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Real House Prices in OECD Countries: The Role of Demand Shocks and Structural and Policy Factors

Dan Andrews

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ABSTRACT/RESUMÉ

Real house prices in OECD countries: the role of demand shocks and structural and policy factors

This paper analyses the factors influencing the level and volatility of real house prices in a panel of OECD countries over the period 1980-2005. Results suggest that real house prices tend to rise proportionally with real household incomes, while declines in structural unemployment and real interest rates are associated with higher real house prices. The process of mortgage market deregulation has coincided with a noticeable increase in real house prices in OECD countries, while high rates of leverage are found to amplify house price volatility. Estimates suggest that tax reliefs on mortgage debt financing costs tend to be capitalised into real house prices and may also amplify price volatility, reflecting the tendency for such policies to encourage leverage. While higher transaction costs are associated with lower house price volatility, this effect is modest compared to the impact of banking supervision. Indeed, prudential banking supervision and policies designed to contain the excessive build-up of leverage are shown to significantly reduce the extent of house price volatility, underscoring the importance of ongoing efforts to reform prudential frameworks in OECD countries.

JEL classification codes: R21; R31; G21; H24.
Keywords: Housing markets; house prices; mortgage markets; financial regulation; taxation.

++++++++++

Prix réels des logements dans les pays de l'OCDE : Le rôle des chocs sur la demande et des facteurs structurels et politiques

Ce document analyse les facteurs qui influencent le niveau et la volatilité des prix réels des logements dans un panel de pays de l'OCDE sur la période 1980-2005. Les résultats suggèrent que les prix réels des logements ont tendance à augmenter proportionnellement avec les revenus réels des ménages, alors que les baisses du chômage structurel et de taux d'intérêt réels sont associées à la hausse des prix réels des logements. Le processus de déréglementation du marché hypothécaire a coïncidé avec une hausse notable des prix réels des logements dans les pays de l'OCDE, tandis que les taux d'endettement élevés ont amplifié la volatilité des prix. Les estimations suggèrent que les allégements fiscaux sur les coûts de la dette hypothécaire de financement ont tendance à être capitalisées dans les prix réels des logements et peuvent amplifier la volatilité des prix, reflétant la tendance de ces politiques à encourager un effet de levier. Bien que les coûts de transaction plus élevés se sont associés à la volatilité des prix, cet effet est modeste par rapport à l'impact de la supervision bancaire. En effet, un contrôle prudentiel des banques et des politiques visant à contenir l'accumulation excessive de l'effet de levier réduisent d'une façon significative la volatilité des prix des logements, ce qui souligne l'importance des efforts en cours pour réformer les structures prudentielles dans les pays de l'OCDE.

Classification JEL : R21 ; R31 ; G21 ; H24.
Mots-clés : Marché du logement ; Prix des logements ; marchés hypothécaires ; réglementation financière ; fiscalité.

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REAL HOUSE PRICES IN OECD COUNTRIES – THE ROLE OF DEMAND SHOCKS AND STRUCTURAL AND POLICY FACTORS

By Dan Andrews[1]

1. Introduction and main findings

1. Public policy interventions in housing markets in OECD countries are widespread. A key question is the extent to which these policies achieve their desired objectives and whether there are any unintended consequences. The main aim of this paper is to consider the impact of housing supply rigidities, tax relief on mortgage debt financing and transaction costs on real house prices. In doing this, the empirical analysis first aims at understanding the drivers of real house prices controlling for macroeconomic factors and housing demand shocks. The second part of the paper analyses empirically the impact of structural and policy features on house price volatility. The approach – which is cross-country in nature – highlights that existing housing policy institutions in some OECD countries can give rise to unintended consequences, on the level and volatility of house prices.

2. The main findings:

Real house prices

- Demographic developments influence the demand for housing. Indeed, estimates show that increases in population stemming from net migration raise real house prices.

- General macroeconomic factors are also found to be important determinants of housing demand and, in turn, real house prices. More specifically, prices tend to increase with gains in households' disposable income: the elasticity of real house prices with respect to disposable income is close to unity. Furthermore, reductions in real interest rates and structural unemployment (*i.e.* the NAIRU) – the latter which may proxy for lower uncertainty surrounding households' future income prospects – are found to increase house prices.

- Over recent decades financial deregulation and mortgage innovations in OECD countries have been associated with a noticeable increase in the effective demand for housing and, thus, real house prices.

- As to be expected, a low price responsiveness of new housing supply has tended to exacerbate the price effect of housing demand shocks (*e.g.* financial and labour market and population shocks). In rigid supply environments, increases in housing demand are much more likely to be capitalised into house prices than to translate into increases in the quantity of housing.

[1] Corresponding author: Dan Andrews (Dan.Andrews@oecd.org) at the OECD Economics Department.The author would like to thank Aida Caldera-Sanchez, Jørgen Elmeskov, Åsa Johansson, Jeremy Lawson, Giuseppe Nicoletti and Jean-Luc Schneider for their valuable comments and Catherine Chapuis for excellent statistical work as well as Irene Sinha for excellent editorial support. The views expressed in this paper are those of the authors and do not necessarily reflect those of the OECD or its member countries.

- Housing taxation varies across countries, although in general owner-occupied housing has favourable tax treatment relative to other forms of investment in many countries. Such generous tax treatment can have adverse effects on housing and other markets by distorting investment and tenure choice. For example, estimates show that tax relief on mortgage debt financing cost tends to be capitalised into real house prices.

Real house price volatility

- House price volatility tends to be higher in environments characterised by high rates of leverage (proxied by statutory ceilings on the loan-to-value (LTV) ratio). There is also some evidence that more generous tax relief on mortgage debt financing costs amplifies volatility, possibly reflecting the tendency for such policies to encourage leverage.

- By contrast, a more responsive housing supply reduces real house price volatility. Volatility has also been less in countries with greater transaction costs in property markets, perhaps because such costs reduce the gains from speculative trade. Effective prudential banking supervision can also significantly reduce the degree of house price variability, and the magnitude of this effect appears to be larger than the impact of other structural and policy factors, such as a more responsive supply side, higher transaction costs and a less generous tax relief on mortgage debt financing.

3. The paper is structured as follows. Section 2 introduces the three main structural and policy factors analysed in the paper, and discusses their possible impacts on real house prices and house price volatility. Section 3 presents a model of real house prices, with special focus on the influence of supply side responsiveness, tax policies and demand shocks. Section 4 analyses the determinants of real house price volatility, considering many of the same factors considered in Section 3 plus the role of transaction costs.

2. Structural and Policy Factors

4. While house prices are likely to be influenced by a number of structural and policy factors, the paper focuses on three key factors – price responsiveness of new housing supply, tax relief for mortgage debt financing and transaction costs – which are discussed in turn. The details of the supply responsiveness estimates are available in Caldera Sanchez and Johansson (2010), while the tax relief and transactions costs indicators are based on information from the OECD housing market questionnaire which covers 33 OECD countries (Johansson 2010).

Supply responsiveness

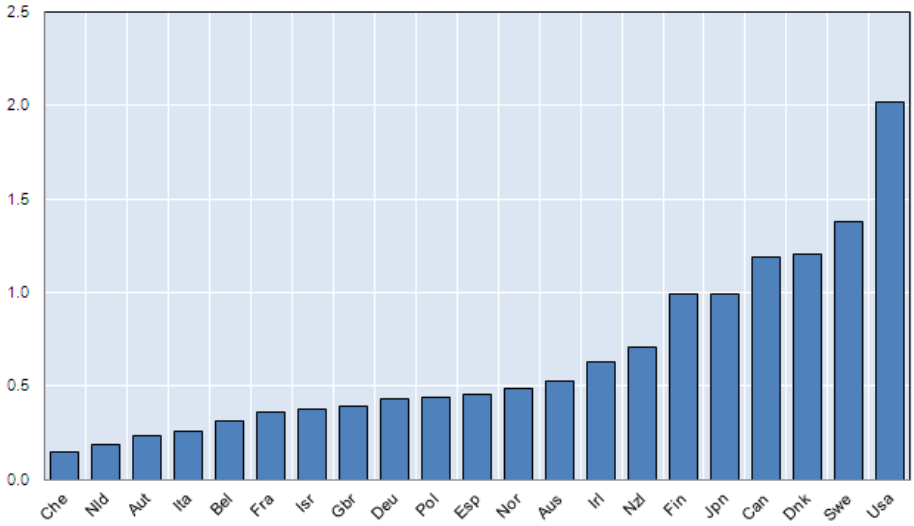
5. A crucial factor determining the functioning of housing markets is the responsiveness of new housing supply to changes in price signals. Differences in supply conditions are important since they determine the extent to which increases in demand for housing results in higher prices. In supply-constrained markets, most of the adjustment occurs in the price of housing, rather than in expanding its supply (Glaeser *et al*. 2008; Gyourko, 2009). Housing supply responsiveness may also influence the volatility of house prices in the presence of large demand shocks (Catte *et al*. 2004).

6. Despite its importance, very little cross-country empirical evidence exists on such supply responsiveness, partly reflecting data constraints. OECD estimates of the long-run price responsiveness (elasticity) of new housing supply for some 20 countries, based on a stock-flow model of the housing sector estimated in an error correction framework, show that housing responsiveness varies substantially across countries (Figure 1). Housing supply tends to be relatively flexible in North America and some

Nordic countries, while it is more rigid in continental European countries and in the United Kingdom. Cross-country differences in new housing supply responsiveness are likely to reflect a variety of factors. While the housing supply responsiveness tends to be lower in countries with a higher population density, public policies – such as zoning and land-use regulations – have also been shown to affect supply responsiveness (Gyourko, 2009; Caldera Sanchez and Johansson 2010).

Figure 1. Price responsiveness of housing supply: selected countries

Estimates of the long-run price-elasticity of new housing supply[1]



1. Estimates of the long-run price elasticity of new housing supply where new supply is measured by residential investments (i.e. the coefficient on lagged prices in the long-run investment equation as reported in Table 1, of Caldera Sanchez and Johansson 2010). Estimation is based on a system of two equations which model the demand and supply of housing in an error correction framework. All elasticities are significant at least at the 10% level. In the case of Spain, restricting the sample to the period 1995-2007, which would reflect recent developments in housing markets (such as the large stock of unsold houses resulting from the construction boom starting in 2000 and peaking in 2007-09), only slightly increases the estimate of the elasticity of housing supply from 0.45 to 0.58. Estimation period is early 1980s to early/mid-2000s. See Caldera Sanchez and Johansson (2010) for details.

Tax relief on mortgage debt financing

7. Existing tax arrangements in OECD countries tend to favour housing over other investments. The tax favouring tends to arise because while mortgage interest is tax deductible in many OECD countries, few countries tax imputed rent and those that do often substantially under-estimate the rental value.[2] Moreover, while property tax is often viewed as a substitute for taxation of imputed rent, the magnitude of the tax is rarely sufficient to offset the subsidy provided by mortgage interest deductibility.

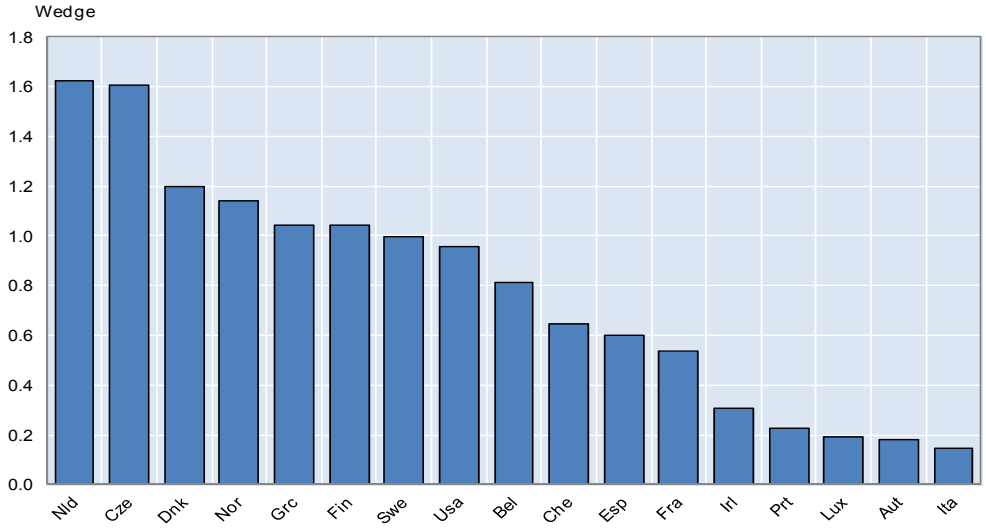
8. The difference between the market interest rate and the debt financing cost of housing (the after tax interest rate) provides one indicator of the extent to which the tax system favours owner-occupied housing with respect to debt financing. This indicator takes into account whether interest payments on mortgages are deductible from taxable income and, if so, any limits on the allowed period of deduction or the deductible amount and whether tax credits for loans are available (see Johansson 2010). While this simplified measure is imperfect, it nevertheless provides a useful indication of the extent to which housing investment is tax advantaged since households generally finance their house purchase with debt. The specific focus on tax relief to debt financing is also appropriate, given the important changes that have taken place in mortgage markets in OECD countries over recent decades. According to this indicator, the

2 For a discussion on housing taxation, see Andrews, Caldera Sanchez and Johansson (2010).

tax relief on debt financing cost is most generous in the Netherlands and effectively zero in countries where mortgage loans are not tax favoured (Figure 2).

Figure 2. Tax relief on debt financing cost of homeownership[1], 2009

Wedge increasing in the degree of tax relief



1. This indicator takes into account if interest payments on mortgage debt are deductible from taxable income and if there are any limits on the allowed period of deduction or the deductible amount, and if tax credits for loans are available (see Johansson 2010 for details). For countries that have no tax relief on debt financing costs, this indicator takes the value of zero.

Source: Calculations based on OECD Housing Market questionnaire. See Johansson (2010) for details.

9. Existing literature highlights the potential for housing tax policies, such as the mortgage interest deduction, to be capitalised into house prices (Capozza *et al* 1996; Harris, 2010). There also tends to be a consensus that tax relief on mortgage debt financing encourages households (particularly those with high incomes) to hold more debt than otherwise (Hendershott *et al.* 2002) and possibly engage in speculative property investment, which may amplify house price variability (Catte *et al.* 2004; Ellis, 2008). The house price capitalisation arising from mortgage interest deductibility can also have important distributional consequences. The results from Bourassa and Yin (2007), based on detailed household-level data, suggest that current mortgage interest deductibility arrangements in the United States reduce the homeownership rates amongst younger urban households, through the reduction in affordability associated with higher home prices.[3]

Transaction costs

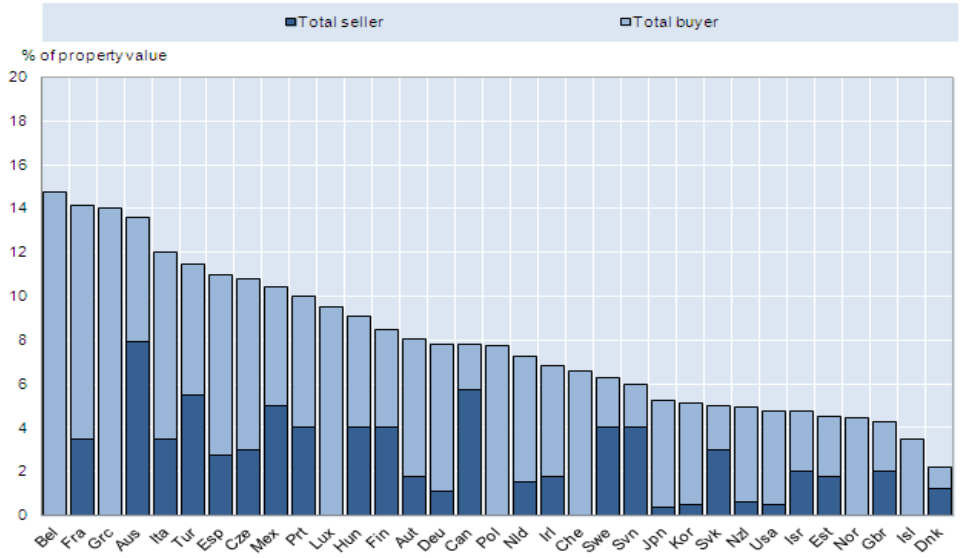
10. Housing transaction costs differ considerably across countries. These include a number of different types of costs and fees, such as transfer taxes (*e.g.* stamp duties, acquisition taxes etc.), registration fees incurred when registering the property in the land registry and notarial or other legal fees (see Johansson 2010 for details), as well as typical real estate agency fees. Among the countries surveyed through the housing market questionnaire, these costs range from around 15% of property value in Belgium to below 4% in Iceland and Denmark (Figure 3).

3 However, it is difficult to establish whether the resulting in decline in homeownership is a permanent or temporary phenomenon.

11. The impact of transaction costs on the price level is unclear, but there is suggestive – cross-country – evidence that higher transaction costs are negatively related to real house price variability (Catte *et al*. 2004). While this might suggest a role for higher transaction costs in discouraging speculative behaviour (which may, in turn, amplify price variability), Catte *et al.* (2004) noted that reliable data on transaction costs were available for too few countries for the relationship to be regarded as robust. Armed with a new measure of transaction costs, this hypothesis is revisited for a broader set of countries in Section 4.

Figure 3. Transaction costs[1], 2009

Transaction costs on buyer and seller



1. Transaction costs refer to average costs. See Johansson (2010) for details. The estimates do not take into account the various tax breaks that exist in countries for certain dwellings implying that the estimated cost may overestimate the actual cost in some countries, in particular in Italy, where such tax breaks are frequent.

Source: Calculations based on OECD Housing Market questionnaire. See Johansson (2010) for details.

3. Real House Prices

12. A key aim of this section is to assess the impact of structural and policy factors on real house prices. Real house prices are important from an efficiency and distributional point of view, since housing costs comprise a non-trivial proportion of the average household's budget in OECD countries (see Andrews *et al* 2010).

13. Much of the recent literature on house prices in OECD countries has taken a single country approach and has often been interested in the role of cyclical factors and assessing the degree of over-valuation. While this approach has obvious appeal, much less is understood on how cross-country differences in structural and policy factors influence real house prices in the medium to longer run. Accordingly, a cross-country panel framework is adopted to assess the impact on average house prices of structural housing market characteristics, such as price responsiveness of new housing supply and tax relief on debt financing costs. While the results are often discussed in the context of the owner-occupied sector, the model takes into account the demand and supply for all dwellings and, thus, also applies to the rental sector. The estimation also controls for rental costs, to take into account the "relative cost" of different tenures.

14. The empirical approach in this paper is broadly consistent with the stock-flow framework. Following Meen (2002), house prices are modelled in the form of an inverted demand curve that takes into account a number of demand shifters (including policies) and the stock of housing. Controlling for the latter is important since disregarding the housing stock would assume that the supply of housing is perfectly elastic and adapts to demand in the long run. Since structural housing market characteristics and policies are only measured at a single point in time, it is not possible – in the cross-country panel framework – to identify their direct effect on outcomes. Instead, the impact of structural factors is identified indirectly through their interaction with demand shocks. In order to generalise the results, a range of potentially important demand shocks are considered – including shocks to the mortgage and labour markets as well as shifts in the population. Insofar as these interaction effects are significant, consistent with prior expectations and robust across different kinds of demand shocks, the results are also likely to provide a good indication of the qualitative effect of policies.

Demand Shocks

15. While there are a number of demand influences on real house prices, three main demand shocks – mortgage market deregulation, changes in labour market conditions and migration shocks – are now discussed in turn. These shocks are chosen on the basis of relevance but also more practical data limitations.

Mortgage market deregulation

16. Given that owner-occupied housing constitutes a household's single largest financial outlay, and generally requires debt financing, developments in housing markets cannot be analysed without reference to the characteristics of housing finance markets. In most countries, this market has changed drastically over recent decades, reflecting a wave of financial deregulation which was initially triggered by the increases in fiscal deficits and emergence of inflationary problems in the 1970s, which increased the need for interest rate flexibility (Edey and Hviding, 1995).[4] While these changes have had important economy-wide effects, they promoted greater competition in mortgage markets which, in turn, significantly lowered borrowing costs (including net interest margins) and have resulted in a substantial expansion in the supply of mortgage loans in many countries (ECB, 2009a; Ellis, 2006). These trends were reinforced by technological advances in communications equipment and data processing, which reduced the transaction costs associated with mortgage lending.[5] Taken together, these factors significantly increased borrowers' capacity to pay for housing at any given level of income and the policy interest rate (Ellis, 2006).

17. To the extent that housing consumption in OECD countries was below its "equilibrium level" during the regulated era, it was natural to expect demand for housing – and, thus, real house prices – to rise once these constraints were removed (Ellis and Andrews, 2001). It is likely, however, that this transition to the new deregulated equilibrium is being influenced by structural and housing market features. Recent empirical evidence for the United States shows that the relaxation of interstate banking regulations had a considerably lesser effect on house prices in counties with more elastic housing supply (Favara and Imbs, 2009). Moreover, the benefits of financial deregulation might more likely be capitalised into house prices in environments where tax relief on mortgage debt financing is generous. For example, Rouwendal (2007) partly attributes the rapid growth in house prices over recent decades in the Netherlands – a country with

[4] The shift to more market-oriented financial systems was also triggered by increasing regulatory avoidance (*e.g.* the development of offshore financial centres), the tendency for banks and other regulated institutions to lose business to the less regulated parts of the financial sector and financial innovation and rapid technological development, which made it progressively easier to circumvent regulations (Edey and Hviding, 1995).

[5] These costs are typically high given the information-intensive nature of the industry. For instance, lenders must exert considerable effort to learn about the credit quality of a borrower and the value of collateral.

particularly generous tax relief (see Figure 2) – to the interaction of mortgage market innovation with very generous mortgage interest deductibility arrangements.

18. While many country-specific studies have emphasised the role of mortgage market deregulation in boosting real house prices (see Favara and Imbs, 2009), there is considerably less formal analysis of this issue in the cross-country setting. This partly reflects data limitations since many cross-country indicators of financial deregulation are purely cross-sectional and, in the event that they possess a sufficient time dimension, are likely to be endogenous to housing market developments (*e.g.* mortgage debt to GDP).

19. The recent release of indicators capturing the timing and extent of reforms to the financial sector provide a useful source of (exogenous) variation to identify the impact of mortgage market deregulation on house prices. Abiad, Detragiache and Tressel (2008) constructed a Financial Reform Index, based on the timing of the removal of: credit and interest rate controls and "excessively high" reserve requirements, entry barriers, state ownership in the banking sector, capital account restrictions and securities market policy. While this index provides only a very broad measure of the timing of financial reform until the mid-2000s, it nonetheless captures policy changes which allowed for greater competition in mortgage markets. While all OECD countries have liberalised their financial sectors over recent decades, the index shows considerable variation in the timing of reform and the extent to which the financial sector was regulated in the earlier period (Figure 4).

20. Another key indicator of the ability of mortgage markets to provide access to housing finance is the maximum LTV ratio, though the time series dimension tends to be less complete when compared to the Financial Reform Index. The maximum LTV ratio has risen in many OECD countries over recent decades, though important cross-country differences remain (See Table A1).[6] As discussed in Andrews and Caldera Sanchez (2010), LTVs capture the down-payment constraint which is particularly relevant for the marginal buyer, such as younger, financially-constrained households, who may struggle to accumulate a deposit. LTVs may also provide an indication of the extent of leverage in the household sector.

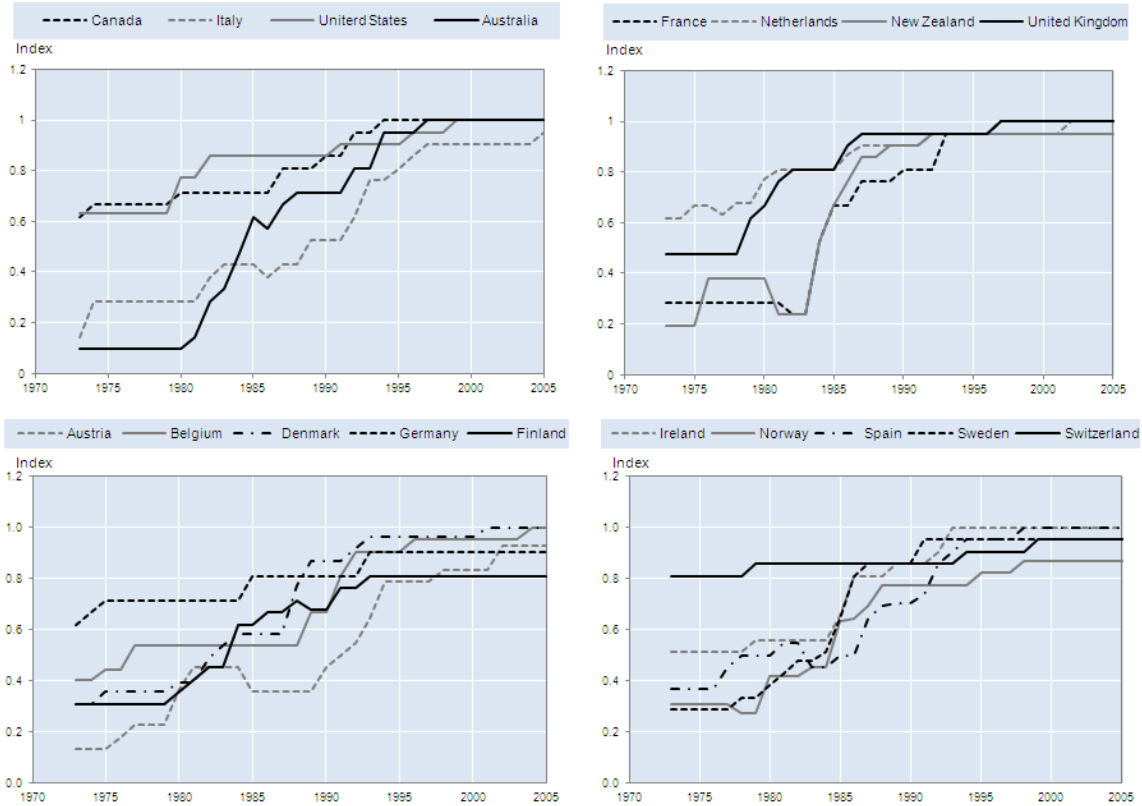
Labour market shocks

21. Developments in conditions influencing a household's degree of financial certainty and/or confidence are also likely to affect housing demand and house prices. For instance, reductions in structural unemployment – proxied by OECD estimates of the non-accelerating inflation rate of unemployment (NAIRU) – may add to housing demand as lower unemployment increases consumer confidence, reduces income uncertainty and increases the pool of potential homebuyers. While labour market shocks are likely to have a less direct impact on housing markets than mortgage market deregulation, previous studies have, nonetheless, found unemployment to be negatively related to house prices (see Abelson *et al*. 2005; Jacobsen and Naug, 2005; Schnure, 2005). It is also likely that the impact of labour market shocks on real house prices will be influenced by structural and housing market features. For instance, greater job security may encourage households to take out more mortgage debt – which could inflate house prices – and tax systems that provide a greater subsidy to mortgage debt financing may amplify this effect.

[6] For instance, regulatory ceilings on LTV ratios have tended to be particularly binding in Germany, while in other countries LTVs are effectively capped by lengthy legal procedures in the event of default (Catte *et al.* 2004).

Figure 4. Index of financial reform: selected countries[1]

Increasing in reform



1. The index is based on the timing of the removal of: credit and interest rate controls and "excessively high" reserve requirements, entry barriers, state ownership in the banking sector, capital account restrictions and securities market policy.

Source: Abiad *et al.* (2008).

Demographic shocks

22. Strong population growth – often underpinned by high immigration inflows – has been one factor behind rapid house price growth observed in OECD countries, such as Ireland and Spain in the early 2000s (Miles and Pillonca, 2008) and more recently in Australia (Ellis, 2010). Gonzalez and Ortega (2009) show that one-third of the run-up in Spanish house prices between 1998 and 2008 can be accounted for by immigration flows, while immigration flows have been an important determinant of house prices in countries which have experienced more modest house price growth, such as Switzerland (Degen and Fisher, 2009). The impact of immigration shocks on real house prices is likely to be greater in environments where housing supply is less responsive, although the extent to which these effects will be long-lasting is unclear, since immigration may also expand the supply side of the economy.[7]

23. In practice, estimating the relationship between migration flows and house prices is complicated by a number of factors. For example, a potentially spurious positive correlation between immigration and house prices could arise if both immigration flows and house prices are driven by unobserved factors, such as expectations of future economic growth. On the other hand, the relationship between immigration and

7 For instance, over the past decade many immigrants to Spain have been employed in the construction sector (see Gonzalez and Ortega, 2009).

house prices could be biased downwards if migrants are sensitive to housing costs and move to areas with cheaper housing. While these concerns are difficult to address in the cross-country panel framework employed in this paper, some attempt is made by controlling for macroeconomic factors and relating current house prices to lagged immigration flows.

Identification Framework

24. The econometric approach tests the extent to which structural housing market factors influence the propagation of housing demand shocks onto real house prices. This choice is driven by the fact that data on structural housing market features are only available at a single point in time. To the extent that a conventional fixed effects panel estimator is employed in the estimation to control for potentially important time-invariant omitted factors, the direct impact of the policy will be subsumed in the country-fixed effects. While a random effects model could potentially exploit the cross-country variation in the data, if the country-specific effects are correlated with other right hand variables, the random effects model will be inconsistent. The Hausman test rejects the random effects model in favour of fixed effects, which is perhaps not surprising since there is likely to be some country-specific element to housing policies.

25. The full model is set out by equation (1), which estimates a long-run relationship between the real house prices (HP), and their potential determinants, in the form of an inverted demand function.[8]

$$HP_{i,t} = \alpha + \beta_1 IR_{i,t-1} + \beta_2 IR_{i,t-1} * Bankreg_i + \beta_3 FinD_{i,t-1} + \sum_j \beta_4^j FinD_{i,t-1} * Structuralfactor_i^j$$
$$+ \beta_5 NAIRU_{i,t-1} + \sum_j \beta_6^j NAIRU_{i,t-1} * Structuralfactor_i^j + \beta_7 Mig_{i,t-1} + \sum_j \beta_8^j Mig_{i,t-1} * Structuralfactor_i^j$$
$$+ \beta_9 Inc_{i,t-1} + \sum_K \beta_{10}^K Z_{i,t-1}^K + \rho_i + \eta_t + \varepsilon_{i,t}$$
[1]

where *i* denotes country and *t* year.

26. The considered demand shocks include an index of financial reforms (FinD), structural unemployment, proxied by the NAIRU, and migration rates, measured by net migration (Mig). The impact of these demand shocks varies depending on time invariant country-specific structural housing markets factors ($Structuralfactor_i^j$), such as the price responsiveness of new housing supply or tax relief on mortgage debt financing costs. The total impact of a considered demand shock, such as financial reform, on house prices is given by ($\beta_3 + \beta_4^j * Structuralfactor_i^j$).

27. The empirical framework also allows the impact of the real interest rate (IR) on real house prices to vary with the country-specific banking regulation ($Bankreg_i$), which is captured by a time invariant index of banking regulations that increases in the degree of regulation.

28. Equation (1) also controls for real household disposable income (Inc), while the variables Z^K control for real construction costs, real rental costs, the dwelling stock, consumer price inflation and the natural increase in the population. The model includes country-fixed effects (ρ), as well as time-fixed effects (η) to control for common global shocks, such as the decline in macroeconomic risk. To reduce the potential for endogeneity problems, the explanatory variables are included with a one-year lag. All

8 To the extent that many of the variables are I(1), the base model was re-estimated in an error-correction framework and the estimated coefficient on the convergence term was significant and negative, suggesting that a co-integrating relationship exists between the variables in the estimations.

variables are expressed in natural logarithms, except for the financial reform index, NAIRU and policy interaction terms.

29. The standard errors are clustered at the country level in order to allow for an arbitrary variance-covariance matrix within each country. According to Bertrand *et al.* (2004), this is analogous to applying a Newey-West correction (Newey and West, 1987) in a panel context. While the findings of Bertrand *et al.* (2004) suggest that these cluster-robust standard errors are reasonably reliable given the number of countries in the sample (N=19), models (see column 2 of Table 2) are also estimated using Stock and Watson's (1993) dynamic OLS (DOLS) estimator to control for sample serial correlation and endogeneity. The DOLS estimator essentially augments equation (1) with lags and leads changes (first differences) of the explanatory variables. The DOLS estimates in this paper employ two lags and leads. Estimation was also performed using three-year annual averages to further reduce the impact of serial correlation on the standard errors, but these results are not shown for sake of brevity.[9]

Data

30. Real house prices are inflation adjusted nominal prices sourced from the OECD Economic Outlook and from national sources. Most of the macroeconomic data is sourced from the OECD Economic Outlook including the real long term interest rate, real household disposable income and consumer price inflation.[10] Real construction cost and real rents are sourced from the OECD Main Economic Indicators and national sources. The stock of housing is the total number of dwellings in a given country sourced from the United Nations Economic Commission for Europe (UNECE) and national sources. The index of banking regulation measures anticompetitive regulations in banking and takes into account regulatory barriers on domestic and foreign entry, restrictions on banking activities and the extent of government ownership and is taken from de Serres *et al.* (2007). The sources for the three structural housing market factors are described in Section 2. The demand shocks are, as described in section 3, the Financial Reform Index sourced from Abiad *et al.* (2008), structural unemployment proxied by NAIRU sourced from OECD Economic Outlook. The immigration and natural increase in the population data are sourced from the OECD Population and Vital Statistics.

31. While data on house prices and key macroeconomic determinants (*e.g.* income and interest rates) are published on a quarterly basis, the Financial Reform Index is only available annually. Accordingly, the econometric specifications are estimated using data at the annual frequency. The sample includes up to 19 OECD countries (depending on the specification) over the period *circa* 1980-2005. Given that the estimation is based on relatively short time series and that adjustment in housing markets takes a long time, the results should be interpreted as shorter-to-medium run effects.

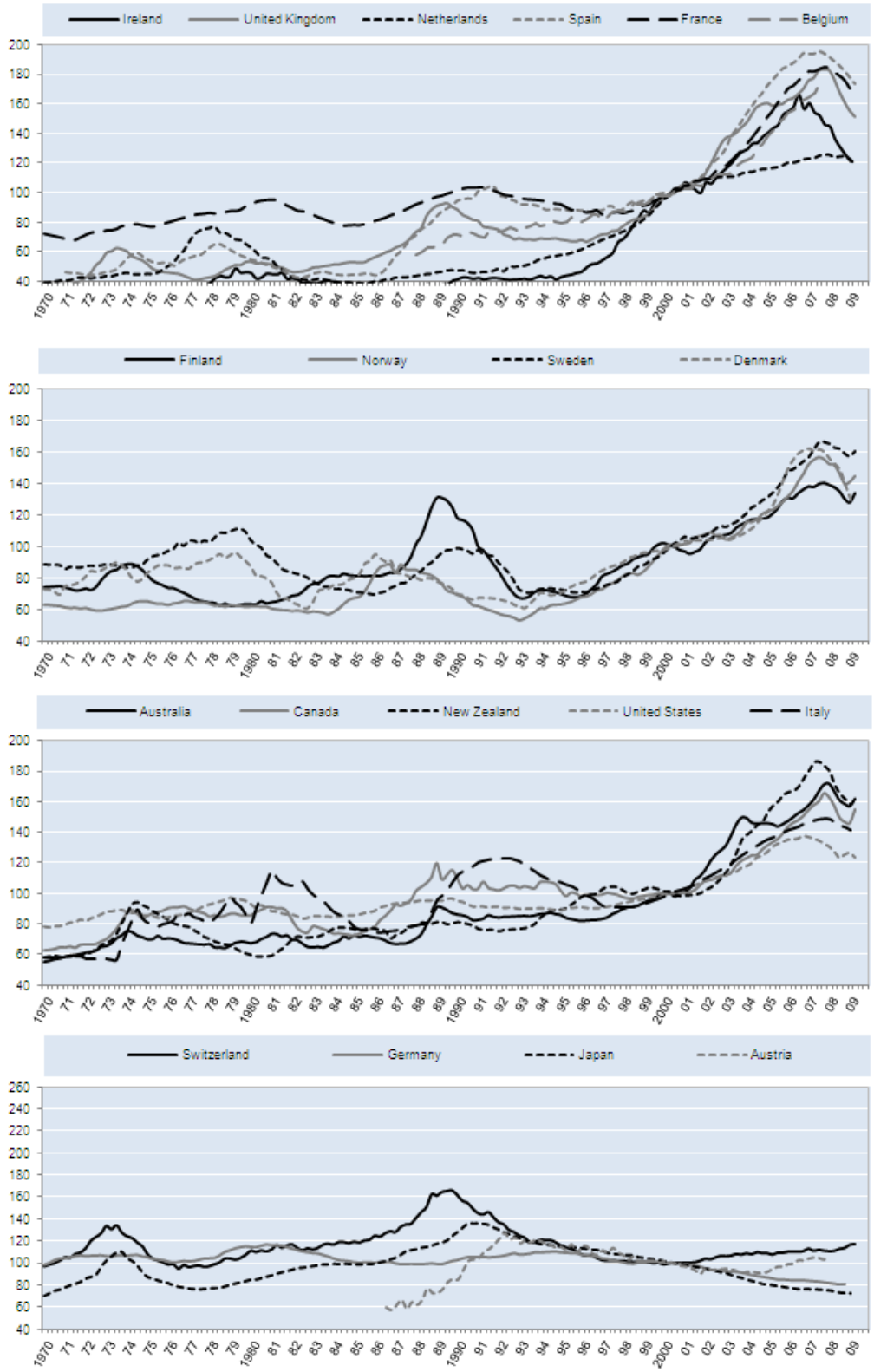
32. Figure 5 plots the evolution of real house prices over the sample period for the OECD countries included in the analysis. These data suggest that real house prices rose strongly in a majority of OECD countries since the mid-1980s. In several countries, prices have increased by more than 90% since the early 1980s (*e.g.* Ireland, Spain, the United Kingdom, the Netherlands, Belgium etc.), while in a few countries real house prices remained stable or even decreased (*e.g.* Japan, Switzerland and Germany etc.).

9 These results are broadly similar and are available on request.

10 The real long term interest rate is measured by the long term interest rate on government bonds deflated by the private consumption deflator.

Figure 5. Real house prices over time

Nominal prices deflated by the consumer price index, index, 2000=100



Sources: National sources and OECD Economic Outlook No. 87.

Empirical Results

Macroeconomic factors

33. Before discussing the influence of demand shocks and structural and policy factors on real house prices, there are a number of other important variables worthy of note. General macroeconomic factors are important in explaining demand for housing and, in turn, real house prices. House prices tend to increase with households' disposable income as income growth generates more demand for housing and drives up land and, thus, house prices (ECB, 2003). Indeed, cross-country panel estimation shows that, in the longrun, the elasticity of real house prices with respect to real household disposable income is close to unity (Table 1).

34. While there is some evidence that increases in consumer price inflation tend to boost real house prices, this effect becomes insignificant in later specifications (Table 1). To some extent, this result is unsurprising, given that the impact of inflation on house prices could go either way. On the one hand, since mortgage debt is extended in nominal terms, higher inflation may increase the longer term attractiveness of housing debt to the extent that it erodes the real value of mortgage debt over time.[11] On the other hand, since financial institutions usually impose lending limits based on repayment ratios, lower inflation will imply lower nominal interest rates which will increase the maximum amount a financial institution will lend to the household (Stevens, 1997).[12]

35. Real construction costs are also an important determinant of real house prices. The estimates suggest that a 10% rise in construction costs is associated with a 4% increase in real house prices. While real rental costs and the dwelling stock are not significant, these variables are retained as control variables for the theoretical reasons outlined above.

36. Real interest rates are, on average, negatively related to house prices, but the interaction term allows the impact of interest rates to vary with the degree of competition in a country's banking sector, which is proxied by the time-invariant measure of banking regulation drawn from de Serres *et al.* (2007). Overall, results suggest that a decline in real interest rates increases house prices, though less so in countries with more strict banking regulation. This result is consistent with the idea that in countries where there is less competition in the banking sector, financial institutions may pass through less of a given decline in the policy rate to the mortgage rates. This interpretation receives some support from the specification in column 2 of Table 1, which suggests that a decline in net interest margins in the banking sector – which may proxy for increased competition – is associated with higher house prices.[13] This specification is not preferred, however, since net interest margins may be influenced by cyclical factors (such as credit risk, risk aversion and interest rate volatility; see Hawtrey and Liang, 2008) and their inclusion results in a non-trivial reduction in the sample size.

37. While the long-term interest rate is likely to be the most relevant in instances where fixed rate mortgages predominate, in countries where the vast majority of mortgages are financed at variable rates (such as Australia and the United Kingdom), house price developments might be more sensitive to the short-term interest rate (see Appendix 1). To account for this, the specification in column 3 of Table 1

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11 Under a high inflation regime, however, the repayment burden is also more front-loaded, which may make liquidity constraints more binding. While Poterba (1984) suggests that the interaction between inflation and mortgage interest deductibility could have explained the strong growth in US house prices during the 1970s, there is no evidence that the impact of inflation on house prices varies with the presence of mortgage interest deductibility in our sample.

12 Financial institutions traditionally determined the amount they would lend to borrowers based on a repayment ratio – the ratio of the initial required mortgage payment to the borrower's disposable income.

13 The net interest margins data are sourced from the OECD Bank Profitability Statistics.

includes a composite interest rate measure where the long- and short-term interest rates are weighted by the share of fixed and variable rate loans. The results are qualitatively similar to those reported in column 1 – declines in real interest rates are associated with increases in house prices but less so in countries where there is less competition in the banking sector. The results are also robust to measuring interest rates in nominal terms.

Table 1. Panel estimation of (log) real house prices: base model

Annual data over circa 1980-2005

	Fixed effects		
	(1)	(2)	(3)
Log of real household disposable income	1.157**	1.315**	0.996*
	[0.499]	[0.498]	[0.492]
Log of long term interest rate	-0.334**	-0.056**	..
	[0.126]	[0.025]	..
Log of long term interest rate x Index of banking regulation	0.155**	..	..
	[0.058]	..	..
Log of net interest margins	..	-0.297*	..
	..	[0.148]	..
Log of weighted interest rate	..	..	-0.200**
	..	..	[0.070]
Log of weighted interest rate x Index of banking regulation	..	..	0.092**
	..	..	[0.035]
Log of real construction costs	0.409***	0.361***	0.406***
	[0.068]	[0.073]	[0.071]
Log of dwelling stock per capita	-0.101	0.177	-0.087
	[0.384]	[0.308]	[0.352]
Log of real rental costs	-0.041	0.002	0.094
	[0.267]	[0.402]	[0.281]
Log of consumer price inflation	0.036	0.041*	0.036
	[0.027]	[0.022]	[0.027]
Log of net migration	0.034	0.016	0.036*
	[0.020]	[0.013]	[0.019]
Log of natural increase of the population	0.01	0.013	0.011
	[0.042]	[0.039]	[0.043]
Constant	-1.802	-4.551	-1.469
	[3.294]	[2.791]	[3.018]
Wald test (p-values)			
H0: Household disposable income coefficient = 1	0.757	0.537	0.994
H0: interest rate coefficients (jointly)=0	0.049**	..	0.0326**
Observations	322	267	315
Number of countries	19	16	19
R-squared	0.82	0.81	0.83

Robust standard errors in brackets, * significant at 10%; ** significant at 5%; *** significant at 1%, country and time fixed effects not shown.

38. Estimates indicate that the impact of interest rates on real house prices is economically small (when banking regulation is at the sample median), which is consistent with previous cross-country panel models of house prices, such as Arnnett (2005). Moreover, this finding survives when additional lags of the real interest rate are included. The relatively small estimated negative impact of real interest rates on house prices reflects the potential interdependence between interest rates and house prices. For instance, a positive correlation between the two variables could be observed in instances where interest rates may respond to innovations in house prices, or when interest rates and house prices have responded simultaneously to economic news. Indeed, recent research which utilises structural vector auto-regression techniques – to allow for a full simultaneity between all asset prices and monetary policy – finds much

larger negative impacts of interest rates on house prices, and also finds evidence that interest rates respond to innovations in house prices (Bjørnland and Jacobsen, 2010). For the demand shocks discussed below, however, simultaneity bias is possibly less of an issue, given that changes in the timing of financial sector reforms and the NAIRU are likely to be exogenous to housing market developments.

Demand shocks

39. To aid the interpretation of the coefficients, Table 2 provides a joint test of significance for each housing demand shock and their interactions with structural factors. It also provides an estimate of the impact of each demand shock when supply responsiveness and tax relief on debt financing cost is set equal to the sample median value. The central estimate in Figure 6 shows the impact of a given change in financial reform (the median rise in the Financial Reform Index between 1980 and 2005) and the NAIRU (a 2 percentage point decline in the structural unemployment rate) on real house prices in the typical OECD country (*i.e*. when supply responsiveness and tax relief is set equal to the sample median value). It is important to note that these figures should be treated as very rough orders of magnitude. These experiments suggest the following:

- The estimates imply that over recent decades financial deregulation has increased real house prices by as much as 30% in the average OECD country (Figure 6). To the extent that housing markets in OECD countries are still adjusting to this shock, however, the long-run impact of financial deregulation on real house prices is likely to be somewhat less. Of course, this is an average effect and the impact of financial deregulation on real house prices in a country such as Australia – which experienced much greater liberalisation over the sample period – is likely to be larger, in the order of 45%.

- Results suggest that a decline in the non-accelerating inflation rate of unemployment (NAIRU) has been associated with an increase in real house prices. The estimates imply that a 2 percentage point decline in the NAIRU – roughly equivalent to sample median change between 1995 and 2005 – increased real house prices in the average OECD country by around 8%. This may reflect a number of mechanisms, including an increase in the pool of potential homebuyers, the expectation of permanent real income gains associated with a better functioning labour market and a decline in perceptions of risk.

40. While long-run equilibrium in the housing market is likely to be influenced by the natural increase in the population, econometric evidence suggests that changes in population growth stemming from increases in net migration tend to have a greater influence on real house prices in the medium term than natural increases (Table 2). This is consistent with the idea that over shorter horizons, the household formation rate – and, thus, the effective demand for housing – is more likely to be influenced by migration patterns. However, the magnitude of this effect is fairly modest and this result is not significant when using alternate econometric specifications, such as DOLS.[14]

[14] To test if the impact of migration on house prices depends on the composition of migrant flows, an interaction term was included to allow the impact of net migration shocks to vary according to the share of a country's immigrants that are tertiary educated. This interaction term, however, is not significant.

Table 2. Panel estimation of (log) real house prices: role of demand shocks and structural housing market features

Annual data over circa 1980-2005

	Fixed effects	Dynamic OLS
	(1)	(2)
Log of long term real interest rate	-0.160**	-0.491*
	[0.075]	[0.261]
Log of long term real interest rate * Index of banking regulation	0.071*	0.230*
	[0.040]	[0.116]
Housing demand shocks and structural features		
Financial reform index	0.603***	0.991***
	[0.174]	[0.236]
Financial reform index x Supply responsiveness	-1.116***	-0.887*
	[0.312]	[0.497]
Financial reform index x Tax relief on housing	0.682**	0.873**
	[0.289]	[0.354]
Non-accelerating inflation rate of unemployment (NAIRU)	-0.038	-0.056
	[0.042]	[0.045]
NAIRU x Supply responsiveness	0.100**	0.116**
	[0.035]	[0.047]
NAIRU x Tax relief on housing	-0.080***	-0.082*
	[0.018]	[0.044]
Log of net migration	0.046**	0.018
	[0.019]	[0.031]
Log of net migration x Supply responsiveness	-0.053*	0.004
	[0.028]	[0.043]
Other variables		
Log of real household disposable income	1.396**	1.198***
	[0.482]	[0.295]
Log of consumer price inflation	0.013	0.002
	[0.018]	[0.038]
Log of real construction costs	0.259***	0.115
	[0.073]	[0.146]
Log of dwelling stock	-0.255	-1.261**
	[0.274]	[0.537]
Log of real rental costs	-1.083***	-1.830***
	[0.287]	[0.399]
Log of natural increase of population	0.015	0.061**
	[0.030]	[0.024]
Constant	3.913	17.493***
	[3.702]	[5.504]
Impact of interacted variables on real house prices evaluated at the median of the structural features (p-values in brackets)		
Total effect of:		
Log of long term real interest rate	-0.02*	0.01
	[0.09]	[0.125]
Financial Reform Index	0.418**	1.121***
	[0.013]	[0.000]
NAIRU	-0.033***	-0.052*
	[0.0004]	[0.075]
Log of net migration	0.018*	0.020
	[0.087]	[0.454]
Other tests (p-values)		
H0: Household Disposable Income Coefficient = 1	0.42	0.51
Number of observations	296	219
Number of countries	17	16
R-squared	0.87	0.92

Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. Country- and time-fixed effects not shown.
Source: OECD calculations.

Structural and Policy factors

41. Policy experiments are also conducted to highlight how estimates of the impact of a particular housing demand shock on real house prices change when the supply responsiveness and tax relief indicator are 0.5 standard deviations above and below their sample median. These experiments are reported in Figure 6 where the upper and lower bound in the figure gives the impact on house prices when supply responsiveness and tax relief are 0.5 standard deviations above and below their sample median.

42. As to be expected, the results indicate that positive shocks to housing demand are less likely to be capitalised into real house prices in environments where housing supply is more responsive.

- The interaction between financial deregulation and the supply elasticity is negative (Table 2), suggesting that the impact of financial deregulation on house prices is smaller in countries where housing supply is more responsive. The magnitude of these effects is reasonably large: if the supply elasticity is half a standard deviation below the median (roughly equivalent to moving from Norway to the Netherlands in Figure 1) the increase in house prices associated with financial deregulation is more than 50% larger than what would have occurred if the supply elasticity was at the median (Figure 6).[15]

- The interaction between the NAIRU and the supply responsiveness is positive, suggesting that the expansionary impact of a decline in structural unemployment on real house prices is smaller in countries where housing supply is more responsive.

- While real house prices are positively related to net migration, the extent to which migration shocks gets capitalised into house prices is lower in countries where housing supply is more responsive to price signals. However, the magnitude of this effect is fairly modest.

43. The results indicate that positive shocks to housing demand are more likely to be capitalised into real house prices in environments where the tax relief on debt financing cost is more generous.

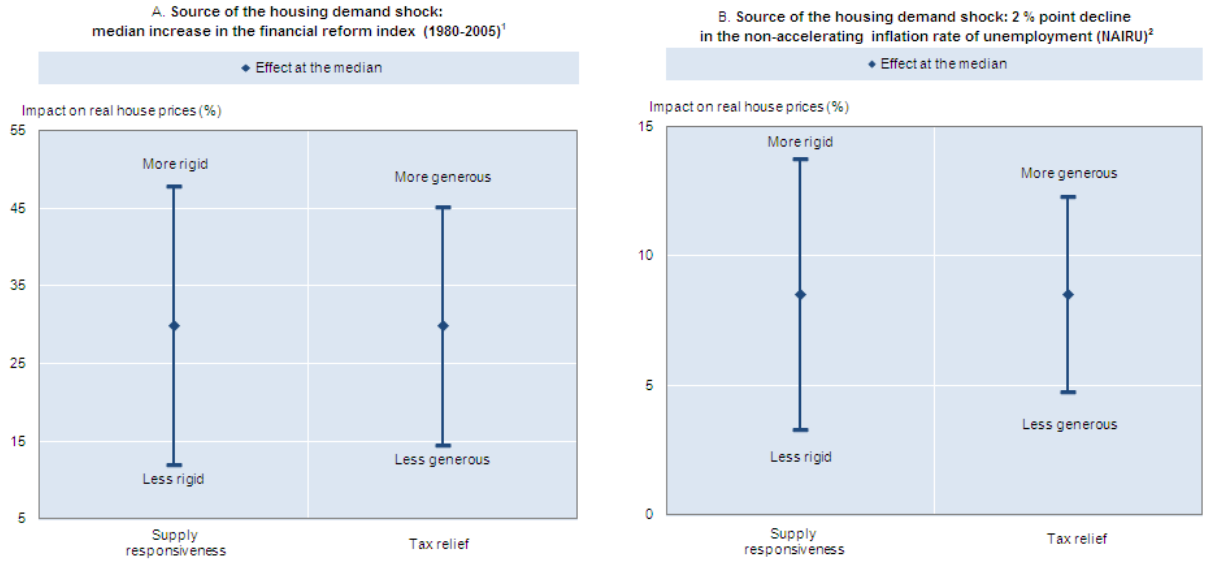
- The interaction between financial deregulation and tax relief is positive (Table 2), suggesting that the impact of financial deregulation on house prices is larger in countries where tax relief to debt financing is more generous.

- The interaction between the NAIRU and the tax relief is negative (Table 2), suggesting that the impact of a decline in structural unemployment on real house prices is larger in countries where tax relief to debt financing is more generous. For example, if tax relief is half a standard deviation above the median (roughly equivalent to moving from Spain to the United States in Figure 2), the increase in house prices associated with a 2 percentage point reduction in the NAIRU is about 50% larger than what would have occurred if the tax relief was at the median (Figure 6).

[15] Figure 4 in Caldera Sanchez and Johansson (2010) shows that the estimated supply elasticity is correlated with population density and a proxy for the extent of regulation, obtained from the World Bank Doing Business (2009) indicators. Regression estimates based on these data imply that a half standard deviation change in the estimated housing supply elasticity is roughly equivalent to a one standard deviation change in an index of building regulation, after controlling for population density. Since policy makers can potentially influence the extent of building regulation, the policy experiments in this paper assume a half a standard deviation change in supply responsiveness.

Figure 6. Real house prices, housing demand shocks and housing market settings

Impact on real house prices (per cent)



The estimates are based on a fixed effects panel regression for 17 OECD countries between 1980 and 2005 (see Table 2). The central estimate shows the impact of a particular demand shock on real house prices when the supply responsiveness and tax relief variables are set equal to the sample median, and all other control variables are set to their sample means.

The upper (lower) bounds show the impact of a given demand shock on real house prices when:
i) the supply responsiveness is 0.5 standard deviations below (above) the median and tax relief is at the sample median.
ii) tax relief is 0.5 standard deviations above (below) the median and the supply responsiveness is at the sample median.

1. The Financial Reform Index ranges between 0 and 1, and is increasing in the degree of liberalisation. The median rise in the index between 1980 and 2005 is about 0.6.
2. In the sample, the median decline in the NAIRU between 1995 and 2005 is around 2 percentage points.

Source: OECD estimates.

Robustness tests

44. These results are broadly robust to alternative estimation techniques, including the Stock and Watson (1993) DOLS estimator to control for sample serial correlation and endogeneity (Column 2; Table 2). The results are also robust to including lagged dependent variables to control for second order serial correlation using Arellano-Bond estimation. Excluding countries with "extreme" housing market and policy features, such as the Netherlands, which has a very low elasticity of supply and very generous tax relief for housing, and the United States, which has a very high elasticity of supply, does not materially alter the results. The results are also broadly robust to using private credit to nominal GDP to proxy for financial deregulation, though this variable is less likely to be exogenous to housing market developments than the Financial Reform Index.

4. Real House Price Volatility

45. Recent developments in the global economy have highlighted the important contribution of fluctuations in house prices to macroeconomic stability and welfare. From the household's perspective, to the extent that housing is its single largest asset, excessive volatility in house prices may reduce welfare. There is also a link between house prices and aggregate demand through wealth effects and the extent to which housing market is a potential factor in macroeconomic instability depends on house price volatility.

In countries with relatively flexible housing supply, however, it is also possible that dwelling investment adjusts more rapidly to demand shocks, contributing more to cyclical swings in economic growth. With this background in mind, the contribution of structural and policy features to house price volatility is worth exploring.

46. Previous research has emphasised the role of structural factors in explaining the cross-country variation in house price volatility. In a small sample of OECD countries, Catte *et al.* (2004) show that countries with more responsive housing supply tend to have experienced lower annual real house price variability between 1971-2002, implying that housing markets in such countries may be better able to accommodate demand shocks (Glaeser and Gyourko, 2008). Moreover, there is a positive relationship between the extent to which housing is tax favoured and house price variability in a sample of European countries, consistent with the idea that tax incentives can make some housing markets more prone to cycles by lowering the cost of leveraging (van den Noord, 2003). There is also some evidence that house price variability over recent decades has been lower in countries where transaction costs in housing markets are higher (Catte *et al*. 2003). Finally, house price variability could also be influenced by macroeconomic factors, with a positive cross-country relationship evident between the variability of consumer price inflation and real house price growth.

47. While the modelling takes into account each of these factors, it also investigates the extent to which banking supervision can affect the volatility of house prices to the extent that problems arising from inadequate banking supervision and, in turn, poorly underwritten residential mortgages contributed significantly to the recent financial crisis. While banking supervision arrangements in OECD countries are complex and difficult to measure, Abiad *et al.* (2008) construct an index of banking supervision that takes into account the following factors:

- Whether a country adopted a capital adequacy ratio based on the Basel standard.
- The extent to which banking supervision agencies are independent of executives' influence.
- Whether the banking supervisory agency conduct effective supervisions through on-site and off-site examinations
- If the banking supervisory agency covers all financial institutions without exception.

Figure 7 shows how the index of banking supervision has varied across OECD countries and over time. According to this measure, while the degree of banking supervision has increased over time, there is considerable cross-country variation in the timing of reforms to banking supervision.

Identification Framework

48. To better understand the influence of macroeconomic factors and structural housing market features on real house price volatility, a cross-country panel model as given by equation 2 is estimated over the period circa 1980-2005 at five year intervals.

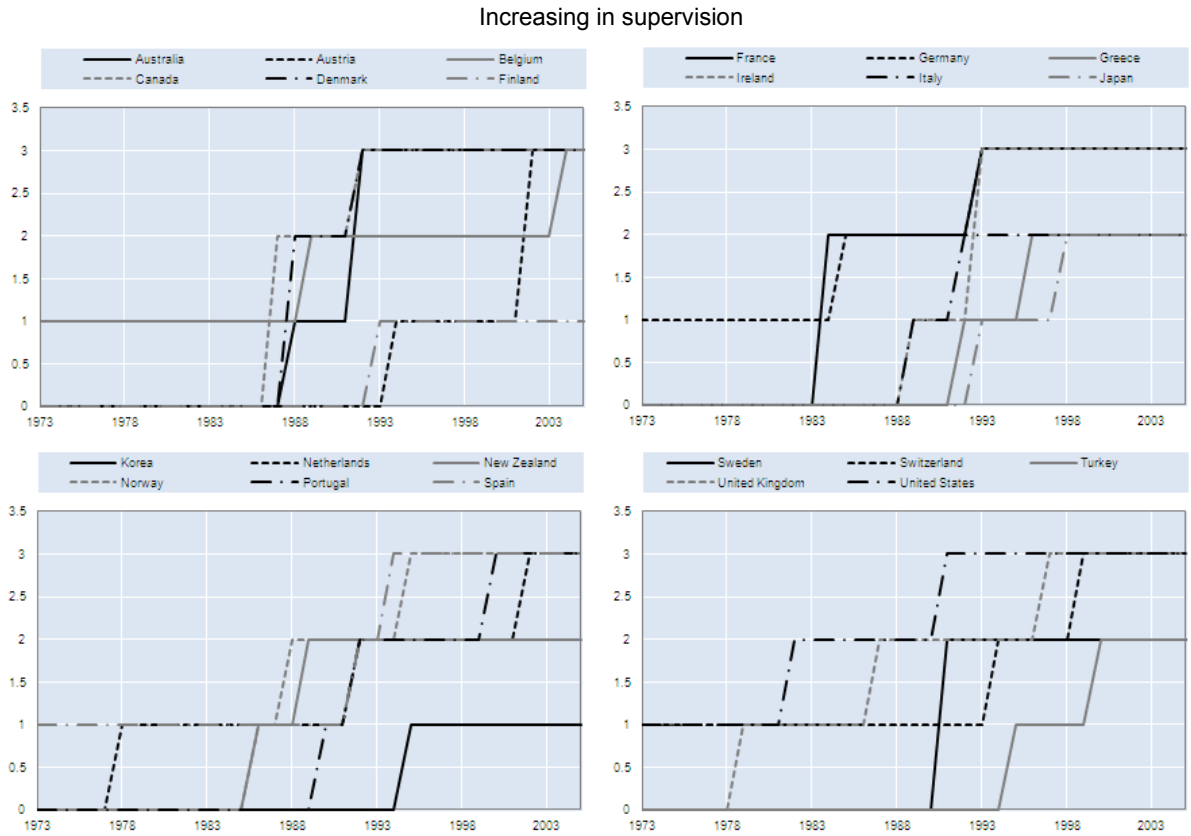
$$\sigma_{i,t}^{HP} = \alpha + \sum_{K} \beta_1^K Z_{i,t}^K + \beta_2 BankSup_{i,t} + \beta_3 SupplyE_i + \beta_4 Taxrelief_i + \beta_5 Transcosts_i + \beta_6 Den_i + \eta_t + \upsilon_{i,t} \quad [2]$$

where: $\upsilon_{i,t} = a_i + \pi_{i,t}$

49. The dependent variable real house price volatility, $\sigma_{i,t}^{HP}$, is constructed by estimating the standard deviation of annual real house price growth over each five-year block, where t gives the date of

the five-year block and i identifies the country. The vector Z^K contains a number of macroeconomic factors, including the level of the unemployment rate and the volatility of: real household income growth, real construction costs, inflation, real interest rates and real dwelling investment growth. These variables are constructed in the same way as the dependent variable. The level of the unemployment rate is included to proxy for the level of economic confidence, as well as the propensity for marginal buyers to be drawn into the market. BankSup is the index increasing in the degree of banking supervision discussed above (see Figure 7).

Figure 7. Index of banking supervision: selected countries



Source: Abiad *et al.* (2008).

50. The time invariant structural housing market features discussed in Section 2 are also included: the estimated price responsiveness (elasticity) of new housing supply (SupplyE), an index of tax relief on debt financing cost of homeownership (Taxrelief) and an estimate of the transaction costs involved in buying a dwelling (Transcosts). The model also controls for population density (Den). Time-fixed effects (η_t) are included to control for common global shocks while the standard errors are clustered at the country level.

51. The sample consists of around 20 OECD countries, between circa 1980-2005, implying up to five observations per country. Data sources are as given in Section 3. In addition to those, population density is sourced from the United Nations database.

52. Equation 2 is estimated using a random effects model, which assumes that the country-fixed effects a_i are uncorrelated with the independent variables. While this is a strong assumption, the Hausman test validates the choice of the random effect model over a fixed effect model. An additional advantage of

the random effect model is that it uses the cross country variation in the data allowing the effect of time invariant variables to be directly estimated from the model.[16]

Effect of leverage on house price volatility

53. In a smaller sample of countries for which data on maximum LTVs are available, the link between leverage and house price volatility is also analysed. The analysis utilises LTVs, as opposed to the financial reform index, to the extent that the former contains more between-country variation than the latter (which is exploited in the random effects estimation) and the LTV provides a more direct measure of the extent of leverage in the economy. This analysis also utilises interaction terms to identify how structural housing market feature *j* influences the impact of leverage – as measured by the maximum LTV – on real house price variability.[17] The regression takes the form:

$$\sigma_{i,t}^{HP} = \alpha + \beta_1 Z_{i,t} + \beta_2 BankSup_{i,t} + \beta_3 SupplyE_i + \beta_4 Taxrelief_i + \beta_5 Trans\cos ts_i + \beta_6 Den$$
$$\beta_7 LTV_{i,t} + \sum_j \beta_8^j \left(LTV_{i,t} * Structuralfactor_i^j\right) + \eta_t + \upsilon_{i,t}$$

where: $\upsilon_{i,t} = a_i + \pi_{i,t}$ [3]

To aid the interpretation of the total effect of the LTV ratio and structural housing market features on housing price volatility, the bottom of Table 3 contains an estimate of the total impact of each variable on house price volatility evaluated at the sample median for the other variable included in the interaction. For instance, the estimated total impact of the LTV ratio on house price volatility is calculated by β_7+ (β_8^j *median value of *Structuralfactor*^{j}).

Empirical Results

54. Overall, results in Table 3 tend to confirm the findings of the earlier descriptive analyses discussed earlier in this Section. Macroeconomic influences appear to play an important role, with the volatility of real household disposable income growth, consumer price inflation and real interest rates positively related to real house price volatility. These variables are jointly statistically significant at the 1% level. The R-squares in Columns 1 and 4 suggest that these macroeconomic variables jointly account for just over two-thirds of the explained variation in real house price volatility over the studied period. However, when the sample is split in half and the model is re-estimated, the positive relationship between the volatility of consumer price inflation and house price variability largely reflects the macroeconomic instability present in the first half of the sample (*i.e.* the 1980s), which possibly reduces the relevance of this result in a low inflation environment.

16 Qualitatively similar results regarding the impact of structural housing policies on house price volatility can be obtained from a fixed effects specification through the use of interaction terms (i.e. by employing a similar framework to that utilised to model house price in this paper). Estimates from this model suggest that financial deregulation has been associated with an increase in house price variability, particularly in countries where housing tax relief is more generous and transaction costs are lower. Unlike the random effects model, however, the fixed effects approach only provides indirect evidence of the impact of structural housing policies on house price volatility.

17 LTVs for selected years are plotted in Figure 14 of Andrews *et al* (2010) and are sourced from Chiuri and Jappelli (2003), Catte *et al.* (2004) and ECB (2009).

Table 3. Panel results on the volatility of real house price growth

	(1)	(2)	(3)	(4)	(5)
Macroeconomic volatility terms					
Log of the volatility of real household income growth	0.234*	0.234**	0.239**	0.193	0.011
	[0.122]	[0.116]	[0.120]	[0.125]	[0.158]
Log of the volatility of CPI inflation	0.349***	0.243**	0.235*	0.258**	0.253
	[0.111]	[0.120]	[0.131]	[0.125]	[0.174]
Log of the volatility of short term real interest rates	0.400***	0.386***	0.421***	0.475***	0.468***
	[0.140]	[0.128]	[0.122]	[0.127]	[0.139]
Structural housing market terms					
Banking supervision index			-0.208**	-0.220***	-0.258***
			[0.085]	[0.075]	[0.048]
Supply responsiveness				-0.388***	2.075**
				[0.123]	[0.973]
Tax relief on housing				0.035	0.217**
				[0.116]	[0.092]
Transaction costs				-0.040*	0.306**
				[0.021]	[0.131]
Loan to value (LTV) ratio					0.055***
					[0.014]
LTV ratio x Transaction costs					-0.005***
					[0.002]
LTV ratio x Supply responsiveness					-0.030***
					[0.011]
Control variables					
Log of the volatility of dwelling investment growth	0.053	0.042	0.063	0.081	0.16
	[0.092]	[0.110]	[0.104]	[0.117]	[0.119]
Unemployment rate	-0.007	0.005	0.011	0.021	0.031*
	[0.014]	[0.017]	[0.016]	[0.014]	[0.018]
Population density				-0.001	0.000
				[0.000]	[0.000]
Constant	2.204***	1.765***	2.203***	2.781***	-1.782
	[0.460]	[0.546]	[0.524]	[0.625]	[1.631]
Hausman Test					
H0: Difference in coefficients not systematic	5.1				
P>Chi2	0.9545				
Chi-2 tests (p-values)					
H0: Macroeconomic coefficients (jointly) = 0	0.000***	0.000***	0.000***	0.000***	0.000***
Impact of interacted variables on real house price volatility evaluated at the median of the structural features (p-values in brackets)					
Total effect of:					
LTV ratio					0.020***
					[0.001]
Supply responsiveness					-0.338***
					[0.000]
Transaction costs					-0.055***
					[0.000]
Time fixed effects?	No	Yes	Yes	Yes	Yes
Number of observations	112	112	112	107	75
Number of countries	22	22	22	20	16
R-squared	0.32	0.37	0.42	0.49	0.60

Standard errors in brackets. * significant at 10%; ** significant at 5%; *** significant at 1%. Time-fixed effects not shown.

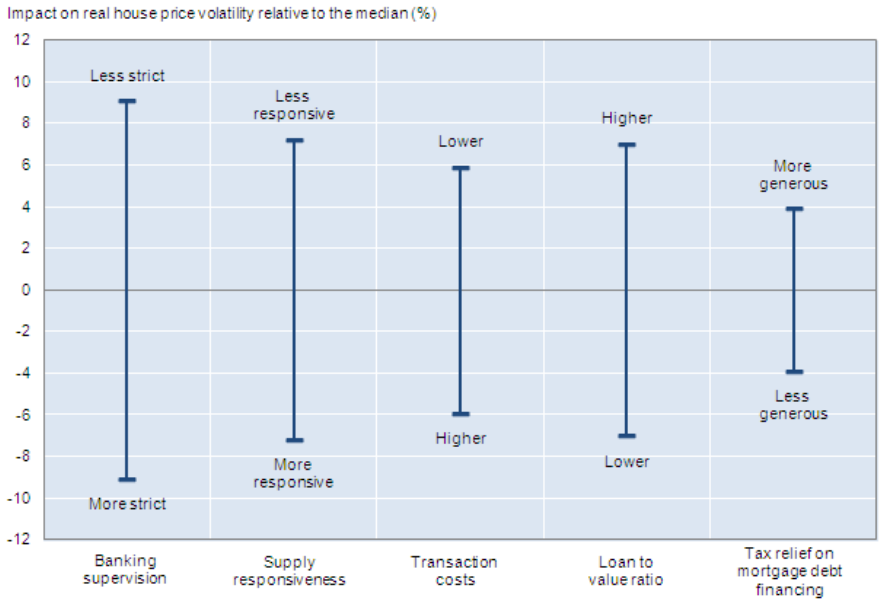
Source: OECD calculations.

55. Problems arising from inadequate banking supervision and, in turn, poorly underwritten residential mortgages contributed significantly to the recent financial crisis, which was characterised by a noticeable increase in house price variability. Consistent with this, more rigorous banking supervision is associated with lower real house price volatility in OECD countries, after controlling for macroeconomic and other structural determinants of house price variability (Columns 3-5). Specifically, a half a standard deviation increase in the extent of banking supervision – roughly equivalent to moving from the average level of banking supervision in the OECD in the mid 1990s to the average level in the OECD in 2005 (Figure 7) – is associated with a 9% decline in real house price volatility (see Figure 8).

56. House prices tend to rise faster in environments with less responsive housing supply, and the variability of house prices is also likely to be higher if the supply of housing is price-inelastic and if the demand for housing is subject to large shocks. After controlling for differences in population density, there is a negative association between housing supply responsiveness and real house price variability over the period 1980-2005 (Column 4).[18] Specifically, a one-half a standard deviation increase in the responsiveness of new housing supply – roughly equivalent to moving from the Netherlands to Norway in Figure 1 – is associated with a 7% decline in real house price volatility (see Figure 8).

Figure 8. Real house price volatility: the role of structural and policy factors[1]

Per cent deviation from the median



1. The upper/lower bounds show the percentage deviation from the sample median house price volatility (which is set equal to zero) arising from a 0.5 standard deviation change in each housing market feature from the median. All other variables are unchanged.

Sources: OECD calculations based on the estimates in Table 3.

18 This estimated effect in not particularly sensitive to the inclusion of population density.

57. While the estimates suggest a negative association between transaction costs in buying real estate and real house price variability, the size of this impact is considerably smaller than the impact of banking supervision (Figure 8).[19]

Role of Leverage

58. While mortgage markets characterised by high LTV ratios may promote economic resilience by helping to facilitate housing equity withdrawal, they also make it easier for investors to take leveraged positions in housing, which may amplify house price variability (Catte *et al.* 2004). Indeed, in a smaller sample of 16 countries, cross-country panel econometric evidence suggests that an increase in the LTV ratio is associated with higher real house price volatility. Holding the supply elasticity and transaction costs at the sample median, half a standard deviation rise in the LTV (equivalent to 5 percentage points) is associated with a 7% increase in real house price volatility (Figure 8).

59. The interaction terms in Column 5 indicate that the positive impact of the LTV ratios on real house price volatility is somewhat less in countries with more responsive housing supply and higher transaction costs. The impact of greater housing supply responsiveness and transaction costs in moderating the impact of a given rise in leverage on house price volatility is broadly similar.[20] In turn, the estimates at the bottom of Table 3 suggest that the overall impact of the supply elasticity and transaction costs on house price volatility remains negative, when evaluated at the sample median of the LTV.

60. Recent developments in the United States have prompted some analysts to question the desirability of a responsive housing supply. For instance, if the increase in demand for housing is driven by a temporary easing of credit standards (Ellis, 2008), this may trigger a large run-up in housing investment which will eventually need to be unwound, thereby amplifying house price variability. However, the econometric results in column 5 of Table 3 do not support this hypothesis. For instance, if a more responsive housing supply amplifies the impact of higher leverage on house price volatility, one would expect the interaction between the LTV and supply elasticity to be positive, as opposed to negative. Of course, it should be noted that this provides only an indirect test of this hypothesis and the econometric estimates are based on data up until 2005, prior to the peak in US house prices. Nevertheless, given the broader benefits of a responsive housing supply, the results imply that a more effective strategy might involve improvements to banking supervision in order to prevent excessive easing of lending standards in the first place.

61. The results in Column 5 suggest that more generous tax relief on debt financing costs is associated with greater house price volatility between 1980 and 2005. Specifically, a half a standard deviation increase in the generosity of tax relief – roughly equivalent to moving from Spain to the United States in Figure 2 – is associated with a 4% increase in real house price volatility. This may reflect the tendency for generous housing tax policies to increase the expected net profits from speculative investments but there is only weak evidence that generous tax incentives have a stronger impact on house price volatility in environments where LTVs are high. Overall, while it seems plausible that more generous

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19 A half a standard deviation increase in transaction costs on the buyer relative to the median level is roughly equivalent to moving from the United States to Germany in terms of buyer-side measure in Figure 4. Revised data for transactions costs were received just prior to publication which resulted in a modest downward adjustment to the data for Italy. While the updated data are reflected in Figure 4, the econometric modelling was concluded well in advance of publication and is thus based on an earlier vintage of data. However, this change should not significantly alter the estimation results, since earlier analysis showed that they were broadly robust to dropping countries with extreme policy settings, such as Italy and the Netherlands.

20 The estimates imply that when supply elasticity or transaction costs are half a standard deviation above the median, the impact of a rise in leverage on house price variability is only about half as large then what would have occurred if supply elasticity or transaction costs were at the sample median.

tax relief on debt financing amplifies house price variability, the impact of tax relief is much smaller and not statistically significant in a larger sample of countries (Column 4). Accordingly, these results should be treated with caution.

5. Discussion

62. Real house prices in OECD countries are influenced by a number of macroeconomic and structural and policy factors. The results indicate that real house prices tend to rise proportionally with real household incomes, while declines in structural unemployment and real interest rates are associated with higher house prices. The process of financial deregulation has coincided with a significant increase in real house prices in the average OECD country, consistent with the idea that greater competition in mortgage markets lowered borrowing costs and increased borrower's capacity to pay for housing. However, the results suggest a greater tendency for demand shocks (such as financial deregulation) to be capitalised into real house prices in countries where tax relief on mortgage debt financing costs is more generous (the same is also true in rigid supply environments). Accordingly, in countries where significant increases in real house prices over recent decades have given rise to concerns about housing affordability, policy initiatives that can remove tax-induced distortions between housing and other investments and improve the degree of supply responsiveness may be desirable. Such policy reforms may also be worth pursuing on equity grounds in light of the potentially regressive impacts of generous tax relief on mortgage debt financing and rigid housing supply on homeownership (see Andrews and Caldera Sanchez 2010).

63. The results also suggest a potential recipe for curbing excessive house price volatility, which carries significant welfare costs given that housing is typically the household's single largest asset.[21] Real house price volatility tends to be lower in countries with more responsive housing supply and higher transaction costs, and there is some evidence that generous tax reliefs for mortgage debt financing amplify volatility. While policy initiatives that can improve the degree of supply responsiveness and remove tax distortions are clearly desirable on efficiency and equity grounds, higher transaction costs imply costs to efficiency and mobility that are likely to outweigh any benefits from lower house price variability (Caldera-Sanchez and Andrews 2010). Moreover, the impact of transaction costs in terms of mitigating house price variability is quite modest when compared to more prudent banking supervision. Indeed, prudential banking supervision and policies designed to contain the excessive build-up of leverage are shown to significantly reduce the extent of house price volatility, underscoring the importance of ongoing efforts to reform prudential frameworks in OECD countries.

[21] As discussed above, while excessive house price volatility may amplify macroeconomic volatility through wealth effects, to the extent that lower house price volatility is achieved at the cost of greater volatility in residential construction, the implications for macroeconomic stability are less clear.

APPENDIX 1: MORTGAGE AND FINANCIAL MARKET FEATURES IN OECD AND CANDIDATE FOR ACCESSION COUNTRIES

	Regulatory limits on loan-to value	Prevailing type of interest rate	Typical maturity (years)	Mortgage equity withdrawal	Bank regulation (increasing in strictness)[1]
Australia	100% if insured	Mainly variable	25	Yes	2.89
Austria	..	Fixed (75%); Variable (25%)	25	No	2.49
Belgium	None	Fixed (75%); Mixed (19%); Variable (6%)	20	No	2.18
Canada	95% if insured	Fixed and Mixed (92%); Variable (8%)	25	Yes	2.68
Chile	..	Variable	..	..	..
Czech Republic	..	Fixed (Mixed)	20	..	3.04
Denmark	0.8	Fixed (75%); Mixed (10%); Variable (15%)	30	Yes	2.06
Estonia	..	Variable	30	..	..
Finland	None	Fixed (2%); Variable (97%); Other(1%)	17	Yes	1.95
France	60% to be eligible for mortgage-backed securities	Fixed/Mixed/Other(86%); Variable (14%)	15	No	1.52
Germany	60% to be eligible for mortgage-backed securities	Mainly Fixed and mixed	25	No	1.97
Greece	..	Variable	15	No	2.92
Hungary	..	Variable (Mixed)	11	..	2.70
Iceland	..	..	..	..	3.37
Ireland	80% (only for building societies)	Variable (70%); Rest mainly mixed	20	Limited	0.74
Israel	..	Variable	15; 30 (max)	..	..
Italy	80% (100% if guaranteed)	Fixed (28%); Rest mainly mixed	15	No	2.74
Japan	None	Fixed (36%), Mixed and Variable (64%)	25	No	2.26
Korea	40-60%	Variable	3; 20 (max)	..	3.31
Luxembourg	..	Variable	20 - 25	..	0.00
Mexico	..	Variable	..	..	2.87
Netherlands	None	Fixed (74%), Mixed (19%), Variable (7%)	30	Yes	1.66
New Zealand	..	Mainly fixed	25	..	1.17
Norway	..	Mainly variable	17	Yes	2.45
Poland	..	Variable	5 - 32.5	..	3.32
Portugal	..	Variable	25 - 30	..	2.38
Russian Federation	..	Fixed/ Variable	15 - 20	..	..
Slovak Republic	..	Variable	..	..	4.45
Slovenia	..	Variable	10	..	..
Spain	80% to be eligible for mortgage-backed securities	Variable (≥75%); Rest mainly mixed	20	Limited	1.78
Sweden	None	Fixed (38%); Mixed (24%); Variable (38%)	25	Yes	2.31
Switzerland	None	Mainly variable	15 - 20	..	2.11
Turkey	..	Variable	10	..	2.70
United Kingdom	100% (only for building societies)	Mixed (28%); Variable (72%)	25	Yes	1.45
United States	90% if guaranteed	Fixed (85%); Mixed (15%)	30	Yes	2.29

1. Measures anticompetitive regulations in banking taking into account regulatory barriers on domestic and foreign entry, restrictions on banking activities and the extent of government ownership (de Serres *et al.* 2007).

Source: ECB (2009b), Catte *et al.* (2004), de Serres *et al.* (2007).

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