Financial Constraints and House Prices
An International Perspective

Heitor Almeida*

09/27/2000 – This Draft

11/03/99 – First Draft

Abstract

In this paper, we show substantial empirical evidence that house prices are more sensitive to shocks to per-capita income, in countries where housing finance is more developed. This result is consistent with the theoretical framework developed in the paper, where we study the impact of progressive relaxation of financial constraints on housing demand and equilibrium house prices. Our results are consistent with recent literature on financial constraints and business investment, which argues that the investment of less constrained firms can be more sensitive to changes in cash flow. More broadly, our results challenge the traditional view that financial development leads to smaller fluctuations in key economic variables. From a policy perspective, our paper suggests that even if financial development is desirable for other reasons, the associated increase in the extent of fluctuations should be an explicit policy concern.

*New York University, Stern School of Business.

E-mail: halmeida@midway.uchicago.edu. I am grateful to Owen Lamont, Stephen Malpezzi, Raghuram Rajan and Luigi Zingales for their guidance and specific suggestions. I also wish to thank Olympia Bover, Peter Englund, Stephen Malpezzi, Felipe Morande and Sock-Yong Phang for kindly providing me with data. All mistakes and omissions are my own.

1 Introduction

There is a large literature about the impact of financial constraints on economic fluctuations. Most of this literature argues that tighter financial constraints should lead to amplified fluctuations. For example, the investment-cash flow literature started with Fazzari, Hubbard and Petersen (1988), argues that the sensitivity of investment to cash flow is higher for firms which are more financially constrained. In an international context, Japelli and Pagano (1989) show that consumption on non-durables is more sensitive to disposable income fluctuations in countries where consumers are more financially constrained. In the context of the housing literature, Lamont and Stein (1999) show that in US city-years when households have higher observed leverage, house prices are more sensitive to changes in per-capita income. They interpret this result as being caused by down-payment requirements (which can generate credit constraints on households).

The fluctuations in economic variables induced by financial constraints are usually interpreted as being "excessive", in the sense that they are higher than what would obtain in an economy of perfect credit markets. The results above suggest that, as financial markets become more developed, we should expect an welfare improving decrease in the degree of fluctuations in key economic variables. The policy implications are natural. Policies which are directed at the relaxation of credit constraints for firms and households should reduce the extent of fluctuations in variables such as consumption, investment and prices.

In this paper, we will argue that financial development may well lead to *amplified* fluctuations, in the context of the housing market. This is in stark contrast with the established view about the role of financial constraints which exists in the literature. The implication of our results is that higher fluctuations may be an undesirable consequence of the process of financial development. From a policy perspective, our results suggest that even if financial development has other economic benefits[1], it is desirable to devise policies to minimize the potential side effects on the extent of fluctuations.

Let us describe in greater detail what we do in the paper. We study the behavior of house prices for a large panel of countries. Housing finance development differs

[1] There are indeed plenty of evidence that financial development has positive effects on the economy as a whole. See Levine (1997) for a survey.

substantially across the world. This allows us to sort countries according to their degree of housing finance development. In countries with less developed housing finance, households will be more financially constrained, in the sense that they will be able to borrow less, in order to finance housing and other consumption and investment items. Take a country with low housing finance development (Italy, for example). In such a country, maximum loan-to-value (LTV) ratios rarely exceed 60%, and the stock of outstanding mortgage debt is typically lower than 20% of GDP[2]. On the other hand, in a country with high financial development (such as Denmark), maximum LTV ratios approach 90%, and the stock of mortgage debt is usually more than 50% of GDP.

The effect of such differences in financial development on house price behavior is considered from a theoretical perspective in section 2. We build a simple model (which draws heavily on Stein, 1995, and Almeida, 2000), to show the following: Although it is true that the presence of financial constraints tend to lead to an excess sensitivity in house prices, it is not true that this sensitivity decreases as households become (progressively) less financially constrained. Indeed, the opposite tends to occur in the model. Consider the example of Denmark and Italy given above. If the degree of financial development in Denmark is not so high that households become financially unconstrained (that is, down-payment requirements are no longer binding), then the model suggests that house prices should be more sensitive to shocks to household income in Denmark than in Italy.

The intuition for this result is simple. If income increases, for example, the value of housing will go up. As long as households can borrow a positive fraction of the value of the houses, the increase in income will also allow the household to borrow more, given the increase in the value of housing, and the fact that borrowing capacity is increasing in the value of housing. Furthermore, if households can borrow a higher fraction of the value of houses, the second effect increases. In other words, the higher is the level of financial development, the higher is the feedback effect from an increase in the value of houses to credit, so financial development will contribute to increase the sensitivity of demand to income, and therefore will also increase the sensitivity of prices to changes in income.

In our view, the reason why the literature has in general not considered the

[2] We also consider other objective and subjective criteria to sort countries according to levels of housing finance development. See section 4.

possibility that relaxation of financial constraints amplify fluctuations is very simple[3]. Previous work focused on the difference between constrained to unconstrained agents. Yet, it is more plausible that all agents are constrained to some extent[4], and we should compare constrained agents according to the degree of financial constraints. This is at the heart of the argument above, which implies that countries with more developed financial markets may have more volatile housing markets.

In order to test this prediction, we look at the sensitivity of house prices to changes in per-capita income across the world, using a panel of countries. We show substantial evidence that house prices are more sensitive to shocks to per-capita income, in countries where housing finance is more developed. Our estimates imply that in a country with low financial development like Italy, in the first year following a positive 1% shock to per-capita income, house prices go up by around 0.5%. On the other hand, in a country with high financial development like Denmark, house prices go up by more than 1% in the first year. These differences are persistent through time. After 4 years, the cumulative price changes are around 1% and 2%, respectively. The differences are statistically significant, and are also large from an economic point of view.

We submit the house price data to a number of robustness checks and alternative estimation techniques. The result described above is for our benchmark specification, where we introduce our measures of financial development in the house price regressions interacting with all the coefficients[5]. The same result holds when we split the sample according to the measures of financial development, or when we use a two-stage approach with separate house price regressions for each country (and a cross-section regression to explain the variation in coefficients). We also show that the result above is not driven by influential outliers.

We submit the data to a number of alternative explanations for the basic result that financial development increases the sensitivity of prices to income.

It could be the case that high income countries have higher sensitivities, simply

---

[3] Almeida (2000), Kaplan and Zingales (1997 and 1999), and Fazzari, Hubbard and Petersen (1999) are exceptions.

[4] This is especially likely to be the case in developing countries.

[5] This benchmark specification is the same as in Lamont and Stein (1999), which form the basis for our empirical work.

because house markets are more liquid in such countries, and not because of financing differences. Also, it could be that house price indices are better measured in high income countries, and since income is correlated with financial development, our result could be driven only by attenuation bias. However, cross-country differences in percapita income are shown to perform very poorly as a potential explanation for our result. Thus, the differences in sensitivities that we document are not due to differences in the overall level of economic development across countries.

Our measures of financial development reflects observed measures of leverage, since it uses information on observed household debt. This is true even for the data on maximum loan-to-value (LTV) ratios available in each country. While some of the LTV data refers to regulatory constraints on mortgages, for some countries the data on maximum LTV ratios are constructed from observed values.

This raises the concern that our measures do not precisely capture the availability of finance to households. Perhaps household debt is low because households choose not to borrow (the usual identification problem). Furthermore, high leverage has been used in the literature as an indication of tighter financial constraints[6].

We address these endogeneity problems by instrumenting our measures of housing finance development with accounting standards, which have been used in the literature as a measure of the availability of finance to firms. Under the assumption that the same underlying forces drive the availability of finance to firms and households[7], this is an appropriate instrument. All the results hold for the instrumental variable regressions. This is strong evidence that our result is indeed driven by differences in the availability of finance to households.

These results are related to several strands of recent finance and macroeconomics literature.

In the context of the investment literature. Kaplan and Zingales (1997), and Cleary (1999) claim that, in their particular samples, the investment of less constrained firms is in fact *more* sensitive to changes in cash flow, in contrast to the traditional view pioneered by Fazzari, Hubbard and Petersen (1988). This is clearly consistent with the results in this

[6] See Whited (1992), for an example.

[7] The correlation between accounting standards and maximum LTV ratios in the data is 0.54.

paper. In terms of the theoretical literature, Almeida (2000) uncovers specific circumstances under which less financial constraints could lead to more fluctuations in business investment and prices of capital goods. This is especially likely to happen, as he shows, when agents are credit-constrained, and borrowing capacity depends on the collateralizable value of the assets invested. One example of such a situation is on housing finance contracts. The results in Almeida (2000) therefore also suggest that, as households become less financially constrained, the demand for housing (and consequently house prices) should become more sensitive to shocks to current income.

The results in this paper are related to those obtained in Lamont and Stein (1999). They compare house price dynamics in different cities in the US, sorted by observed leverage ratios for households, and find that high observed leverage in a US city-year increases sensitivity to per-capita income shocks in that city-year. However, there are important differences in the applicability and interpretation of their results and ours.

As we argue above, the results in this paper provide evidence that tighter financial constraints can actually lead to *smaller* fluctuations in investment and prices. On the other hand, it would be problematic to interpret the evidence in Lamont and Stein (1999) in the same way. Indeed, the authors never pursue this direction of interpretation. A possible interpretation of the Lamont and Stein results is that household leverage is driven by changes in house prices. Homeowners have high leverage in a given city-year because house prices are low, and not because it is easier to borrow in that city. If this is the case, then city-year observed leverage cannot be interpreted as a measure of the degree of credit constraints on households.

The advantage of our approach is that housing finance development is less controversial, as a measure of the ability of households to borrow. It is very hard to argue that homeowners are more financially constrained in the UK than in Israel or Thailand.

On the other hand, even if observed leverage does reflect differences in the ability to borrow across US cities[8], there is a clear advantage in looking at international data. Since housing finance systems differ much more across different countries in the world than

[8] This interpretation seems hard to reconcile with some of the Lamont and Stein results. They instrument leverage with state-level homestead exemptions. This is based on the Gropp, Scholz and White (1997) argument that in states with generous exemptions, households could have easier access to mortgages. However, none of the coefficients on instrumented leverage are significant.

across US states, it is much easier to capture the effect of different laws and institutions, which affect the availability of housing finance. Indeed, our scheme to classify countries (described in section 4) is an attempt to summarize different quantitative and qualitative criteria into measures of the development of housing finance systems across the world.

Our empirical approach also borrows from Japelli and Pagano (1989, 1994). They use data on liquidity constraints on households in order to study the relationship between financial development and several macroeconomic variables, such as savings, growth and the sensitivity of the consumption of non-durables to changes in current income. Our results are both consistent with, and different than theirs. They find (in the 1994 paper) that tighter liquidity constraints on households can increase savings and the growth rate of a country. Therefore, financial development (or financial deregulation) does not necessarily lead to better outcomes, which is consistent with the result we obtain in this paper. On the other hand, Japelli and Pagano find in their 1989 paper that the sensitivity of consumption of non-durables to current income is higher in countries where households are more financially constrained. This is at odds with our conclusion about the relative sensitivity of house prices and housing demand across countries.

This paper also contributes to the literature on housing markets itself. Almost all evidence on house price dynamics comes from studies of specific countries. Englund and Ioannides (1997) are an exception. They characterize house price dynamics for a cross-section of 15 OECD countries. However, they do not focus on the impact of financial constraints on dynamics. Malpezzi (1990) and Malpezzi and Mayo (1997b) discuss some possible interactions between financial development and housing markets, but do not focus on price dynamics.

Finally, our results are intimately related to previous attempts to evaluate the relationship between financial market liberalization and house price volatility[9]. The general theme in that literature is that, within the OECD countries, those with more liberal financial markets experienced higher house price volatility during the 1980's and 1990's. Our evidence adds to this literature in the following ways. We make a rigorous attempt to classify countries according to their degree of housing finance development. We also consider a larger cross section of countries, which includes developing countries and

other non-OECD countries. We perform formal econometric analysis of the effects of financial development on the housing market, which are absent from previous work. We also focus on a different object. While the previous literature focuses on house price volatility, we emphasize the sensitivity of prices to income shocks.

We proceed as follows. Section 2 considers the theoretical reasons why financial constraints could affect house price behavior, in the context of a simple model. Section 3 describes our data on house prices and per-capita GDP. Section 4 gives a detailed summary of how we construct measures of housing finance development. Section 5 contains the main empirical results, and some robustness checks. Section 6 presents more evidence that the results are indeed driven by the availability of finance. Section 7 concludes

[9] See Borio, Kennedy and Prowse (1994), Muellbauer at al. (1998), Renaud (1995) and Stephens (1995).

2. A simple model of the effects of financial development on house price behavior

Consider the following scenario, which is adapted from Stein (1995) and Almeida (2000).

There are two goods, housing (*H*), and food (*Z)*. The price of housing (*P*) is measured in units of food. The individual is initially endowed with H_0 units of housing, and a given amount of outstanding debt D_0 raised in the past against the house[10]. There are two time periods. At time t_1 the individual chooses how many units of housing he will buy or sell[11] (H_1). The amount spent on the house must be lower than the individual's total wealth at time t_1. Besides the value of the housing endowment, the individual has income equal to W_1, and he can raise mortgage debt against the value of his new house. We will assume throughout that the riskless rate of interest in this economy is equal to *1*. The maximum amount that a household can borrow is assumed to be equal to a fraction of the value of the house, that is:

$$(1) \qquad B_1 = (1-\tau)PH_1$$

As in Almeida (2000), B_1 can be seen as the fraction of the liquidation value of houses which can be recovered by creditors. The parameter τ measures the degree of financial development. The lower the τ, the easier it is for a household to borrow in order to finance the purchase of the house. If $\tau=0$ in particular, we know the household will be financially unconstrained.

---

[10] That is, households are repeat buyers. See Stein (1995) for a discussion about this hypothesis. It is worth noting here that in a country like the US, 60% of all home sales are to repeat buyers. In any case, as we will see below, the assumption that households are repeat buyers is not necessary for all the results. In particular, the result that the sensitivity of prices to income is increasing in financial development does not depend on repeat sales.

[11] This assumes no rental market for houses. See Stein (1995) for a discussion of this assumption. In particular, notice that this assumption is excessively strong. All that is needed is that renting entails some extra costs (such as those related to moral hazard problems) in comparison with home ownership.

In terms of the real world, the parameter depends on variables such as the costs of enforcing and disposing of collateral, regulations about housing finance and the amount of information creditors have about borrowers[12].

The parameter τ can also be seen as a measure of the degree of rationing faced by households in the mortgage market. Another possible approach would be to focus on the relative cost of funds, or more specifically, on the wedge between the borrowing rate in the mortgage market, and an appropriate lending rate. However, as discussed by Japelli and Pagano (1989), this wedge does not appear to be a viable explanation of the cross-country differences in the financial liabilities of households. Differences among the interest rate wedges seem negligible, and there is no clear relation between lending volumes and wedges. Consistent with our approach, Japelli and Pagano (1989, 1994) also focus on cross-sectional differences in liquidity constraints on households[13].

Given this set up, the budget constraint of a household in period t_1 is:

$$(2) \qquad PH_1 \leq PH_0 + (1-\tau)PH_1 + W_1 - D_0$$

At time t_2 the household derives utility from H_1, and also from the other good, according to:

$$(3) \qquad U(H_1, Z) = \alpha \ln(H_1) + (1-\alpha)\ln(Z)$$

The household earns income also in period t_2. If there are any savings left over from the previous period, the household saves it until the final period. He must also repay the debt raised in the previous period. Therefore, his budget constraint in t_2 is:

$$(4) \qquad Z \leq W_2 - (1-\tau)PH_1 + \{PH_0 + W_1 - D_0 + (1-\tau)PH_1 - PH_1\}$$

[12] See Japelli and Pagano (1994) for a more detailed discussion. Stein (1995) and Spiegel (1999) endogeneize down payment requirements using models based on moral hazard and adverse selection issues.

[13] Nevertheless, the focus of their analysis is different. They examine the sensitivity of consumption of non-durables to current income.

The term in curly brackets is the excess savings left over from the previous period. If a household is unconstrained, then the period t_1 constraint is never binding, and the household chooses the optimal amounts of housing according to:

$$(5) \qquad H_1^U(P) = \alpha \frac{W_1 + W_2 + PH_0 - D_0}{P}$$

In order to determine the equilibrium price of housing, we assume that the supply of housing in period t_1 is fixed at $H_s = 1$.

Therefore, the equilibrium condition yields the unconstrained equilibrium price as:

$$(6) \qquad P(\tau) = \frac{\alpha}{1-\alpha H_0}(W_1 + W_2 - D_0)$$

We will assume throughout that $W_2 = D_0$, so that households have enough income at the final date to repay the original amount of debt they were endowed with.

Consider now the constrained household problem. Our solution method is the following. First, we assume that the constraint (2) binds, and derive the optimal housing demand of a constrained agent. Then, we use the market equilibrium condition to get the constrained equilibrium price, $P^*(\tau)$. Given this price, we must make sure that the individual is indeed constrained. The condition for this is that the unconstrained demand at the constrained equilibrium price violates the budget constraint (2), that is:

$$(7) \qquad H_1^U[P^*(\tau)] > H_1^*[P^*(\tau)] = 1$$

Let us do that. Assuming that (2) binds, we get:

$$(8) \qquad H_1^*(P) = \frac{PH_0 + W_1 - D_0}{\tau P}$$

Therefore, the equilibrium constrained price function is:

(9) $$P^*(\tau) = \frac{W_1 - D_0}{\tau - H_0}$$

Using equations (5) to (8), we can show that this is a feasible equilibrium as long as:

(10) $$\tau \geq H_0 + \frac{(1-\alpha H_0)(W_1 - D_0)}{\alpha W_1} \equiv \tau_{\min}$$

Intuitively, if the level of financial development is high enough, such that the parameter τ goes below a certain level, households will always be unconstrained. Given this, we can write the price function generally as:

(11) $$P(\tau) = \begin{cases} \frac{W_1 - D_0}{\tau - H_0}, \text{if } \tau \geq \tau_{\min} \\ \frac{\alpha W_1}{(1-\alpha H_0)}, \text{if } \tau \leq \tau_{\min} \end{cases}$$

The two values are equal at $\tau = \tau_{\min}$, so the price function is continuous in τ. Furthermore, it is clear that $P(\tau)$ is decreasing in τ. This has a straightforward interpretation. Relaxation of financial constraints increase housing demand, and given our assumption of fixed supply, should increase house prices in equilibrium.

The function $P(\tau)$ will have two other properties which are crucial for my purposes. As long as $D_0 > 0$, there will be a range of τ for which the effects of a change in household income (an increase in W_1), will have an amplified effect on house prices if households are constrained. In other words, $\partial P / \partial W_1$ will be higher if agents are constrained. According to the definition in Stein (1995), there is a *multiplier effect* in operation in the model.

Furthermore, the sensitivity of house prices to changes in income will be increasing in financial development (decreasing in τ), as long as households are financially constrained (τ greater than $\tau_{\min}$). This is the key hypothesis that we attempt to test using our international data on house prices. Let us derive and interpret these results.

Proposition 1

Let $D_0 > 0$, and define $\tau_{max} = H_0 + (1-\alpha H_0)/\alpha$. Then, if $\tau_{min} \leq \tau \leq \tau_{max}$, prices will be more sensitive to changes in income than in the situation where $\tau \leq \tau_{min}$. In words, prices will be more sensitive to changes in income if households are financially constrained.

Proof: First notice that $D_0 > 0$ implies that $\tau_{min} < \tau_{max}$, so the range above is well defined. Using equation (11):

$$(12) \qquad \frac{\partial P}{\partial W_1} = \frac{\alpha}{1-\alpha H_0} \quad \text{if} \quad \tau \leq \tau_{\min}$$

This is the sensitivity of prices to income if households are financially unconstrained. If households are constrained we get:

$$(13) \qquad \frac{\partial P}{\partial W_1} = \frac{1}{\tau - H_0} \quad \text{if} \quad \tau \geq \tau_{\min}$$

The expression in (13) is larger than that in (12), as long as $\tau \leq \tau_{max}$.

Proposition 2

The sensitivity of prices to changes in income is decreasing in τ if $\tau \geq \tau_{min}$. In words, as long as households are financially constrained, the sensitivity of prices to income increases with financial development.

Proof: As long as $\tau \geq \tau_{min}$, the sensitivity of prices to income is given by equation (13). It is easy to see that increases in τ decrease this sensitivity. If τ decreases so much that households become unconstrained, the sensitivity jumps to the value in equation (12), which is lower than the value in equation (13) by proposition (1).

This means that, as long as the level of financial development is not so high that households are effectively unconstrained, the sensitivity of prices to income should be higher in situations where households can borrow a higher fraction of the value of their

homes.

Figure 1 depicts the sensitivity of prices to income, as a function of τ. It illustrates well our main result. If we compare economies where households are unconstrained, with economies where households are constrained, we get the traditional result that financial constraints increase the sensitivity to shocks that affect net worth. In our model, this is true at least for $\tau \leq \tau_{max.}$ However, if we compare two economies which differ according to the degree of financial constraints, it is always the case that less financial constraints mean higher sensitivity to changes in income.

The interpretation of this increase in sensitivity depends on whether we have $\tau < \tau_{max}$ or not. In the first case, the sensitivity of prices to income is excessive, in the sense that it is higher than in an unconstrained economy. Further decreases in τ in this range make the economy depart even more from its unconstrained behavior. On the other hand, if $\tau > \tau_{max}$, the increase in sensitivity is only moving the economy closer to its unconstrained solution.

In order to understand these results, it is useful to consider the sensitivity of demand to changes in income, both in the constrained and unconstrained cases. We have:

$$(14) \qquad \frac{\partial H^U}{\partial W_1} = \frac{\alpha}{P}$$
$$\frac{\partial H^*}{\partial W_1} = \frac{1}{\tau P}$$

It is clear from these equations that the sensitivity is higher in the constrained economy, since both α and τ are lower than one. There are two reasons for this. In the unconstrained economy, an increase in income generates an income effect, which tends to increase demand for houses. However, part of the income effect goes to the other good, which is also normal (if $\alpha<1$). On the other hand, in the constrained economy all the increase in income is channeled to housing, since the demand for houses is lower than the unconstrained optimum. In words, financial constraints amplify the income effect of the demand for houses. The second effect is related to credit. As long as $\tau < 1$, the increase in income will also allow the household to borrow more, given the increase in the value of housing, and the fact that borrowing capacity is increasing in the value of housing. These

two effects make demand more sensitive to income if households are financially constrained.

Furthermore, the lower the τ the higher is the second effect in the constrained economy. This is why the sensitivity is always increasing in τ (if $\tau > \tau_{min}$). In words, the higher is the level of financial development, the higher is the feedback effect from an increase in the value of houses to credit, so financial development will contribute to increase the sensitivity of demand to income, and therefore will also increase the sensitivity of prices to changes in income.

Proposition 1 also argues that the sensitivity of equilibrium prices in the constrained economy can be actually lower than in the unconstrained case, if τ is high enough ($\tau > \tau_{max}$). This happens because of the effect of τ in the intercept of the function $H_1^*(P)$. We can write:

$$(15) \qquad H_1^*(P) = \frac{H_0}{\tau} + \frac{W_1 - D_0}{\tau P}$$

The elasticity of demand with respect to prices is higher if the intercept is lower. Therefore, a given increase in prices will have a higher effect on demand if the parameter τ is higher. A smaller increase in prices is required to balance demand and supply, if τ is higher. Therefore, even though the sensitivity of demand to income is higher for given prices in a constrained economy, the impact on equilibrium prices can be lower if τ is high enough.

We now turn to the empirical analysis. The model above suggests that house prices should be more sensitive to changes in household income, if households can borrow a higher fraction of the value of their homes. In other words, as households become progressively less financially constrained, house prices should become more sensitive to changes in household income. Thus, if we compare two countries with different levels of housing finance development, house prices should be more sensitive to income in the country with higher financial development.

3 Data Description

In this study, we use house price data for 29 countries, listed in table 2. Ideally, the house price index for each country should have the following properties. First, it should refer to residential property prices. It should be representative of the whole country, and of a high enough percentage of the residential real estate transactions occurred in a given year. It is also desirable that the index is adjusted for changes in the quality of the property traded. Unfortunately, quality-adjusted nationwide indices only exist for a few countries, such as some of the Scandinavian countries, and the UK. The quality of the indices we were able to obtain, and the availability of time series data differ across different countries. We list all our sources, and the information we have about the different indices in the appendix.

We were able to get data on most OECD countries for the period 1970-1998, and therefore we chose this period as our benchmark period. Data for Australia, Belgium, Canada, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Netherlands, Norway, Sweden, UK and US come from Englund and Ioannides (1997), for the period 1970-1993. These different indices are also reported on the Bank of International Settlements Annual Reports. We were able to use these to update Englund and Ioannides data until 1998.

Besides these countries, we found data for Austria, Chile, Hong Kong, Israel, Korea, Malaysia, New Zealand, Portugal, Singapore, Spain, Switzerland, Taiwan and Thailand. Not all countries have time series available for the whole benchmark period, but this is less of a concern than the quality of the indices. It is not obvious that all of these indices are of worse quality than many of the BIS indices, although this is probably true on average. For example, the New Zealand data are representative of the country, and quality adjusted. Since we will attempt to identify an effect that is related to the degree of the development of housing finance in each country, it is very important to have data on developing countries. Naturally, our results (even if obtained only with the BIS data) may be subject to qualifications arising from the quality of the data. We try to address some of these concerns in section 5.6.

We will also need data on per-capita GDP for each country, and indicators of development of housing finance. We discuss the latter in detail in the next section. The

GDP data comes from the IMF financial statistics. We summarize our data in table 1 below. We use yearly changes in the logs of all variables. We deflate all our data using the consumer price index, also from the IFS database.

Notice that there are some very extreme observations in our data, both for changes in per-capita GDP and real house prices. The extreme GDP values are both for Israel. We will later show that our results are not driven by such outliers. Table 2 gives a summary of the house price data per country.

4 Housing finance across the world

4.1 Measuring housing finance development

The theoretical arguments in section 2 suggest that financial constraints can play an important role in shaping the behavior of house prices. The relevant empirical measure should capture the extent to which households can access housing finance in different countries.

Our most important empirical measure will be the maximum loan-to-value (LTV) ratio that households can achieve in each country. This is an exogenous limit on the amount that a household can borrow, in order to finance house purchases. The maximum LTV ratio is the direct empirical counterpart of the parameter $(1-\tau)$ in the model of section 2.

Japelli and Pagano (1989, 1994) also use maximum LTV ratios as a measure of the availability of credit to households, in an international context. As they argue, LTV ratios are a direct measure of liquidity constraints on households. They argue that such measures of liquidity constraints do a better job of explaining the large cross-sectional differences in consumer debt than variables related to the demand for credit (such as taxes, age structure and earning profiles), or than the wedge between borrowing and lending rates.

We collected substantial data on LTV ratios and household debt for the countries in our sample. LTV ratios were available from different sources, but the best cross-section for our purposes comes from Japelli and Pagano (1994). Since there can be concerns about the comparability of the data from different sources, we take LTV ratios from Japelli and Pagano whenever they are available for a country in our sample. The values reported in table 3 below are the raw averages of their data for 1971-1980, and 1980-1987. We augment their data with data for Austria, Canada and Singapore, taken respectively from Deutsch (1997), Guiso, Japelli and Terlizzese (1994), and Phang and Wong (1994). Our other sources for LTV ratios report values that are consistent with the data on table 3.

It is interesting to notice the substantial variations in LTV ratios across the world. It does seem to be true that developing countries have lower LTV ratios. It is only 30% in Korea, and 40% in Taiwan. The highest values are generally for Anglo-Saxon and

Scandinavian countries, besides Singapore (85%).

We complement the LTV data with other quantitative and qualitative criteria, which we explain below. The purpose of this is two-fold. First of all, these criteria can be used as a verification of the usefulness of the LTV ratio as a measure of financial constraints on households. Furthermore, to the extent that the LTV ratios are not a precise measure of the degree of financial constraints on households[14], these other criteria can add information.

With this motivation, the second quantitative variable we actually use is the actual amount of debt households have in each country, scaled by national income or GDP. This allows to check whether it is the case that high LTV ratios are indeed associated with high debt levels in the different countries.

The data on household debt was more erratic. There are many different sources, but few of them have data on a wide enough cross section of countries. The definitions of household debt also differed widely. The widest cross-section is again in Japelli and Pagano (1994), but they consider total consumer credit, and not only mortgage debt. There are many other sources with data on mortgage debt, but often for a small cross section of countries. Our strategy here was to build an index that takes into account the information from the different sources, even when the data were not directly comparable across sources. The data we used is reported fully in the appendix. For example, if a country is systematically classified among the ones with high household debt, we assign it a value of one. Similar considerations are true for our definitions of average and low household debt. If there was any doubt about how to classify a particular country, we assigned it a "NA".

There are also other variables that help identifying financial constraints, which are used in the literature about housing markets, but which are either less objective, or less widely available than LTV ratios or household debt. For example, demographic variables such as the slope of the age-tenure profile can also be indicative of financial constraints. If households can become homeowners at a relatively young age, this can also be an indication of lax constraints. Other candidates are interest rate ceilings and maximum maturity on mortgages, and costs of enforcing contracts and disposing of collateral.

[14] See Japelli and Pagano (1994) for a discussion. As they argue, maximum LTV ratios are not always easy to measure. In some countries, for example, payment arrangements are at the discretion of the individual lender, with no statutory maximum LTV ratios. In other countries, regulatory ceilings differ across classes of mortgages.

Furthermore, there are variables such as bank lending practices, which are widely mentioned in the literature, but which are of a nearly subjective nature.

Variables such as these have been widely used in the literature to discuss housing finance in different countries. Table 3 incorporates this information in the following way. If the literature about housing finance characterizes a particular country as being one where there are substantial constraints to mortgage financing, we assign this particular country with a value of zero in the fourth column. If there is clear evidence that a country is characterized by a slight degree of financial constraints, we assign it a value of one. Again, the appendix describes our sources in detail. We call this variable "literature dummy".

The final variable we report in table 3 is a ranking of countries according to the "level of housing finance", which is reported by Borio (1996). The author examines in detail the characteristics of credit to the non-government sector in different OECD countries, and explicitly ranks the countries in a scale of one to four, where four is assigned to countries with highest level of housing finance. We rescale his index to be between zero and one, and group together the average values into 0.5.

As mentioned above, our other measures can be used as a verification of the usefulness of the LTV ratio as a measure of financial constraints on households. Table 4 displays the correlation matrix for the variables in table 3. All the different measures of financial constraints are highly positively correlated. For example, the correlation between LTV ratios and out literature dummy is 0.71. This shows that the other variables that authors use to characterize housing finance markets in the literature are consistent with the information in LTV ratios. Similarly, the high correlation between LTV ratios and household debt (0.79), shows that household debt is strongly affected by limitations on the supply of credit, and is not only demand driven. All the correlations reported below are strongly statistically significant, so we do not report p-values.

This seems to indicate that our data on LTV ratios does a good job of describing international differences in mortgage finance markets, from the perspective of financial constraints on households. We will use the LTV ratios in our empirical analysis as an objective measure of the availability of finance to households in the different countries.

Finally, the last column in table 3 makes an attempt to summarize all the information we collected in an index of the development of housing finance. Except for the

LTV ratios, all the other columns are relative rankings across countries. We transform the LTV column in a relative ranking between zero and one, and then average across the four columns. This gives us an *index of housing finance development*. This index should be seen only as a relative comparison across countries. For example, a value of 0.04 for Italy does not mean that Italians can get no mortgage financing, but only that there is a lot of evidence that Italy can be ranked among the countries in our sample where there are clear constraints to mortgage financing.

In our empirical analysis, we will also use this index as an alternative measure of housing finance development. Its somewhat subjective nature is the housing market counterpart to the classification scheme designed by Kaplan and Zingales in their 1997 paper about financial constraints on firms. To the extent that our results hold both with the LTV ratios and with the housing finance index, our results are strengthened.

5 Empirical Results

Our goal is to test the hypothesis that house prices are more sensitive to income shocks, in countries where housing finance is more developed. We start by doing this in the simplest possible way, and then we refine our empirical approach.

5.1 Financial constraints and the sensitivity to current income

In table 5, we report the results of the following regressions. We regress the annual change in the log of real house prices at country i ($dP_{t,i}$), on current log changes in per-capita GDP (dY_t), and an interaction term $dY_{t,i}$*FD_i , where FD_i is our measure of financial development in country i. We allow for time and country fixed effects (not reported).

The first column reports the result of a simple regression of house prices on changes in income. The elasticity of prices with respect to contemporaneous income is 0.99, in this simple regression[15].

The results in the last two columns suggest that the development of housing finance does change the sensitivity of house prices with respect to changes in current income, in the direction predicted by the model in section 2. The coefficients on the interaction terms are positive and strongly significant. This is true both when we use the housing finance index (column 2), and when we use the LTV ratio (column 3) as a measure of financial development. The implied economic magnitude of financial development is also large. If we take a country where the maximum LTV ratio is 0.85 (such as the US), the implied sensitivity of house prices to income is around 1.7. For a country with maximum LTV equal to 0.5 (such as Italy), the implied sensitivity is only around 0.5.

These results are suggestive, but from an empirical perspective it is desirable to consider more fully specified models of house price behavior. For example, there is plenty of evidence that there is a consistent autoregressive pattern in house prices. There is positive autocorrelation at short lags, but negative serial correlation at longer lags[16]. This

[15] This value is well in line with the coefficient of 0.8 obtained for the US data, in Lamont and Stein (1999).

[16] See for example Case and Shiller (1989), and Cutler, Poterba and Summers (1991).

pattern has been shown to hold in international data as well[17]. We should also consider the possibility that other variables such as interest rates are important forces driving house price behavior. To the extent that the sensitivity of house prices to income still depends on financial development in the context of a more complex empirical model, our result is strengthened.

There are other advantages in considering a fully specified dynamic empirical model as well. It allows us to evaluate the impact of financial development on house price dynamics. And given the concerns about the quality of some of our house price indices, this will allow us to evaluate the properties of our data in the context of the literature on house price dynamics.

5.2 Benchmark model of house price dynamics

Tables 6 reports our search for an appropriate empirical model to fit our data. We drop the interaction terms associated with financial development for the moment. Column 1 of table 6 reports the estimation results associated with the model proposed by Lamont and Stein (1999), in their study of house price dynamics in US cities. They regress annual log house price changes (dP_t) on current log changes in per-capita GDP (dY_t), once-lagged log house price changes (dP_{t-1}), and on the start of period ratio of price to per-capita income (P_{t-1}/Y_{t-1}), plus fixed effects. Lamont and Stein show that the parsimonious specification in column 1 captures well the effects of longer price lags, and also of lagged changes in per-capita GDP.

It turns out that our results mirror precisely these results obtained for the US data, as described in table 6. Lamont and Stein's model (column 1) also describes our data reasonably well. Adding further price and income lags cannot improve the fit substantially, and these further lags are not statistically significant in the presence of the three variables in column 1 (see column 2). These extra lags can become important if we take away the ratio between house prices and income, but the overall fit is worse (column 3), indicating that P_{t-1}/Y_{t-1} indeed captures well the effects of longer lags. Finally, the results on column 4 (with no lagged price data) indicate that at least some autoregressive pattern in house price

[17] See Englund and Ioannides (1997).

dynamics is essential to describe the data well. As in Lamont and Stein, we can clearly take the specification on column 1 as our benchmark specification. This has the added advantage of allowing us to compare our coefficients to theirs.

Our coefficients on column 1 have similar values to those obtained in Lamont and Stein[18]. The main difference is the higher elasticity of house prices to income in the international data (0.7 versus 0.36). All our coefficients are strongly significant (with robust standard errors), and the t-statistics are similar as well. This is particularly important, given our initial concerns about the quality of our house price indices. Even though the overall fit of the model is worse than in the US data (R^2 of 0.5, versus 0.75 in Lamont and Stein), the international data is good enough to generate coefficients that are as reliable as in the US data. In particular, the international data also show the "momentum effect" (house prices tend to go up tomorrow if they go up today), and long term reversal (the negative coefficient on Pt-1/Yt-1)[19].

5.3 Financial constraints and house price dynamics

We will now reintroduce our interaction term to the benchmark specification (specification in column 1) described above. Again, the question we are asking is whether house prices are more sensitive to changes in current income, in countries with high financial development.

The results are reported in table 7. The interaction term is positive, and statistically significant, both for LTV ratios and for the index of financial development.

We also report the results which obtain when we use interaction coefficients for all variables in our benchmark specification (columns 3 and 4). This allows all the coefficients in our benchmark specification to differ according to the level of financial development. Notice that the current sensitivity of house prices to changes in income is still higher in countries with higher financial development.

---

[18] The coefficients on dPt-1 and Pt-1/Yt-1 are remarkably close to each other. Lamont and Stein obtain values of 0.495 and -0.195 for these coefficients.

The coefficients on the other variables (lagged price changes and price to income ratio) are free to vary in this specification of the test. However, they are not significantly different from each other in the two sets of regressions. The effect of financial constraints is clearly on the sensitivity of house prices to changes in income[20].

In order to give a visual illustration of the the economic significance of the effect of financial development, we simulate the impact of a 1% shock to GDP percapita using the coefficients in table 7, column 4. We take two hypothetical countries, one with maximum LTV equal to 0.85 (like the US), and the other with maximum LTV to 0.5 (such as Italy). Figure 2 shows the cumulative house price changes in these two countries. The result we are emphasizing is evident to the eye. The sensitivity of prices to the income shock is considerably higher in the country with high financial development. Prices increase rapidly in such a country, with cumulative price change reaching 1.75% after 3 years. By comparison, a country with low financial development displays a slower and more subdued price response.

5.4 Explaining the individual coefficients

An alternative approach to the one we used in the previous sub-section is to test for the effect of financial development using a two-stage procedure. First, we run a regression for each country, using our benchmark specification (column 1, table 6). Then, we run a cross-section regression where we try to explain the pattern found in the sensitivity of price changes to income changes. This has the advantage of allowing for different dynamics for each country in the sample, but our power to identify an effect of financial development decreases.

---

[19] In a previous version, we also included changes in the real interest rate among the variables which determine house price behavior, but the results were not very strong. The contemporaneous correlation between changes in real rates and changes in house prices is negative (after controlling for further lags), but it is not significant. Also, neither the first nor the second lags appear to be significant for the overall data.

[20] The disadvantage associated with this specification is that, including P_{t-1}/Y_{t-1} among the regressors is only valid under the assumption that there is a constant long run price-to-income ratio (the country fixed effects allow for long run price-to-income ratios to vary across countries, and the time effects allow for general world trends in price-to-income ratios). However, we get the same results in the specification with lags of income changes and one more lag of price changes (column 3 of table 6). These results are nor reported, but are available from the author.

Table 8 shows the estimated sensitivities of prices to current income, for each country in the sample. It also displays data on accounting standards (see section 6.1 ahead) and our data on per capita income in constant international prices, which we use as control variables in the second stage regression[21]. The rationale behind this control is as follows.

It could be the case that high income countries have higher price-income elasticities, simply because house markets are more liquid in such countries, and not because of financing differences. Also, it could be that house price indices are better measured in high income countries, and since income is correlated with financial development, our result could be driven only by measurement error and attenuation bias[22].

Tables 9 and 10 show our results. Overall, the same pattern shown in the previous section emerges. Countries with high financial development tend to have higher price-income elasticities, even after controlling for income and home ownership. This is evidenced by the positive coefficients on the rows associated with HFD and LTV. Also, the effects of income and home ownership are not very important, even before controlling for financial development. In particular, after adjusting for financial development, the effect of income appears to be negative. Therefore, there is little support for the alternative explanations in our data. Financial development seems to be the most important variable to explain the pattern in price-income elasticities[23].

This pattern is also clear in figure 3, which shows graphically the pattern of coefficients and LTV ratios. Figure 3 also makes it clear that there are some outliers in our sample. Clearly, Japan (particularly) and Italy have estimated coefficients (3.72% and -1.74% respectively), which are out of line with the rest of the sample. After we remove these outliers from the regression, the conclusions above are considerably strengthened, as shown in table 10. The effect of financial development is positive, large and significant both for HFD and LTV, income has a negative effect after controlling for financial development. This result is specially suggestive, given the loss in power associated with this specification, as compared to the specification in the previous section.

---

[21] Per-capita income is the average from 1970 to 1990 measured in constant international prices, from the Barro and Lee (1994) data set.

[22] Indeed, the correlation between income and the housing finance index is around 0.70 in our data.

[23] Some coefficients are not significant in table 14, but this seems to be caused by some influential outliers, as shown in the following table.

5.5 Testing for non-linear effects

The empirical results above suggest that financial development increases the sensitivity of prices to income. This is also a robust implication of the model in section 2 (proposition 2). Another implication of the model is that this sensitivity should be higher if financial constraints are binding, than if financial constraints do not bind. If the degree of financial development is so high that households become financially unconstrained, then the sensitivity of prices to income should decrease. This could generate a non-monotonicity on the relationship between financial development and the price-income elasticity.

Naturally, this will only occur if financial constraints become irrelevant for countries with very well developed housing finance. Although we do not believe this is the case for the different countries we consider we can try to accommodate these considerations by looking for non-linear effects of financial development[24]. This is what we do in tables 11 and 12. In table 11, we run separate regressions for the top, bottom and middle one-third of the observations, sorted by financial development. The difference in sensitivities from the top to the middle third of the sample tends to be positive, and higher than the difference from the middle to the bottom third. Thus, there is no evidence for non-monotonicity in the data.

This result is confirmed in table 12. We do the two-stage approach of the previous sub-section, introducing the square of the measure of financial development as a regressor. This should allow us to capture any non-linearities present in the data. Column (1) seems to identify non-monotonicities, given the negative coefficient on the square term. However, this result is driven solely by the outliers Japan and Italy. After we remove them from the sample, the coefficient on the square term becomes positive.

5.6 Robustness Checks

Table 2 shows that our data is characterized by some very extreme values for house price and GDP changes. In the first two columns of table 13 we report what happens if we

eliminate these outliers. We sort the observations on both dY_t and dP_t, eliminate the 1% top and bottom realizations, and repeat our exercise of table 7 (interaction specification).

It is clear from the estimated coefficients that our result is not driven by some influential outliers. The coefficients on the interaction variable are positive, and of higher magnitudes than in table 7. Furthermore, statistical significance (as measured by robust p-values) increases.

One specific concern that we raised before was with the quality of some of our house price indices. Two typical problems are that some indices are known not to be representative of the whole country (Chile, France, Japan, Spain, Switzerland, Taiwan), while other indices are not really residential property indices (Greece and Portugal, which are construction indices, and Japan, which is a land price index). There are some other indices for which we have no reliable information about these characteristics (Austria). These problems could lead to measurement error in house prices, which could bias our coefficients.

Here, we address these possible criticisms by dropping all the countries cited above from the analysis. The results are reported in table 13, columns 3 and 4. Our results survive this important robustness check, despite the loss in statistical power. The magnitudes are very similar to those in table 7, and still significant.

[24] Even for a country like the US, which has very well developed housing finance, previous work has shown that down payment requirements can act as substantial constraints on household behavior. See Linneman and Wachter (1989), and Lamont and Stein (1999).

6 Are the results driven by financial development ?

Our major claim in this paper is that the behavior of house prices depends crucially on the level of financial development across the world. This is evidence that financial constraints on households matter. Furthermore, house prices are more sensitive to income shocks in countries with more developed housing finance. This is evidence that less financial constraints can lead to *higher* fluctuations in investment and prices.

We believe that our index of housing finance development captures well the extent to which households are financially constrained in different countries of the world. One potential problem with this argument is that our index of financial development reflects observed measures of leverage. We use data on household debt to construct our index. Some of the LTV data refers to regulatory constraints on mortgages, but for some countries the data on maximum LTV ratios are constructed from observed values.

This may raise a concern that our index is not a precise measure of the availability of finance to households. Perhaps household debt is low because households choose not to borrow (the usual identification problem)[25]. More importantly, high leverage has been used in the literature as an indication of tighter financial constraints[26].

We try to address these potential criticisms by instrumenting our measure of housing finance development with an alternative measure of financial development, which is not directly related to leverage.

More specifically, we use the index of accounting standards computed by the Center for International Financial Analysis and Research[27]. The idea is that, the higher the standards of financial disclosure in a country, the easier it is for firms to raise funds from a wide circle of investors. We use the data on accounting standards from LaPorta et al (1998), as an instrument for the housing finance variables. Under the assumption that

---

[25] Japelli and Pagano (1989) do address this identification problem directly, and conclude that differences in observed debt reflect mostly the extent to which households are liquidity constrained.

[26] Nevertheless, this is not the case in the consumption and savings literature. For example, Japelli and Pagano (1989, 1994) use high LTV ratios and high consumer debt as evidence of higher availability of credit.

[27] Accounting standards have been used as a measure of financial development in Rajan and Zingales (1998), for example.

similar variables influence the availability of finance to firms and households, accounting standards is an appropriate instrument. Furthermore, it is not subject to the same criticisms as an index which reflects leverage directly.

Our empirical results for the interactive specification are reported in table 14. It is clear that our main result is robust to this important variation in specification. The coefficient on the interaction terms $dY_{t,i}*FD_i$ is always positive and significant, both when we use the (instrumented) housing finance index, and the (instrumented) LTV ratio as a measure of housing finance development. Indeed, the results are even stronger than the previous result without the instrument, in terms of t statistics.

Table 15 shows the results for the alternative two-stage specification (eliminating the outliers). Again, the results indicate that endogeneity of leverage is not an issue here.

We see this as strong indication that it is indeed the availability of finance in a country which drives the cross-country differences in the sensitivity of prices to income.

7 Conclusions and Extensions

In this paper, we show substantial empirical evidence that house prices are more sensitive to shocks to per-capita income, in countries where housing finance is more developed. This result is consistent with the theoretical framework developed in section 2, where we study the impact of progressive relaxation of financial constraints on housing demand and equilibrium house prices. Our results are also consistent with recent literature on financial constraints and business investment (Almeida, 2000, Cleary, 1999 and Kaplan and Zingales, 1997 and 1999), which argues that the investment of less constrained firms can be more sensitive to changes in cash flow.

More broadly, our results challenge the traditional view that financial development should lead to smaller fluctuations in key economic variables. From a policy perspective, our results suggest that even if financial development has other economic benefits, it is desirable to devise policies to minimize the potential side effects on the extent of fluctuations.

There are some important extensions to the current work, both empirical and theoretical.

Our empirical results show that financial development increases the sensitivity of prices to income. This is also a robust implication of the model in section 2. However, we cannot conclude from the analysis that financial constraints amplify sensitivities, in relation to an unconstrained economy. The problem is that we cannot identify the unconstrained price-income elasticity with our empirical approach, specially since we found no evidence for non-monotonicities in section 5.5. The magnitude of the estimated impacts of a 1% change in income (see figures 3 and 4) strongly suggest that there are amplification mechanisms at work in our data, but this is no final proof.

One way to tackle this problem is to find a variable which is correlated with household net worth, but which does not increase the unconstrained demand for houses. In this case, we know that the sensitivity of prices to income in an unconstrained economy is

zero, and we can attribute all the estimated sensitivities to financial constraints[28]. This is an open question for future research.

The model in section 2 equates housing finance development to a decrease in down-payment requirements (or an increase in LTV ratios). Although this seems to be consistent with the data, it is a one-sided view of financial development, even when we consider only the household sector. There are other theoretical effects of financial development which can affect the ability of households to finance their housing expenditures, and the ability to hedge against income fluctuations. The model assumes that the only way a household can raise credit is by pledging the house as collateral. One possible effect of financial development is to improve the chances that households raise uncollateralized debt (such as credit card debt)[29]. This can potentially revert the result that financial development increases the sensitivity of prices to income. A similar effect would probably arise if financial development also meant a better ability to hedge against income fluctuations. It would be interesting to extend the model in section 2 to accommodate these considerations.

One important caveat is that neither the model in section 2 (like Stein, 1995) nor Almeida, 2000 is a fully dynamic model. Therefore, some of the empirical analysis in sections 5 and 6 is not fully grounded in theory. An important extension is to consider the impacts of financial development in a fully dynamic model of the housing market which allows for the impact of credit constraints (perhaps along the lines of Ortalo-Magne and Rady, 1998, 1999).

[28] The investment literature uses variations in cash flow which are not explained by variations in Tobin's Q as such an instrument. If we can find an empirical counterpart to Tobin's Q in the housing market, this approach can be implement to our data as well.

[29] In terms of the model in section 2, this implies that households can raise debt in period 1 against future income W_2.

Appendix

Data Description

Our house price indices were constructed from various sources. Most of the data for developed countries were supplied by Peter Englund. It is the same data used in Englund and Ioannides (1997). Below we refer to this source as "EIO". We updated their data set using the Annual Reports from the Bank of International Settlements (BIS). We list all the specific sources for each country, and the information we have about the respective indices.

Australia. EIO, and BIS. Weighted average index of prices for all capital cities and other areas; obtained from quarterly national census of home loan approvals, available annually.

Austria. Maclennan, Muellbauer and Stephens (1998). Index *apparently* based on existing houses, from the European Mortgage Federation (EMF).

Belgium. EIO, and BIS. Index based on annual transactions reports on small and medium sized dwellings from entire country, with outliers excluded, available annually.

Canada. EIO, and BIS. Average annual transaction prices reported by multiple listing services for entire country, covering 70% of all transactions.

Chile. Data provided by Felipe Morande, from Morande, F. and R.Soto (1992) updated by R. Soto. Based on standardized dwellings in the area of Santiago, annual average.

Denmark. EIO, and BIS. Average value of single-family houses, including only arms' length sales, available annually.

Finland. EIO and BIS. Average price per apartment and terraced houses, obtained per square meter, as recorded by realtors (including 30% of all transactions), weighted by region, available quarterly.

France. EIO and BIS. Index based on BIS own estimate, based on annual values for the Paris region, adjusted by four-year survey for entire country.

Germany. EIO and BIS. Transaction prices per square meter, obtained from realtors for the four largest cities, available annually.

Greece. Maclennan, Muellbauer and Stephens (1998). Construction index, from the EMF.

Hong Kong. From Chou and Shih (1995). Yearly change in the property price index, not

quality adjusted.

Ireland. EIO and BIS. Average transactions price for existing homes, based on all loan approvals, available annually.

Israel. Property price index representative of the entire country, from the Social Sciences Data Archive.

Italy. EIO and BIS. Average price for new and completely refurbished dwellings in large and middle-sized cities and tourist areas, reported by realtors, available annually.

Japan. EIO and BIS. Based on a survey of prices per square meter of land transactions in residentially zoned areas, appraised by realtors, conducted annually.

Korea. Data from Kim (1993). Real price index from the Korea Housing Bank.

Malaysia. Data provided by S. Malpezzi. Real housing price index, used in Malpezzi and Mayo (1997a).

Netherlands. EIO and BIS. Weighted average sales price for existing single and multi-family houses, reported by realtors, including 50-60% of all transactions, available annually.

New Zealand. Data from O'Donovan and Rae (1997). Valuation New Zealand house price series. Average prices of free-hold house sales, adjusted for quality.

Norway. EIO and BIS. Average sales price of existing homes, weighted by type of dwelling, reported by Property Owner's Association, covering about 50% of all transactions.

Portugal. Maclennan, Muellbauer and Stephens (1998). Construction index, from the EMF.

Singapore. Data from Phang and Wong (1997). Value weighted average of current prices of five types of property in five planning districts. Excludes public housing.

Spain. Data provided by O. Bover. Prices per square meter of new dwellings in Madrid, used in Bover (1993).

Sweden. EIO and BIS. Index based on owner-occupied one- and two-dwelling buildings, based on reports of title registrations for arm's length transactions, weighted by type of dwelling, available annually.

Switzerland. Data from Hoesli, Giacotto and Favarger (1997). Repeat sales index for condominiums in Geneva.

Taiwan. Data from Chang and Lai (1993). Change of house prices in Taipei.

Thailand. Data provided by S. Malpezzi. Real housing price index, used in Malpezzi and Mayo (1997a).
UK. EIO and BIS. Index based on survey of all dwellings with building societies mortgages, weighted by type of dwelling, available annually.
US. EIO and BIS. Index based on sales price of existing single-family homes, based on realtor reports, adjusted by regional availability of single-family homes and homeowner mobility, available annually.

Construction of the Index of Household Indebtedness

Our starting point to construct the index in the second column of table 3 is the table below, constructed from various sources. If a country is systematically ranked in the two top quartiles in the different studies in the table below, it is assigned a value equal to one in table 3. This is true of Australia, Canada, Denmark, Finland, Germany, Norway, Sweden, Switzerland, UK and US. If a country is systematically ranked in the middle quartiles, it is assigned a value of 0.5 in table 3. This is the case of Austria, Belgium, France, Ireland, Japan, Netherlands, Portugal, and Spain. If a country is systematically ranked in the bottom quartiles, it is assigned a value of zero (Korea, Italy and Greece). An eye examination of the table below makes it clear that our classification is not very controversial. If there are doubts about how to classify a country, or if there is no data available, we assigned a "na" to such a country.

All the data we used is listed on table A.1 below.

Construction of the Literature Dummy

We use verbal descriptions of the housing market in different countries to add information to our indicators of the development of housing finance. Information for each individual country is listed below. For the countries that are not listed below, we were not able to find relevant discussions. These countries get a value "na" in table 3. If the evidence below suggests that households are constrained, the literature dummy (LD) is set equal to zero. If the literature strongly suggests that households do not face substantial financial

constraints, we set our dummy variable to one.

Austria. Deutsch (97) discusses Austrian housing finance. According to the author, Austria is a clear example of liquidity constraints generated by high down-payment rates. This evidence is complemented by Deutsch and Tomman (1995), who describe mortgage finance in Austria as characterized by rather prudent lending practices. LD = 0.

France. Holmans (1994) gives data on moving owners and age/tenure relationships in France. In France, the slope of the age/tenure profile is high; indicating that people may have to wait more in order to be able to buy house. Also the percentage of moving owners is smaller than in the UK and the US. Japelli and Pagano (1994) mention that the costs of enforcing contracts and disposing of collateral exceed 10% in Greece, Belgium, Spain, France, Italy, Portugal (EMF, 1990) while they are just around 5% in the rest of the European community. Finally, Miles (1994) classifies France households as being "credit rationed to a limited extent". LD = 0.

Germany. Deutsch and Tomman (1995) describe mortgage finance in Germany as characterized by rather prudent lending practices. Holmans (1994) gives data on moving owners and age/tenure relationships in Germany. The slope of the age/tenure profile is high, indicating that people may have to wait more in order to be able to buy house. Also the percentage of moving owners is smaller than in the UK and the US.

Muellbauer, J. (1992) compares the German and the British housing finance systems, concluding that gearing is certainly, on average, lower in Germany than in the UK. Mulder and Wagner (1998) compare Germany to the Netherlands. In Netherlands, the transition to home ownership is more concentrated at young ages. The author sees this as evidence that Germans need more time to save in order to buy house. Finally, Miles (1994) classifies German households as credit rationed to a limited extent. LD = 0.

Greece. Pirounakis (1997) gives relevant data on the Greek housing market. There are 69.5% of owner-occupiers in Greece, in 1981, but only 9% of those are repaying mortgages. According to the author, housing credit is very small. Boleat (1985) characterizes Greece as having an underdeveloped housing finance system. LD = 0.

Israel. Bar Nathan, Beenstock and Haitovsky (1998) describe housing finance in Israel. According to them, no well-developed mortgage market exists. Housing is largely financed out of own resources, and it is common that parents help their children to finance house

purchases. LD = 0.

Italy. Guiso, L. T. Japelli and D. Terlizzese (1994) present evidence suggesting that mortgage market imperfections are the most important factor in explaining the shape of the Italian tenure-age profile. In Italy, home ownership ratio increases slowly with age, peaking just before retirement, while in the US and UK, the profile peaks much earlier. Besides the high down payment requirements that we document in table 3, interest rate spreads are high and maturities are low. Also, there are substantial costs of enforcing contracts and disposing of collateral. Miles (1994) classifies Italian households as credit rationed to a limited extent. LD = 0.

Japan. Lomax (1994) suggests that, in general, mortgages remain rationed to a much greater extent in continental Europe and Japan, as compared to the UK and US. Miles (1994) also mentions that people are able to borrow more, and for longer, in the US and UK than in Japan or continental Europe. Finally, Miles (1994) classifies Japan as credit rationed to a limited extent. LD = 0.

Korea. According to Kim (1993), there is no significant formal housing finance in Korea. Hannah, Kim and Malpezzi (1993) basically agree with Kim (93), and Green, Malpezzi and Vandell (1994) mention that few Korean homeowners obtain significant debt financing, with most having 100% equity or close to it. LD = 0.

Netherlands. Mulder and Wagner (1998) compare Netherlands to Germany, and generally describe the Dutch housing finance system as very efficient and free of down payment and other constraints. LD = 1.

New Zealand. Boleat (1985) analyzes housing finance in New Zealand. Generally, there is a shortage of mortgage finance. A two-year period of savings is essential to secure a mortgage, and down payment is at least 20%. For its standard of living, New Zealand still has a fairly primitive housing finance system. High LTV loans are generally not available. LD = 0.

Portugal. Boleat (1985) characterizes Portugal's housing finance as typical of an underdeveloped economy. The financial system in general is not well developed, with a considerable amount of activity outside the main institutional framework.

Japelli and Pagano (1994) mention the high costs of enforcing contracts and disposing of collateral in Portugal. LD = 0.

Switzerland. Boleat (1985) describes the Swiss housing finance system as one of the most efficient in the world. For example, there is considerable evidence that mortgage debt, as a percentage of GDP is highest in Switzerland. LD = 1.

Taiwan. Chang and Lai (1993) say that In Taiwan, the institutional environment for real estate finance is not well established. There is a lack of well developed financial institutions. LD = 0.

Thailand. Boleat (1985) mentions that in Thailand, the main source of housing finance are friends and relatives. Housing lending is a very small percentage of total bank lending. LD = 0.

UK. The UK is usually used in the literature as an example of a country with little restrictions on household finance. Besides all the evidence described above, Miles (1994) classifies the UK as having a slight extent of credit rationing. LD = 1.

US. Similar to the UK. LD = 1.

References

Almeida, H. (1999), "Financial Constraints, Asset Liquidity and Investment," mimeo, University of Chicago.

Almeida, H. (2000), "Credit Constraints and Investment-Cash Flow Sensitivities", mimeo, University of Chicago.

Bar Nathan, M., M. Beenstock and Y. Haitovsky (1998), "The Market for Housing in Israel," *Regional Science and Urban Economics*, 28: 21-49.

Barro, R. and J. Lee (1994), "Sources of Economic Growth," *Carnegie-Rochester Conference Series on Public Policy*, 40: 1-46.

Boleat, M. (1985), *National Housing Finance Systems*, Croom Helm, London.

Borio, C. (1996), "Credit Characteristics and the Monetary Policy Transmission Mechanism in Fourteen Industrial Countries: Facts, Conjectures and Some Econometric Evidence," in C. Kool and C. Winder, *Monetary Policy in a Converging Europe*, Kluwer Academic Press.

Borio, C., N. Kennedy and S. Prowse (1994), "Exploring Aggregate Price Fluctuations Across Countries: Measurement, Determinants and Monetary Policy Implications," *BIS*

Economic Papers, 40.

Bover, O. (1993), "Un Modelo Empirico de la Evolucion de los Precios de la Vivienda en Espana," *Investigaciones Economicas*, XVII: 65-86.

Case, K.E. and R.J. Shiller (1989), "The Efficiency of the Market for Single-Family Homes," *American Economic Review*, 79: 125-137.

Chang, C.O and P. Lai (1993), "Indicators of Real Estate Cycles in Taiwan," mimeo.

Chou, W.L and Shih, Y.C (1995), "Hong Kong Housing Markets: Overview, Tenure Choice and Housing Demand," *Journal of Real Estate Finance and Economics* 10: 7-21.

Cleary, S. (1999), "The Relationship Between Firm Investment and Financial Status," The Journal of Finance, LIV: 673-692.

Cutler D.M., J.M. Poterba and L.H. Summers (1991), "Speculative Dynamics," *Review of Economic Studies*, 58: 529-546.

Deutsch, E. (1997), "Indicators of Housing Finance. Intergenerational Wealth Transfers," *Real Estate Economics*, 25: 129-172.

Deutsch, E. and H. Tomman (1995), "Home Ownership Finance in Austria and Germany," *Real Estate Economics*, 23: 441-74.

Englund, P. and Y. Ioannides (1997), "House Price Dynamics: An International Empirical Perspective," *Journal of Housing Economics*, 6: 119-136.

Fazzari S., G. Hubbard and M. Petersen (1988), "Financing Constraints and Corporate Investment," *Brooking Papers on Economic Activity* 1:141-95.

Fazzari S., G. Hubbard and M. Petersen (2000), "Investment-Cash Flow Sensitivities Are Useful: A Comment on Kaplan and Zingales," *Quarterly Journal of Economics*.

Green, R., S. Malpezzi and K. Vandell (1994), "Urban Regulations and the Price of Land and Housing in Korea," *Journal of Housing Economics*, 3: 330-356.

Gropp, R., R. Scholtz and M. Weiss (1997), "Personal Bankruptcy and Credit Supply and Demand," *Quarterly Journal of Economics*, 112:217-251.

Guiso, L. T. Japelli and D. Terlizzese (1994), "Housing Finance Arrangements, Intergenerational Transfers and Consumption. The Italian Experience," *Economic Modeling*, 11:145-155

Hannah, L., K.H. Kim and E. Mills (1993), "Land Use Controls and House Prices in Korea," *Urban Studies*, 30: 147-56.

Hoesli, M., C. Giacotto and P. Favarger (1997), "Three New Real Estate Price Indices for Geneva, Switzerland," *Journal of Real Estate Finance and Economics* 15:1, 93-109

Holmans, A.E. (1994), "House Prices, Land Prices, the Housing Market and House Purchase Debt in the UK and Other Countries," *Economic Modeling*, 11:157-199.

Japelli, T. and M. Pagano (1989), "Consumption and Capital Market Imperfections: An international Comparison," *American Economic Review*, 79: 1088-1105.

Japelli ,T. and M. Pagano (1994), "Savings, Growth and Liquidity Constraints," *Quarterly Journal of Economics*, 109: 83-109.

Kaplan, S. and L. Zingales (1997), "Do Financing Constraints Explain why Investment is Correlated with Cash Flow?," *Quarterly Journal of Economics* 169-215.

Kaplan, S. and L. Zingales (2000), "No. Investment-Cash Flow Sensitivities are not Useful Measures of Financial Constraints," *Quarterly Journal of Economics*.

Kim, K.H. (1993), "Housing Prices, Affordability and Government Policy in Korea," *Journal of Real Estate Finance and Economics*, 6: 55-71.

Lamont, O. and J. Stein (1997), "Leverage and House Price Dynamics in US Cities," *NBER Working Paper* 5961.

Lamont, O. and J. Stein (1999), "Leverage and House Price Dynamics in US Cities," *RAND Journal of Economics*, 30: 498-514.

LaPorta, R., F. Lopez-De-Silanes, A. Shleifer and R. Vishny (1998), "Law and Finance," mimeo, Harvard University.

Levine, D. (1997), "Financial Development and Economic Growth: Views and Agenda," *Journal of Economic Literature*, XXXV: 688-726.

Levine, D. and H. Servos (1998), "Stock Markets, Banks and Economic Growth," *American Economic Review*, 88: 537-558.

Linemman, P. and S. Wachter (1989), "The Impacts of Borrowing Constraints on Homeownership," *AREUEA Journal*, XVII, 389-402.

Lomax, J. (1994), "Market Structure, Institutional Development and the Provision of Housing Finance," *Economic Modeling*, 11:215-227

Malpezzi, S. (1990), "Urban Housing and Financial Markets. Some International Comparisons," *Urban Studies*, 27: 971-1022.

Malpezzi, S. and S. Mayo (1987), "User Cost and Housing Tenure in Developing

Countries," *Journal of Development Economics*, 25: 197-220.

Malpezzi, S. and S. Mayo (1997a), "Getting Housing Incentives Right: A Case Study of the Effects of Regulation, Taxes, and Subsidies of Housing Supply in Malaysia," *Land Economics*, 73(3): 372-391.

Malpezzi, S. and S. Mayo (1997b), "Housing and Urban Development Indicators: A Good Idea whose Time has Returned," *Real Estate Economics*, 25: 372-391.

Maclennan, Muellbauer and Stephens (1998), "Asymmetries in Housing and Financial Market institutions and EMU," *Oxford Review of Economic Policy*, 14:54-80

Miles, D. (1994), *Housing, Financial Markets and the Wider Economy*. Wiley, London.

Morande, F. and R.Soto (1992), "Una nota sobre la construccion de series de precios de activos reales: Tierra y Casas en Chile," *Revista de Análisis Económico*, vol 7:169-178.

Muellbauer, J. (1992), "Anglo-German Differences in Housing Market Dynamics," *European Economic Review*, 36:539-548.

Mulder C. and M. Wagner (1998), "First Time Home-Ownership in the Family Life Course: A West German-Dutch Comparison," *Urban Studies*, 35: 687-713.

O'Donovan, B. and D. Rae (1997), "The Determinants of House Prices in New Zealand: An Aggregate and Regional Analysis," *New Zealand Economic Papers*, 31:175-198.

Ortalo-Magne, F. and S. Rady (1998), "Housing Market Fluctuations in a Life-Cycle Economy with Credit Constraints," mimeo

Ortalo-Magne, F. and S. Rady (1999), "Why Are Housing Prices So Volatile? Income Shocks In a Stochastic Heterogeneous-Agents Model," mimeo

Phang, S.Y. and W. K.Wong (1997), "Government Policies and Private Housing Prices in Singapore," *Urban Studies*, 34: 1819-29.

Pirounakis, N. G. (1997), *The Greek Economy: Past, Present and Future*, St. Martin's Press, New York.

Poterba, J.M (1991), "House Price Dynamics: The Role of Tax Policy and Demography," *Brookings Papers in Economic Activity*, p.143-183.

Rajan, R. and L. Zingales (1998), "Financial Dependence and Growth," *American Economic Review*, 88: 559-573.

Renaud, B. (1995), "The 1985-1994 Global Real Estate Cycle, its Causes and Consequences," World Bank Policy Research Working Paper 1452.

Spiegel, M. (1999), “Housing Return and Construction Cycles, ” mimeo, Yale School of Management.

Stein, J. (1995), “Prices and Trading Volume in the Housing Market: A Model with Down-Payment Effects,” *Quarterly Journal of Economics*, May: 379:406.

Stephens (1995), “Monetary Policy and House Price Volatility in Western Europe,” *Housing Studies*, 10:105-120.

Whited, T. (1992), " Debt, Liquidity Constraints and Corporate Investment: Evidence from Panel Data," *Journal of Finance* 47: 425-60.

Table 1: Summary statistics, 29 countries, 1970-1998

Variable	*Description*	Obs	Mean	Standard Deviation	Max	Min
dP	Change in log real house price	651	0.019	0.099	-0.608	0.664
dY	Change in log real percapita GDP	758	0.028	0.038	-0.264	0.365

Sources: IMF international financial statistics (IFS), for GDP, population and inflation data. For the sources of the house price data, see the appendix.

Table 2. Summary of house price data per country, 1970-1998
Annual change in log real house prices

Country	Obs	Mean	Standard Deviation	Max	Min
Australia	28	0.009	0.071	-0.123	0.253
Austria	7	0.042	0.016	0.016	0.061
Belgium	28	0.016	0.062	-0.115	0.138
Canada	28	0.014	0.070	-0.177	0.139
Chile	23	0.025	0.190	-0.608	0.249
Denmark	28	0.009	0.084	-0.162	0.128
Finland	28	0.007	0.106	-0.214	0.261
France	28	0.010	0.058	-0.101	0.210
Germany	27	0.003	0.087	-0.135	0.224
Greece	8	0.000	0.032	-0.058	0.030
Hong Kong	12	0.042	0.184	-0.257	0.376
Ireland	28	0.021	0.070	-0.136	0.180
Israel	27	0.024	0.082	-0.113	0.226
Italy	22	0.007	0.106	-0.149	0.293
Japan	28	0.013	0.111	-0.313	0.242
Korea	16	0.059	0.073	-0.052	0.171
Malaysia	14	0.059	0.105	-0.136	0.253
Netherlands	28	0.022	0.093	-0.174	0.273
New Zealand	21	-0.002	0.070	-0.124	0.126
Norway	28	0.016	0.086	-0.182	0.179
Portugal	12	0.021	0.034	-0.020	0.080
Singapore	23	0.073	0.183	-0.302	0.453
Spain	22	0.021	0.118	-0.117	0.307
Sweden	28	-0.004	0.072	-0.163	0.113
Switzerland	22	0.004	0.072	-0.172	0.109
Taiwan	15	0.082	0.201	-0.105	0.664
Thailand	16	-0.001	0.012	-0.025	0.018
UK	28	0.022	0.111	-0.145	0.322
United States	28	0.015	0.031	-0.049	0.074
Total	651	0.019	0.099	-0.608	0.664

Sources: See the appendix.

Table 3. Indicators of development of the housing finance market

Country	LTV ratio	Household debt; 1=high or average to high. 0.5 = average 0 = low	Borio Ranking; 1= high 0.5 = average 0 = low	Literature dummy; = 0 if credit constrained	Index of Housing Finance Development
Australia	0.78	1	1	na	0.87
Austria	0.68	0.5	0.5	0	0.34
Belgium	0.70	0.5	1	na	0.63
Canada	0.80	1	1	na	0.89
Chile	na	na	na	na	na
Denmark	0.90	1	na	na	0.98
Finland	0.83	1	na	na	0.88
France	0.80	0.5	0.5	0	0.42
Germany	0.73	1	0.5	0	0.50
Greece	0.50	0	na	0	0.03
Hong Kong	na	na	na	na	na
Ireland	0.85	0.5	na	na	0.69
Italy	0.53	0	0	0	0.04
Israel	0.50	na	na	0	0.04
Japan	0.60	0.5	0	0	0.18
Korea	0.30	0	na	0	0.00
Malaysia	0.65	na	na	na	0.28
Netherlands	0.75	0.5	1	1	0.77
New Zealand	0.73	na	na	0	0.26
Norway	0.78	1	na	na	0.80
Portugal	0.60	0.5	na	0	0.23
Singapore	0.85	na	na	na	0.88
Spain	0.70	0.5	0.5	na	0.47
Sweden	0.93	1	0.5	na	0.83
Switzerland	na	1	1	1	1.00
Taiwan	0.40	na	na	0	0.02
Thailand	0.65	na	na	0	0.14
United Kingdom	0.84	1	1	1	0.95
United States	0.85	1	1	1	0.96

Sources: LTV data is from Japelli and Pagano (1994), with the exception of Austria, Canada and Singapore. Data refer to the maximum LTV ratio, averaged over the period 1971-1987. Austria LTV data is from Deutsch (1997). Canada LTV data is from Guiso, Japelli and Terlizzese (1994). Singapore LTV data is from Phang and Wong (1997). The Borio ranking is from Borio (1996). It measures the share of total credit to the non-government sector that goes to households. The index of household indebtedness is constructed from various different sources. See the appendix, specially table A.1. The literature dummy is also constructed from various sources in the literature. See the appendix for a discussion of each specific country. The index in the final column is an average of the four previous columns (LTV ratio rescaled to be between 0 and 1).

Table 4. Correlation matrix for the different indicators of housing finance development

	LTV ratio	Household indebtedness index	Borio ranking	
LTV ratio	1.00			
Household indebtedness index	0.79	1.00		
Borio ranking	0.59	0.62	1.00	
Literature dummy	0.71	0.62	0.89	

Sources: own calculations from several sources cited in the text.

Table 5. Results from univariate specification

	All Data	FD = HFD index	FD = LTV ratio
dYt	0.99	0.33	-1.25
	(2.91)	(2.03)	(-1.79)
dYt*FD		1.59	3.46
		(3.23)	(2.97)
No of Obs	641	606	584
Adjusted R^2	0.28	0.32	0.32

The dependent variable is dP_t, the change in log real house price in year t, in country j. dY_t is the change in GDP per-capita in country j, year t. All regressions include country and year fixed effects. Robust t-statistics in parenthesis.

Table 6. Benchmark empirical model

	(1)	(2)	(3)	(4)
dYt	0.704	0.710	0.866	1.002
	(3.4)	(3.3)	(2.80)	(3.24)
dPt-1	0.456	0.450	0.377	
	(6.95)	(5.88)	(3.72)	
Pt-1 /Yt-1	-0.176	-0.190		
	(8.61)	(7.88)		
dYt-1		0.001	0.218	0.540
		(0.01)	(1.61)	(3.37)
dYt-2		-0.124	0.075	0.128
		(0.95)	(0.55)	(1.03)
dPt-2		0.061	-0.108	
		(0.926)	(1.53)	
No of Obs	612	583	583	604
Adjusted R^2	0.48	0.49	0.39	0.31

The dependent variable is dP_t, the change in log real house price in year t, in country j. dY_t is the change in GDP per-capita in country j, year t, and P_{t-1}/Y_{t-1} is the ratio of house prices to income per-capita.
All regressions include country and year fixed effects.
Robust t-statistics in parenthesis.

Table 7. Interaction with financial development

	FD = HFD index	FD = LTV ratio	FD = HFD index	FD = LTV ratio
dYt	0.337	-0.426	0.341	-0.545
	(2.92)	(0.83)	(3.27)	(1.40)
dPt-1	0.481	0.485	0.556	0.72
	(11.04)	(10.8)	(4.08)	(1.83)
Pt-1 /Yt-1	-0.156	-0.159	-0.21	-0.386
	(7.94)	(7.49)	(3.89)	(2.73)
dYt*FD	0.885	1.71	0.935	1.955
	(2.563)	(1.96)	(2.96)	(2.74)
dPt-1*FD			-0.129	-0.322
			(0.72)	(0.64)
(Pt-1 /Yt-1)*FD			0.089	0.305
			(1.26)	(1.71)
No of Obs	579	558	579	558
Adjusted R^2	0.51	0.52	0.51	0.52

The dependent variable is dP_t, the change in log real house price in year t, in country j. dY_t is the change in GDP per-capita in country j, year t, and P_{t-1}/Y_{t-1} is the ratio of house prices to income per-capita.
All regressions include country and year fixed effects.
Robust t-statistics in parenthesis.

Table 8. Separate regressions for each country

	Coefficient	Account. Std.	Income
Australia	1.51	0.75	0.84
Austria	0.08	0.54	0.67
Belgium	0.88	0.65	0.71
Canada	1.25	0.74	0.92
Chile	2.78	0.52	0.23
Denmark	2.28	0.62	0.76
Finland	1.71	0.77	0.73
France	1.18	0.69	0.76
Germany	0.59	0.62	0.76
Greece	0.96	0.55	0.37
Hong Kong	-0.39	0.69	0.57
Ireland	1.04	na	0.43
Italy	-1.74	0.64	0.48
Israel	0.36	0.62	0.65
Japan	3.72	0.65	0.69
Korea	0.73	0.62	0.23
Malaysia	0.82	0.76	0.22
Netherlands	1.42	0.64	0.72
New Zealand	-0.07	0.7	0.70
Norway	2.17	0.74	0.78
Portugal	-0.50	0.36	0.32
Singapore	2.31	0.78	0.44
Spain	1.92	0.64	0.50
Sweden	1.24	0.83	0.82
Switzerland	0.29	0.68	0.96
Taiwan	1.11	0.65	0.32
Thailand	-0.03	0.64	0.14
United Kingdom	1.92	0.78	0.67
United States	0.41	0.71	1.00

Coefficient is the coefficient on income change in the benchmark specification which includes lagged price changes and last period ratio of prices to income. Income is the 1970-1990 average GDP percapita measured in constant international prices, from Barro and Lee (1994). The data on accounting standards from LaPorta et al (1998).

Table 9. Explaining the individual coefficients

	(1)	(2)	(3)	(4)	(5)
HFD	1.176			1.391	
	(2.17)			(1.84)	
LTV		1.273			1.095
		(1.92)			(1.31)
Income			0.510	-0.477	0.403
			(0.574)	(0.414)	(0.36)
Obs	27	26	29	27	26
Adjusted R^2	0.16	0.10	-0.02	0.09	0.06

The dependent variable is the coefficient on income change in the benchmark specification which includes lagged price changes and last period ratio of prices to income, for each country. HFD is the housing finance index (see table 3), and LTV the loan to value ratio. Income is the 1970-1990 average GDP percapita measured in constant international prices, from Barro and Lee (1994).

Table 10. Explaining the individual coefficients (no Japan, no Italy)

	(1)	(2)	(3)	(4)	(5)
HFD	1.186			1.825	
	(3.08)			(3.45)	
LTV		1.327			1.479
		(2.89)			(2.49)
Income			0.155	-1.293	-0.319
			(0.22)	(1.69)	(0.42)
Obs	25	24	27	25	25
Adjusted R^2	0.26	0.24	-0.04	0.32	0.21

The dependent variable is the coefficient on income change in the benchmark specification which includes lagged price changes and last period ratio of prices to income, for each country. HFD is the housing finance index (see table 3), and LTV the loan to value ratio. Income is the 1970-1990 average GDP percapita measured in constant international prices, from Barro and Lee (1994). The observations for Japan and Italy have been dropped from the regressions.

Table 11. Testing for non-linear effects

	FD = HFD index		FD = LTV Ratio	
	High-Med	Med-Low	High-Med	Med-Low
dYt	0.414	0.384	0.784	0.248
	(1.03)	(1.65)	(2.18)	(1.25)
dPt-1	-0.011	-0.062	-0.049	-0.081
	(0.19)	(0.43)	(0.69)	(0.61)
Pt-1 /Yt-1	-0.056	0.092	0.037	0.030
	(1.50)	(1.78)	(1.19)	(0.66)
No of Obs	411	406	384	378
Adjusted R^2	0.55	0.50	0.55	0.49

The data are sorted based on the measure of financial development, and separate regressions are run for the top, medium and bottom one-third of the observations (approximately). The dependent variable is dP_t, the change in log real house price in year t, in country j. dY_t is the change in GDP per-capita in country j, year t, and P_{t-1}/Y_{t-1} is the ratio of house prices to income per-capita. All regressions include country and year fixed effects. Robust t-statistics in parenthesis.

Table 12. Testing for non-linear effects with individual coefficients

	All sample	All sample	No outliers	No outliers
HFD	2.003		0.589	
	(0.83)		(0.35)	
LTV		0.640		0.322
		(0.25)		(0.19)
HFD square	-0.827		0.590	
	(0.35)		(0.37)	
LTV square		0.644		1.017
		(0.25)		(0.61)
Obs	27	26	25	24
Adjusted R^2	0.09	0.06	0.23	0.22

The dependent variable is the coefficient on income change in the benchmark specification which includes lagged price changes and last period ratio of prices to income, for each country. HFD is the housing finance index (see table 3), and LTV the loan to value ratio. The observations for Japan and Italy have been dropped from the regressions in columns (3) and (4).

Table 13. Robustness Checks

	No Outliers	No Outliers	Selected Countries	Selected Countries
	FD = HFD index	FD = LTV ratio	FD = HFD index	FD = LTV ratio
dYt	0.127	-0.816	0.181	-0.783
	(0.408)	(1.07)	(1.31)	(1.80)
dPt-1	0.418	0.416	0.433	0.445
	(9.917)	(9.89)	(10.44)	(10.74)
Pt-1 /Yt-1	-0.119	-0.122	-0.145	-0.152
	(6.00)	(5.68)	(7.108)	(7.19)
dYt*FD	1.355	2.434	1.264	2.197
	(2.89)	(2.35)	(3.74)	(2.79)
No of Obs	562	542	448	448
Adjusted R^2	0.47	0.48	0.51	0.51

The top and bottom 1% of the observations sorted on dP_t and dY_t were discarded in the first two columns.
All the observations for Austria, Chile, France, Greece, Japan, Portugal, Spain, Switzerland and Taiwan were eliminated from the regressions in the last two columns.
The dependent variable is dP_t, the change in log real house price in year t, in country j. dY_t is the change in GDP per-capita in country j, year t, and P_{t-1}/Y_{t-1} is the ratio of house prices to income per-capita.
All regressions include country and year fixed effects. Robust t-statistics in parenthesis.

Table 14. Instrumenting housing finance with accounting standards

	FD = HFD index	FD = LTV ratio
dYt	0.136	-1.831
	(0.684)	(2.57)
dPt-1	0.474	0.470
	(11.2)	(10.9)
Pt-1 /Yt-1	-0.155	-0.156
	(7.73)	(7.34)
dYt*FD	1.640	4.107
	(4.11)	(3.81)
No of Obs	553	532
Adjusted R^2	0.51	0.51

The dependent variable is dP_t, the change in log real house price in year t, in country j. dY_t is the change in GDP per-capita in country j, year t, and P_{t-1}/Y_{t-1} is the ratio of house prices to income per-capita.
The housing finance index and the LTV ratio are instrumented with accounting standards.
All regressions include country and year fixed effects.
Robust t-statistics in parenthesis.

Table 15. Explaining the individual coefficients with instrument for financial development (no Japan, no Italy)

	(1)	(2)	(3)	(4)	(5)
HFD	2.224			3.865	
	(2.70)			(2.44)	
LTV		2.455			3.531
		(2.81)			(2.36)
Income			0.155	-3.556	-2.164
			(0.22)	(1.94)	(1.48)
Obs	24	23	27	24	23
Adjusted R^2	0.03	0.10	-0.04	-0.05	-0.01

The dependent variable is the coefficient on income change in the benchmark specification which includes lagged price changes and last period ratio of prices to income, for each country. HFD is the housing finance index (see table 3), and LTV the loan to value ratio. Income is the 1970-1990 average GDP percapita measured in constant international prices, from Barro and Lee (1994). The observations for Japan and Italy have been dropped from the regressions. The housing finance index and the LTV ratio are instrumented with accounting standards.

Table A.1. Indicators of household indebtedness

	Japelli and Pagano (1989) Housing Mortgage Loans, as % of total consumption	Kim (93) Housing Loans outstanding as % of GNP	Boleat (1985) Mortgage Debt as % of National Income	Holmans (1994) House purchase debt as % of GDP	Guiso, Japelli and Terlizzese (1994) Mortgage Debt as % of GNP	Muellbauer et al (1998) Outstanding residential mortgage debt as % of GDP
Australia	na	na	na	na	na	Na
Austria	na	na	na	na	na	30-33
Belgium	na	na	na	na	na	22
Canada	na	na	36	na	na	Na
Chile	na	na	na	na	na	Na
Denmark	na	na	na	na	na	65
Finland	na	na	na	na	na	30
France	na	na	28	16	21	21
Germany	na	na	37	20	22	51
Greece	9.9	na	na	na	na	6
H. Kong	na	na	na	na	na	na
Ireland	na	na	na	na	na	27
Italy	7.8	na	6	na	7	7
Israel	na	na	na	na	na	na
Japan	32.7	32.9	15	na	25	na
Korea	na	9.4	na	na	na	na
Malaysia	na	na	na	na	na	na
Netherl.	na	na	na	na	na	60
New Zeal.	na	na	na	na	na	na
Norway	na	na	na	na	na	na
Portugal	na	na	na	na	na	26
Singapore	na	na	na	na	na	na
Spain	7.7	na	na	na	na	22
Sweden	80.3	na	na	na	na	57
Switz.	na	na	64	na	na	na
Taiwan	na	na	na	na	na	na
Thailand	na	na	na	na	na	na
UK	46.4	44.9	28	46	58	51
US	61.7	55.2	41	39	45	na

Table A.1 continued

	Borio (96) Credit to household sector as % of GDP, 1983	Borio (96) Credit to household sector as % of GDP, 1993	Miles(1994) Stock of Mortgage Debt as % of household disposable Income	Japelli and Pagano (1994) Household debt for current and durable consumption as % of NNP, 1970	Japelli and Pagano (1994) Household debt for current and durable consumption as % of NNP, 1980
Australia	43	52	na	na	7.7
Austria	20	28	na	na	Na
Belgium	31	41	na	3.5	4.6
Canada	38	56	50	na	Na
Chile	na	na	na	na	Na
Denmark	na	na	66	16.1	14.9
Finland	na	na	na	17.4	15
France	29	26	48	1.7	2.4
Germany	46	48	na	4.1	7.9
Greece	na	na	na	0	0.1
H. Kong	na	na	na	na	Na
Ireland	na	na	na	6.1	8.6
Italy	17	10	7	2.4	2.5
Israel	na	na	na	na	Na
Japan	21	32	38	5.9	7.4
Korea	na	na	na	na	Na
Malaysia	na	na	na	na	Na
Netherl.	41	49	na	2.1	4.1
New Zeal.	na	na	na	na	Na
Norway	na	na	na	13.3	13.7
Portugal	na	na	na	na	1.5
Singapore	na	na	na	na	Na
Spain	12	25	10	na	4.9
Sweden	na	na	na	na	31.6
Switz.	78	91	64	na	Na
Taiwan	na	na	na	na	Na
Thailand	na	na	na	na	na
UK	31	63	67	na	5.7
US	46	60	60	15.8	16.1

Figure 1

Sensitivity of Prices to Income and Financial Development

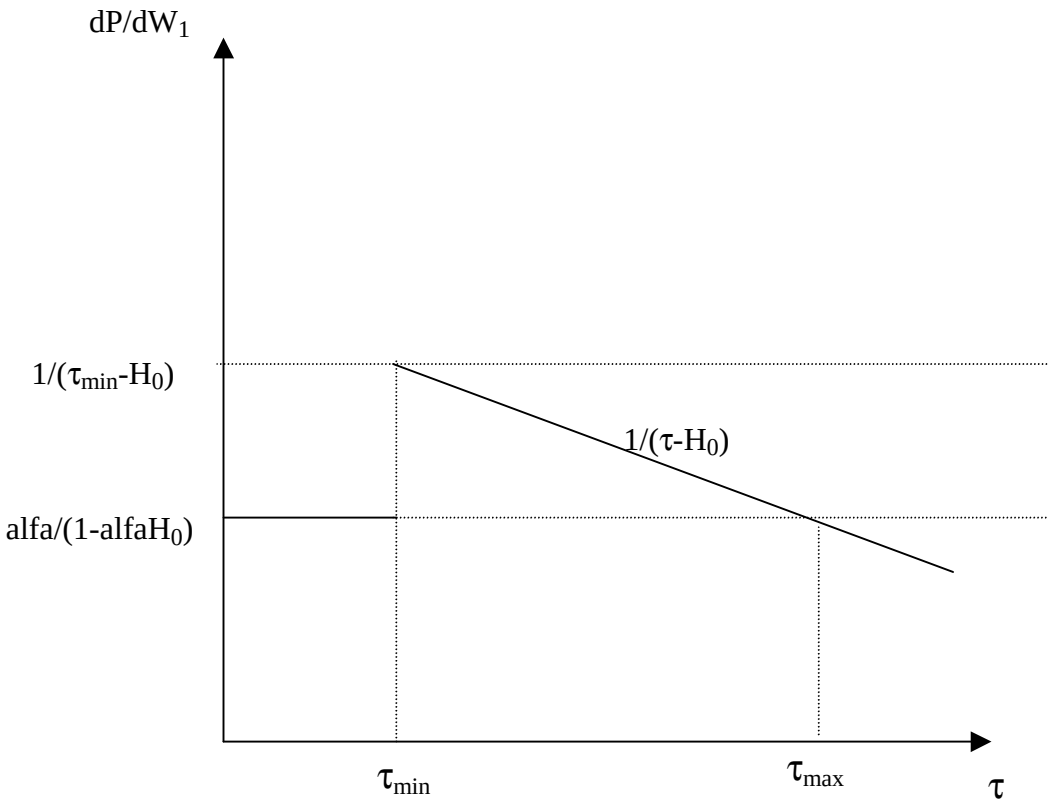

Figure 2

Cumulative Price Change

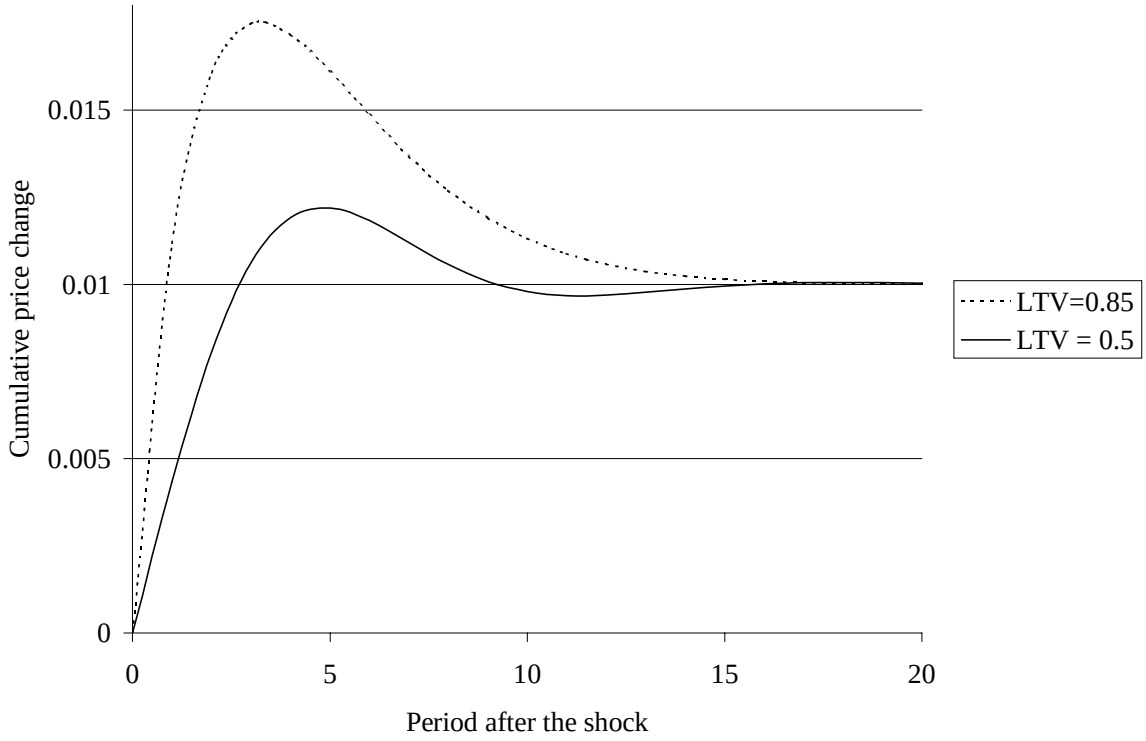

Figure 3

Sensitivity of Prices to Income and Financial Development
Empirical Estimates