Germany	Index for total resales	Bundesbank	quarterly	not applicable	1970-2010
Greece	Index for dwellings in urban areas	Bank of Greece	quarterly	not applicable	1993-2010
Hong Kong	Private domestic house price index for all classes	Ratings and Valuation Department	monthly	period average	1993-2010
Hungary	Actual sales price	FHB Mortgage Bank	quarterly	not applicable	1998-2009
Iceland	House price index	Statistics Iceland	monthly	period average	2000-2010
India	Residex, 15 cities	National Housing Bank	semi-annual	cubic spline interpolation	2001-2009
Indonesia	Residential property price index, new developments in big cities	Bank of Indonesia	quarterly	not applicable	1990-2010
Ireland	Index for second-hand houses	Irish Department of Environment	quarterly	not applicable	1970-2010
Israel	Average price of owner-occupied dwellings	Central Bureau of Statistics	quarterly	not applicable	1998-2010
Italy	Media 13 area urbane numeri indice dei prezzi medi di abitazioni, usate	Nomisma	quarterly	not applicable	1970-2010
Japan	Nationwide urban land price index	Japan Real Estate Institute	quarterly	not applicable	1970-2010
Korea	Nationwide house price index	Kookmin Bank	quarterly	not applicable	1986-2010

Appendix Table 2. House Price Data Availability - continued

Country	Definition	Source	Original frequency	Frequency adjustment	Time span
Latvia	Average price of a standard apartment, Riga	Latio and Arco Real Estate	monthly	period average	2005-2010
Lithuania	Apartment price index, 5 largest cities (Vilnius, Kaunas, Klaipeda, Siauliai and Panevezys)	Ober Haus	monthly	period average	1994-2010
Luxembourg	Average price of all dwellings	Departmente du Logement and STATEC	quarterly	not applicable	2005-2010
Malaysia	House price index	Bank Negara	annual	cubic spline interpolation	1988-2010
Malta	House price index	Central Bank of Malta	annual	cubic spline interpolation	1980-2008
Netherlands	Index for existing dwellings	De Nederlandsche Bank	quarterly	not applicable	1970-2010
New Zealand	Quotable value index for all dwellings	Reserve Bank of New Zealand	quarterly	not applicable	1970-2010
Norway	Nationwide index for dwellings	Statistics Norway	quarterly	not applicable	1970-2010
Philippines	Prime 3-bedroom condominium price, Makati	Colliers International	quarterly	not applicable	1994-2010
Poland	Average price of new flats, Warsaw	Central Statistical Office and REAS Consulting	annual	cubic spline interpolation	2000-2009
Portugal	Index for all dwellings	Instituto Nacional de Estatistica	quarterly	not applicable	1988-2010
Russia	Index for all apartments in the secondary market	Federal State Statistics Service	quarterly	not applicable	2002-2009
Serbia	Price of new-construction dwellings	Statistical Office of the Republic of Serbia	semi-annual	cubic spline interpolation	1999-2009
Singapore	Property price index for all residential	Urban Redevelopment Authority	quarterly	not applicable	1990-2010
Slovak Republic	Residential property prices	National Bank of Slovakia	quarterly	not applicable	2005-2010
Slovenia	Average price of second-hand flats, Ljubljana	SLONEP and Statistical Office of Slovenia	quarterly	not applicable	1995-2009
South Africa	House price index	ABSA	monthly	period average	2000-2009
Spain	Precio medio del m2 de la vivienda, mas de un ano de antiguedad	Banco de Espana	quarterly	not applicable	1971-2010
Sweden	Index for one- and two-dwelling buildings	Statistics Sweden	quarterly	not applicable	1970-2010
Switzerland	Price index for single-family homes	Swiss National Bank	quarterly	not applicable	1970-2010
Thailand	Index for single detached houses	Bank of Thailand	quarterly	not applicable	1991-2010
Trinidad & Tobago	Median house price	Central Bank of Trinidad & Tobago	annual	cubic spline interpolation	1980-2008
Ukraine	Price of flats, Kiev	Blagovest	monthly	period average	2000-2010
United Arab Emirates	Index for foreign-ownership areas	Colliers International	quarterly	not applicable	2007-2010
United Kingdom	Mix-adjusted house price index	ODPM	quarterly	not applicable	1970-2010
United States	Nationwide single family house price index	OFHEO/FHFA	quarterly	not applicable	1970-2010
Uruguay	Average price of apartments, Montevideo	Situacion Inmobiliario	semi-annual	cubic spline interpolation	1999-2008

Note: Series are adjusted for inflation and seasonality. When needed, series from different sources are spliced to have a longer time span.

Tracking House Prices: OFHEO/FHFA versus Case-Shiller

It has been argued that the house prices reported by the Federal Housing Finance Agency (FHFA), and formerly by the Office of Federal Housing Enterprise Oversight (OFHEO), underestimate the real drop in prices that started in the latter half of 2007 in the U.S. as another commonly-used index, S&P/Case-Shiller, suggests that a sharper correction in house prices has taken place. We present a simple calculation using Home Mortgage Disclosure Act (HMDA) database that indeed shows that recalculating the OFHEO/FHFA national index based on state-level mortgage origination weights brings this index much closer to the Case-Shiller index.

The idea behind using state weights based on mortgage originations stems from the fact that many issues at the fore of policy discussions such as mortgage restructuring and implications of negative equity depend crucially on where the decline in house prices is larger. For instance, if house prices are stable or increasing in some states where only a small portion of overall loans have been originated but they decline sharply in others where large number of loans have been originated, an indicator that tracks the median or equally-weighted house prices would underestimate the size of the problem. Hence, a national house price index should put weights on state-level house prices based on recent mortgage originations.

It should be noted that, despite their differences as indicators of house price changes, both the original and the *recalculated* OFHEO/FHFA house price indices have value, which can be put into context as stock versus flow concepts. While the weighting with mortgage originations matters as it dictates the number of households in negative equity due to price rises and falls, the original index serves as a measure of the gross housing wealth position across the country.

First, some brief background on the sources of differences between the two indices is due. While both OFHEO/FHFA and Case-Shiller concentrate on single-family homes and use the repeat-sales methodology, major differences in data coverage and computation remain. In particular, OFHEO/FHFA's national index has a broader geographical coverage than Case-Shiller national home price index. Case-Shiller does not cover 13 states and has only incomplete coverage for another 29 states.[23,24] Additionally, OFHEO/FHFA index includes refinance appraisals while Case-Shiller considers purchases only. Moreover, OFHEO/FHFA index is based on conforming mortgage loans, and hence (at least in theory), does not take

[23] The states for which no data are available for use in constructing the Case-Shiller national index are Alabama, Alaska, Idaho, Indiana, Maine, Mississippi, Montana, North Dakota, South Carolina, South Dakota, West Virginia, Wisconsin, and Wyoming.

[24] The states where only partial coverage is available for use in constructing the Case-Shiller national index are Arizona, Arkansas, California, Colorado, Delaware, Florida, Georgia, Iowa, Illinois, Kansas, Kentucky, Louisiana, Michigan, Minnesota, Missouri, Nebraska, Nevada, New Mexico, New York, North Carolina, Ohio, Oklahoma, Oregon, Pennsylvania, Tennessee, Texas, Utah, Virginia, and Washington.

into account jumbo and (most of) non-prime loans.[25] Finally, OFHEO/FHFA index gives equal weight to each home valuation while Case-Shiller applies a weighting system in which a home's effect on the index is proportional to its value.

In order to reconstruct the OFHEO/FHFA index using state weights, from 1996 to 2007, we first calculate the number of originated loans in each state base don HMDA data. We distinguish between loans that were originated for home purchase versus those that were originated for refinancing purposes. Then, we use the state's share of originations as weights to calculate a national index. These calculations leave us with the following pictures.

Year-on-year decline in house prices are recorded to be sharpest by the Case-Shiller index, yet the *recalculated* OFHEO/FHFA index comes close to that and shows a considerable decline in 2007 while the original OFHEO/FHFA national index still records a small but positive change in house prices. Hence, taking which states the households that are most likely to be affected by house price changes are located into account makes a crucial difference. Discussions on policies to address mortgage market problems should perhaps consider this when it comes to tracking house prices.

[25] To address the discrepancy with the Case-Shiller index related to this impact, OFHEO/FHFA started publishing a purchase-only index in addition to its original index in 2007. We show both OFHEO/FHFA indices.