

Financial Constraints and House Prices

An International Perspective

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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. The policy implications are clear and important. Even if financial development is desirable for other reasons, the potential associated increase in volatility should be an explicit policy concern.

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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) argue 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 also obvious. Policies which are directed to the relaxation of credit constraints for firms and households should reduce volatility 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 volatility may be an undesirable product of the process of financial development. The importance of this result from a perspective of economic policy is clear. Assuming financial development has other associated benefits¹, it is desirable to devise policies to minimize the potential side effects on volatility.

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

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 GDP². 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 very simple model (which draws heavily on Stein, 1995, and Almeida, 1999), to show a very important point. 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 very simple. If households are unconstrained, an increase in income generates an income effect, which tends to increase demand for houses. However, part of the income effect goes to other goods consumed by households. On the other hand, if households are constrained, 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 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

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.

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

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, 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 possibility that relaxation of financial constraints amplify fluctuations is very simple³. Previous work has failed to appreciate the difference between comparing constrained to unconstrained agents, and comparing 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 0.4%. 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 index of financial development in the house price regressions interacting with all the coefficients⁴. The same result holds when we split the sample

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

⁴ This benchmark specification is the same as in Lamont and Stein (1999), which form the basis for our empirical work.

according to the index 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 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. The same is true for home-ownership ratios⁵.

There are potential problems with the way we measure housing finance development. Our index of financial development reflects observed measures of leverage, since it uses information on observed household debt. The loan-to-value data is in a sense more exogenous (and we show that all the results hold if the LTV data is used alone), but 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 raise two types of concerns. The most obvious one is 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). An even more serious problem is that the causality could run in the opposite direction that we are emphasizing. For example, it could be that LTV ratios in Italy are low *because* house prices are more sensitive to shocks in Italy, for some exogenous reason.

We address these endogeneity problems by instrumenting the index of housing finance development with accounting standards, which has been used in the literature as a measure of the availability of finance to firms. Under the assumption that the same

⁵It could be that all the agents who are actually buying and selling houses in low income countries are relatively rich, and therefore less financially constrained than agents in more financially developed countries. Also, if the rate of home ownership is low, the amplification mechanisms described in the model in section 2 become less important (since a change in house prices causes no wealth effect for non home owners).

underlying forces drive the availability of finance to firms and households, this is an appropriate instrument. All the results hold for the instrumental variable regressions.

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 paper. In terms of the theoretical literature, Almeida (1999) 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 I show, when the amount of financing borrowers can raise depends on the availability of collateral. One example of a situation where borrowing is heavily collateralized is on housing finance contracts. The results in Almeida (1999) 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 way⁶. Homeowners could have high leverage in a given city-year because house prices are low, and not because it is easier to borrow in that city. Indeed, high leverage has been used elsewhere as an indicator of tighter financial constraints⁷. 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.

⁶ Indeed, the authors never pursue this direction of interpretation.

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

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 volatility⁸. 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

⁷ See Whited (1992), for example.

⁸ See Borio, Kennedy and Prowse (1994), Muellbauer et al. (1998), Renaud (1995) and Stephens (1995).

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

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 (1999).

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 house⁹. There are two time periods. At time t_1 the individual chooses how many units of housing he will buy or sell¹⁰ (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 I . The maximum amount that a household can borrow is assumed to be equal to a fraction of the value of the house, that is:

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

As in Almeida (1999), 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. In terms of the real world, the parameter depends on variables

⁹ 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.

¹⁰ 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.

such as the costs of enforcing and disposing of collateral, regulations about housing finance and the amount of information creditors have about borrowers¹¹.

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

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

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

$$U(H_1, Z) = \alpha \ln(H_1) + (1-\alpha) \ln(Z) \quad (2)$$

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:

$$Z \leq W_2 - (1-\tau)PH_1 + \{PH_0 + W_1 - D_0 + (1-\tau)PH_1 - PH_1\} \quad (3)$$

Where 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:

$$H_1^U(P) = \alpha \frac{W_1 + W_2 + PH_0 - D_0}{P} \quad (4)$$

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:

¹¹ See Japelli and Pagano (1994) for a more detailed discussion. Stein (1995) and Spiegel (1999) endogenize down payment requirements using models based on moral hazard and adverse selection issues.

$$P(\tau) = \frac{\alpha}{1 - \alpha H_0} (W_1 + W_2 - D_0) \quad (5)$$

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 (1) 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 (1), that is:

$$H_1^U [P^*(\tau)] > H_1^* [P^*(\tau)] = 1 \quad (6)$$

Let us do that. Assuming that (1) binds, we get:

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

Therefore, the equilibrium constrained price function is:

$$P^*(\tau) = \frac{W_1 - D_0}{\tau - H_0} \quad (7)$$

Using equations (4) and (6), we can show that this is a feasible equilibrium as long as:

$$\tau \geq H_0 + \frac{(1 - \alpha H_0)(W_1 - D_0)}{\alpha W_1} \equiv \tau_{\min} \quad (8)$$

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:

$$P(\tau) = \begin{cases} \frac{W_1 - D_0}{\tau - H_0}, & \text{if } \tau \geq \tau_{\min} \\ \frac{\alpha W_1}{(1 - \alpha H_0)}, & \text{if } \tau \leq \tau_{\min} \end{cases} \quad (9)$$

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 τ_{\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 (9):

$$\frac{\partial P}{\partial W_1} = \frac{\alpha}{1 - \alpha H_0} \quad \text{if} \quad \tau \leq \tau_{\min} \quad (10)$$

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

$$\frac{\partial P}{\partial W_1} = \frac{1}{\tau - H_0} \quad \text{if} \quad \tau \geq \tau_{\min} \quad (11)$$

The expression in (11) is larger than that in (10), 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 (11). 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 (10), which is lower than the value in equation (11) 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:

$$\frac{\partial H^U}{\partial W_1} = \frac{\alpha}{P}$$

$$\frac{\partial H^*}{\partial W_1} = \frac{1}{\tau P}$$

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:

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

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 will also need data on per-capita GDP and real interest rates (that we use as a control) for each country, and indicators of development of housing finance. We discuss the latter in detail in the next section. The GDP and interest rate data come from the IMF

financial statistics¹². We summarize our data in table 1 below. We use yearly changes in the logs of all variables¹³. 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. Notice there are no discernible patterns in house price volatilities, when we compare developed and developing countries. For example, the highest volatility is in the Taiwan data, but the lowest is in Thailand. Such a comparison is not really warranted, however, since there is less data available for the developing countries in general.

¹² The interest rate is the rate on medium or long term government bonds, also used in Englund and Ioannides (1997)

¹³ The change in the real interest rate is computed as the difference in logs of the variable $(1 + \text{interest rate in percentage terms} / 100)$.

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.

Two variables come to mind immediately. Perhaps the most important variable is the loan-to-value (LTV) ratio that households can achieve in each country. If maximum LTV ratios are fixed by regulation, it is a clear exogenous limit on the amount that a household can borrow, in order to finance house purchases. The LTV ratio is the direct empirical counterpart of the parameter $(1-\tau)$ in the model of section 2.

The second clearly important variable 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.

Naturally, as discussed by Japelli and Pagano (1994), there are problems with both these measures. Household debt clearly suffers from an identification problem. It is hard to know whether a country has low household debt because households are financially constrained, or because there is little demand for loans. There is no similar problem with LTV ratios, as long as the data refers to maximum ratios allowed by regulatory reasons. However, the available data does not always refer to maximum LTV ratios. Maximum *observed* LTV ratios may suffer from the same identification problem, since the regulatory constraint need not be binding. Furthermore, high observed LTV ratios may occur both because household debt is high, or because house prices are low. If house prices fluctuate a lot, we can observe high LTV ratios even in countries where there are high minimum down payment requirements.

In any case, 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%).

The data on household debt was slightly 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. 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.

Finally, the last column in table 3 is an attempt to summarize all this information 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 our 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. This relative ranking is complemented by the absolute information contained in LTV ratios, and in the measures of household debt found in table A1 in the appendix.

Naturally, all subjective classifications are subject to criticisms. We consider the HF index as being our most informative measure of the extent to which households are financially constrained, but we will always check that any result also obtains if we use the LTV ratio as a measure of the development of housing finance.

Given the criticisms associated with the LTV data, our indices 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 indices in table 3. All the different measures of financial constraints are highly positively correlated. For example, the

correlation between LTV ratios and our 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), and between household debt and our literature dummy (0.62) show that household debt is strongly affected by limitations on the supply of credit, and is not only demand driven¹⁴. All the correlations reported below are strongly statistically significant, so we do not report p-values.

¹⁴ The high correlation between household debt and LTV ratios is also present on Japelli and Pagano (1994).

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 regression¹⁵.

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 as a measure of financial development. The implied economic magnitude of financial development is also large. If we take a country at the 80th percentile value of HF (about 0.9), the implied sensitivity of house prices to income is around 1.4. For a country at the 20th percentile ($HF=0.15$), 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 lags¹⁶. This pattern has been shown to hold in international data as well¹⁷. We should also consider the possibility that other variables such as interest rates are important forces driving house

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).

¹⁷ See Englund and Ioannides (1997).

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 and 7 report 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 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.

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). Although this is consistent with evidence on Malpezzi (1990), and Poterba (1991), it is desirable to verify that our results hold also in a more flexible specification such as the one in column 3. We will do this throughout the paper.

Our coefficients on column 1 have similar values to those obtained in Lamont and Stein¹⁸. 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 $Pt-1/Yt-1$).

Table 7 shows that changes in the real interest rate are not robust determinants of house price behavior, even when considered on their own¹⁹. 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. Therefore, we will drop the changes in real interest rates from our benchmark specification (column 1 in table 6).

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 8. In the first column, we use our index of financial development constructed in the previous section. The interaction term is positive, and

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.

¹⁹ This is true even when we take only the countries considered in Englund and Ioannides (1997). This result is therefore at odds with their finding of a negative correlation between changes in real interest rates and changes in house prices.

statistically significant. In the second column, we show that the same result obtains if we use loan to value ratios as a measure of financial development.

Table 9 shows that the same result holds in the specification with lags of income changes and one more lag of price changes (column 3 of table 6). If anything, the effect of financial development is stronger in this specification, as evidenced by the coefficients on the interaction terms and their t-statistics.

In table 10, we parameterize our test of the effect of financial constraints in a less tight way. We sort our sample according to the value of the housing finance index (columns 1 to 3), or according to the value of the LTV ratio (columns 4 to 6), and run separate regressions for (approximately) the top and bottom one third of the observations. This allows for a non-linear effect of financial development, and also allows the coefficients on the other variables to differ in each sub-sample.

Table 10 shows again that the sensitivity to income is higher in countries with higher levels of financial development, for this different specification. The difference in coefficients is large, and statistically significant. Also, notice that 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. This result also holds in the looser specification which does not include the ratio of prices to income, as shown in table 11.

These two tables seem to indicate that the only coefficient which differs significantly across the two samples sorted by financial development is the elasticity to current income. In table 12, we confirm that this result also holds when we use the whole sample, and interaction coefficients for all variables in our benchmark specification. This result could lead to the conclusion that the effect of financial development is only on the sensitivity of prices to current income, but there is a caveat. Take for example the lag specification in table 11. We can only interpret the coefficient on dY_{t-1} as the pure effect of lagged income on price changes if income follows a random walk (that is, if dY_t is independent of past lags). Otherwise, this coefficient will also depend on the contemporaneous sensitivity of prices to income.

As we show in table 13, income does not follow a random walk in our sample. The coefficient on dY_{t-2} is negative and strongly significant for the whole sample. Furthermore,

the dynamics of income differs significantly according to the level of financial development, as shown in column 2 of table 13. It turns out that this difference is driven only by the Israel data, as we show in columns 3 and 4. However, if we exclude Israel from the sample, the first lag of changes in income becomes significant. Overall, we cannot conclude that income follows a random walk in this sample. Therefore, our results cannot rule out the possibility that financial development changes the whole dynamics of house prices, and not only the current sensitivity to income.

In order to illustrate the economic significance of the effect of financial development, we simulate the impact of a 1% shock to GDP percapita using the coefficients in tables 12 and 13. This allows the dynamics of income to vary with financial development as well. We take two hypothetical countries, one with an index of housing finance development equal to 0.8, and the other with an index equal to 0.1. 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. Cumulative price change in the country with high financial development reaches more than 2% after 3 years, while it barely goes over 1% in the country with low financial development²⁰. This is clear evidence that tighter financial constraints dampen fluctuations in house prices across the world.

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, and is also good for illustrative reasons.

Table 14 shows the estimated sensitivities of prices to current income, for each country in the sample. It also displays our data on home ownership ratios, and per capita income in

²⁰ The fact that cumulative price changes are higher in the long run for countries with high financial development is driven by the differences in income dynamics (cumulative income changes are higher with high financial development), and the fact that our specification restricts cumulative income changes to be equal to cumulative price changes in the long run.

constant international prices, which we use as control variables in the second stage regression²¹. The rationale behind these controls 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 bias²².

Finally, home ownership ratios could be important for the following reason. If countries with low financial development tend to have lower home ownership ratios, then we would expect such countries to have lower price-income elasticities, even if differences in financial development are unimportant. There are at least two reasons for that. First, it could be that all the agents who are actually buying and selling houses in low income countries are relatively rich, and therefore less financially constrained than agents in more financially developed countries. Also, if the rate of home ownership is low, the amplification mechanisms described in the model in section 2 become less important (since a change in house prices causes no wealth effect for non home owners).

Tables 15 and 16 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 elasticities²³.

This pattern is also clear in figure 3, which shows graphically the pattern of coefficients and housing finance indices. Figure 3 also makes it clear that there are some

²¹ Home ownership ratio is the percentage of households who own their own house (see appendix for the sources), and 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.

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. 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, and home ownership is unimportant.

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 consider²⁴, we can try to accommodate these considerations by looking for non-linear effects of financial development. This is what we do in tables 17 and 18. In table 17, 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 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 18. We do the two-stage approach of the previous sub-section, introducing the square of the index of financial development (or the square of the LTV ratio) 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.

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).

After we remove them from the sample, the coefficient on the square term becomes positive, consistent with table 17.

5.6 Robustness Checks

Table 2 shows that our data is characterized by some very extreme values for house price and GDP changes. In table 19 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 8.

It is clear from table 19 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 8. 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 on table 20. 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 despite the loss of observations and statistical power.

One caveat is that we cannot claim that this adjustment controls for all the heterogeneity across the different indices. The ideal house price index should also be quality adjusted, and should be representative of enough transactions within a year. According to Englund and Ioannides (1997), even within the OECD, such perfect indices exist only for Denmark, Finland, Sweden and the UK. With the possible exception of New Zealand, the data for non-OECD countries probably does not fulfill all these requirements. Although the adjustment in table 20 indicates that our results are not driven by differences in the quality of the indices, it may not be a definitive rebuttal of criticisms along these lines.

6 Addressing Alternative Explanations

6.1 Is the result 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 do 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 do 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 at least two types of concerns. The most obvious one is 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 constraints²⁶.

Perhaps an even more serious problem is that the causality could run in the opposite direction that we are emphasizing. For example, it could be that LTV ratios in Italy are low *because* house prices are more sensitive to shocks in Italy, for some exogenous reason.

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 Research²⁷. 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

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.

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 similar variables influence the availability of finance to firms and households, accounting standards is an appropriate instrument²⁸. 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 21. 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 LTV ratio as a measure of housing finance development. Indeed, the results are even stronger than in table 8 (in terms of t statistics).

Table 22 shows the results for the alternative two-stage specification (eliminating the outliers). Again, the results are very similar to those in table 15, indicating 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 is driving the sensitivity of prices to income, and not the other way around.

6.2 Is the result driven by differences in income dynamics ?

As we showed in table 13, the dynamics of income is also significantly affected by financial development, for our whole sample. In particular, the sensitivity of current changes in income to lagged changes is higher for countries which are more financially developed. This suggest the following explanation for our results. A current shock in income has more information about future changes in countries with more financial development. Therefore, house prices should respond more to such shocks, even if financial development does not matter. In other words, given this difference in dynamics, we cannot really compare shocks of similar relative magnitudes across different countries.

Table 13 also shows that Israel is the country driving the difference in income dynamics. Therefore, one way to address this alternative explanation is to remove Israel from the sample, and to see whether the difference in sensitivities disappears.

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

²⁸ Indeed, the correlation between accounting standards and our index of housing finance development is 0.54.

This is what we do in tables 23 and 24. Table 23 reports a version of table 21 (where housing finance is instrumented by accounting standards), for a sample which does not include Israel. The interaction coefficients are still highly significant, indicating that differences in income dynamics do not drive the results. Finally, table 24 shows that the results for the alternative two-stage specification. again, housing finance development seems to be an important determinant of house price behavior.

In figure 4, we repeat the exercise in figure 1 for the coefficients in table 23, which are estimated without Israel. In this case, as shown in table 13, there is no substantial difference in income dynamics, and therefore we restrict the coefficients on lagged income changes to be the same for all levels of financial development. The estimated coefficients are in column 5 in table 13²⁹. It is clear from this figure that house prices are still much more sensitive to income in countries with high financial development.

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, 1999, 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. The policy implications are clear and important. Even if financial development is desirable for other reasons, the potential associated increase in volatility should be an explicit policy concern.

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

²⁹ There is no substantial difference if we use the coefficients in column 4 (which allow for differences in income dynamics) instead.

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 constraints³⁰. 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)³¹. 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.

However, even if financial development affects mostly LTV ratios, there are important effects of financial development that the model does not consider. In the model, we assume that the initial amount of debt (D_0), and the initial size of the house (H_0) are given. Financial development will clearly tend to increase both these variables, in a more complete model. In the context of business investment, Almeida (1999) endogeneizes these

³⁰ 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.

³¹ In terms of the model in section 2, this implies that households can raise debt in period 1 against future income W_2 .

variables (H_0 can be interpreted as the initial size of the firm). I show that the impact of endogenous past debt is to amplify the effects of unexpected cash-flow shocks. It is also true in that model, that the amplification effect generated by past debt is (generally) higher, the higher is the liquidity of collateral. Both these effects are caused by the backward-looking nature of existing debt. If agents are hit with a negative shock, this will not reduce by much the amount of debt they have to repay today, but it will reduce current debt capacity (which is endogenous). This implies that the positive impact of financial development on the volatility of investment (and prices) should survive this more complete set up.

One important caveat is that neither the model in section 2 (like Stein, 1995) nor Almeida, 1999 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).

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.

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

<i>Variable</i>	<i>Description</i>	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
dR	Change in log gross real interest rate	671	0.001	0.039	-0.321	0.514

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 specific mention of credit constraint	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
dY _t	0.99 (2.91)	0.33 (2.03)	-1.25 (-1.79)
dY _t *FD		1.59 (3.23)	3.46 (2.97)
No of Obs	641	606	584
Adjusted R2	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)
dY _t	0.704 (3.4)	0.710 (3.3)	0.866 (2.80)	1.002 (3.24)
dP _{t-1}	0.456 (6.95)	0.450 (5.88)	0.377 (3.72)	
P _{t-1} /Y _{t-1}	-0.176 (8.61)	-0.190 (7.88)		
dY _{t-1}		0.001 (0.01)	0.218 (1.61)	0.540 (3.37)
dY _{t-2}		-0.124 (0.95)	0.075 (0.55)	0.128 (1.03)
dP _{t-2}		0.061 (0.926)	-0.108 (1.53)	
No of Obs	612	583	583	604
Adjusted R2	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. Introducing changes in the real interest rate

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dRt	0.034 (0.531)	-0.066 (0.41)	0.071 (1.02)	0.040 (0.34)	0.026 (0.14)	-0.09 (0.47)	-0.063 (0.36)	0.285 (0.89)
dRt-1		-0.23 (0.86)			-0.124 (0.69)		-0.233 (1.22)	
dRt-2		-0.178 (1.11)			-0.064 (0.49)		-0.238 (1.32)	
dYt			1.569 (4.27)	1.074 (4.01)	1.013 (4.00)			1.133 (3.53)
dPt-1				0.401 (6.06)	0.391 (5.03)			
Pt-1/Yt-1				-0.170 (8.23)	-0.176 (7.44)			
No of Obs	556	519	556	550	505	543	500	318
Adjusted R2	0.17	0.15	0.34	0.50	0.50	0.18	0.17	0.30

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 , P_{t-1}/Y_{t-1} is the ratio of house prices to income per-capita, and dRt is the change in log gross real interest in year t .

All regressions include country and year fixed effects.

In columns (6) and (7) we have eliminated the top 1% observations, ranked by dPt and dRt .

In column (8) we use observations on OECD countries only.

Robust t-statistics in parenthesis.

Table 8. Interaction between income and financial development

	FD = HFD index	FD = LTV ratio
dY _t	0.337 (2.92)	-0.426 (0.83)
dP _{t-1}	0.481 (11.04)	0.485 (10.8)
P _{t-1} /Y _{t-1}	-0.156 (7.94)	-0.159 (7.49)
dY _t *FD	0.885 (2.563)	1.71 (1.96)
No of Obs	579	558
Adjusted R2	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. All regressions include country and year fixed effects. Robust t-statistics in parenthesis.

Table 9. Interaction between income and financial development, lag specification.

	FD=HF Index	FD=LTV Ratio
dY _t	0.326 (2.01)	-0.810 (1.21)
dY _t *FD	1.219 (2.82)	2.526 (2.29)
dP _{t-1}	0.430 (7.25)	0.437 (7.06)
dP _{t-2}	-0.158 (2.27)	-0.169 (2.54)
dY _{t-1}	0.142 (0.93)	0.166 (1.02)
dY _{t-2}	0.086 (0.44)	0.105 (0.53)
No of Obs	552	532
Adjusted R2	0.45	0.45

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 10. Separate regressions for high and low levels of financial development

	FD = HFD index			FD = LTV Ratio		
	High	Low	Diff	High	Low	Diff
dYt	1.371 (3.63)	0.392 (4.03)	0.979 (2.23)	1.432 (3.59)	0.420 (2.69)	1.012 (2.63)
dPt-1	0.492 (26.172)	0.522 (3.982)	-0.03 (0.43)	0.472 (12.542)	0.535 (5.66)	-0.063 (1.32)
Pt-1 /Yt-1	-0.158 (5.67)	-0.236 (4.53)	0.078 (0.83)	-0.121 (5.131)	-0.189 (4.65)	0.068 (0.85)
No of Obs	173	168		180	174	
Adjusted R2	0.60	0.52		0.60	0.55	

The data are sorted based on the measure of financial development, and separate regressions are run for the top 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 11. Separate regressions for high and low levels of financial development, lag specification.

	FD = HF Index			FD = LTV Ratio		
	High	Low	Diff	High	Low	Diff
dYt	1.678 (3.05)	0.352 (1.72)	1.326 (2.81)	1.746 (3.36)	0.353 (1.62)	1.393 (2.68)
dYt-1	0.140 (0.59)	0.236 (0.94)	-0.096 (0.24)	0.247 (0.75)	0.196 (0.87)	0.051 (0.08)
dYt-2	0.348 (2.36)	-0.221 (1.25)	0.570 (1.77)	0.230 (1.10)	-0.267 (2.03)	0.497 (1.17)
dPt-1	0.430 (5.44)	0.495 (3.88)	-0.065 (0.70)	0.426 (4.83)	0.534 (5.21)	-0.108 (0.90)
dPt-2	-0.230 (2.48)	-0.217 (1.76)	-0.013 (0.01)	-0.199 (1.81)	-0.210 (1.98)	0.011 (0.08)
No of Obs	166	158		173	163	
Adjusted R2	0.58	0.45		0.60	0.51	

The data are sorted based on the measure of financial development, and separate regressions are run for the top 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 . All regressions include country and year fixed effects. Robust t-statistics in parenthesis.

Table 12. Interaction between income and financial development, all variables.

	FD = HFD index	FD = LTV ratio
dY _t	0.341 (3.27)	-0.545 (1.40)
dP _{t-1}	0.556 (4.08)	0.72 (1.83)
P _{t-1} /Y _{t-1}	-0.21 (3.89)	-0.386 (2.73)
dY _t *FD	0.935 (2.96)	1.955 (2.74)
dP _{t-1} *FD	-0.129 (0.72)	-0.322 (0.64)
(P _{t-1} /Y _{t-1})*FD	0.089 (1.26)	0.305 (1.71)
No of Obs	579	558
Adjusted R2	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 13. The dynamics of income

	All sample, no FD	All sample	Israel	No Israel
dY _t -1	0.092 (0.72)	-0.052 (0.36)	-0.263 (1.33)	0.270 (2.04)
dY _t -1*HFD		0.403 (2.20)		0.003 (0.02)
dY _t -2	-0.153 (3.88)	-0.137 (2.11)	-0.283 (1.43)	-0.067 (1.11)
dY _t -2*HFD		-0.075 (1.16)		-0.100 (1.32)
No of Obs	700	657	26	631
Adjusted R ²	0.32	0.34	0.05	0.43

The dependent variable is dY_t , the change in income percapita in year t , in country j . In the second row we run a separate regression for the Israel data. In the third row we run a regression for the whole data without Israel. HFD is the housing finance index. All regressions include country and year fixed effects. Robust t-statistics in parenthesis.

Table 14. Separate regressions for each country

	Coefficient	HFD	Income	Home Ownership Ratio
Australia	1.51	0.87	0.84	0.70
Austria	0.08	0.34	0.67	0.61
Belgium	0.88	0.63	0.71	na
Canada	1.25	0.89	0.92	0.62
Chile	2.78	na	0.23	na
Denmark	2.28	0.98	0.76	na
Finland	1.71	0.88	0.73	0.63
France	1.18	0.42	0.76	0.43
Germany	0.59	0.50	0.76	0.17
Greece	0.96	0.03	0.37	0.70
Hong Kong	-0.39	na	0.57	0.43
Ireland	1.04	0.69	0.43	na
Italy	-1.74	0.04	0.48	0.49
Israel	0.36	0.04	0.65	0.80
Japan	3.72	0.18	0.69	0.60
Korea	0.73	0.00	0.23	0.40
Malaysia	0.82	0.28	0.22	0.59
Netherlands	1.42	0.77	0.72	0.09
New Zealand	-0.07	0.26	0.70	0.71
Norway	2.17	0.80	0.78	0.67
Portugal	-0.50	0.23	0.32	na
Singapore	2.31	0.88	0.44	0.55
Spain	1.92	0.47	0.50	0.74
Sweden	1.24	0.83	0.82	0.45
Switzerland	0.29	1.00	0.96	0.30
Taiwan	1.11	0.02	0.32	0.80
Thailand	-0.03	0.14	0.14	0.89
United Kingdom	1.92	0.95	0.67	0.53
United States	0.41	0.96	1.00	0.76

Coefficient is the coefficient on income change in the benchmark specification which includes lagged price changes and last period ratio of prices to income. HFD is the housing finance index (see table 3). Home ownership ratio is the percentage of dwellers who own their own house (see appendix). Income is the 1970-1990 average GDP percapita measured in constant international prices, from Barro and Lee (1994).

Table 15. Explaining the individual coefficients

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HFD	1.176 (2.17)				1.391 (1.84)	1.415 (1.62)		
LTV		1.273 (1.92)					1.095 (1.31)	1.029 (0.95)
Income			0.510 (0.574)		-0.477 (0.414)	-0.79 (0.60)	0.403 (0.36)	0.069 (0.05)
Home Ownership				0.245 (1.174)		0.482 (0.40)		0.100 (0.08)
Obs	27	26	29	24	27	23	26	22
Adjusted R2	0.16	0.10	-0.02	-0.04	0.09	0.00	0.06	-0.07

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. Home ownership ratio is the percentage of dwellers who own their own house (see appendix). Income is the 1970-1990 average GDP percapita measured in constant international prices, from Barro and Lee (1994).

Table 16. Explaining the individual coefficients (no Japan, no Italy)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HFD	1.186 (3.08)				1.825 (3.45)	1.829 (3.34)		
LTV		1.327 (2.89)					1.479 (2.49)	1.498 (2.10)
Income			0.155 (0.22)		-1.293 (1.69)	-1.731 (2.21)	-0.319 (0.42)	-0.867 (1.09)
Home Ownership				-0.089 (0.11)		0.077 (0.11)		-0.33 (0.42)
Obs	25	24	27	22	25	21	25	20
Adjusted R2	0.26	0.24	-0.04	-0.05	0.32	0.30	0.21	0.11

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. Home ownership ratio is the percentage of dwellers who own their own house (see appendix). 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 17. Testing for non-linear effects

	FD = HFD index		FD = LTV Ratio	
	High-Med	Med-Low	High-Med	Med-Low
dYt	0.414 (1.03)	0.384 (1.65)	0.784 (2.18)	0.248 (1.25)
dPt-1	-0.011 (0.19)	-0.062 (0.43)	-0.049 (0.69)	-0.081 (0.61)
Pt-1 /Yt-1	-0.056 (1.50)	0.092 (1.78)	0.037 (1.19)	0.030 (0.66)
No of Obs	411	406	384	378
Adjusted R2	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 18. Testing for non-linear effects with individual coefficients

	All sample	All sample	No outliers	No outliers
HFD	2.003 (0.83)		0.589 (0.35)	
LTV		0.640 (0.25)		0.322 (0.19)
HFD square	-0.827 (0.35)		0.590 (0.37)	
LTV square		0.644 (0.25)		1.017 (0.61)
Obs	27	26	25	24
Adjusted R2	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 19. No Outliers

	FD = HFD index	FD = LTV ratio
dY _t	0.127 (0.408)	-0.816 (1.07)
dP _{t-1}	0.418 (9.917)	0.416 (9.89)
P _{t-1} /Y _{t-1}	-0.119 (6.00)	-0.122 (5.68)
dY _t *FD	1.355 (2.89)	2.434 (2.35)
No of Obs	562	542
Adjusted R2	0.47	0.48

The top and bottom 1% of the observations sorted on dP_t and dY_t were discarded

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 20. Only Residential Property Indices, Representative of the Whole Country

	FD = HFD index	FD = LTV ratio
dY _t	0.181 (1.31)	-0.783 (1.80)
dP _{t-1}	0.433 (10.44)	0.445 (10.74)
P _{t-1} /Y _{t-1}	-0.145 (7.108)	-0.152 (7.19)
dY _t *FD	1.264 (3.74)	2.197 (2.79)
No of Obs	448	448
Adjusted R2	0.51	0.51

All the observations for Austria, Chile, France, Greece, Japan, Portugal, Spain, Switzerland and Taiwan were eliminated from the regressions.

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 21. Instrumenting housing finance with accounting standards.

	FD = HFD index	FD = LTV ratio	FD = HFD index	FD = LTV ratio
dY _t	-0.069 (0.19)	-3.552 (2.78)	0.136 (0.684)	-1.831 (2.57)
dP _{t-1}			0.474 (11.2)	0.470 (10.9)
P _{t-1} /Y _{t-1}			-0.155 (7.73)	-0.156 (7.34)
dY _t *FD	2.904 (4.02)	7.297 (3.82)	1.640 (4.11)	4.107 (3.81)
No of Obs	579	557	553	532
Adjusted R2	0.29	0.29	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 22. Explaining the individual coefficients with instrument for financial development (no Japan, no Italy)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HFD	2.224 (2.70)				3.865 (2.44)	2.203 (2.79)		
LTV		2.455 (2.81)					3.531 (2.36)	2.196 (2.31)
Income			0.155 (0.22)		-3.556 (1.94)	-2.107 (2.16)	-2.164 (1.48)	-1.421 (1.41)
Home Ownership				-0.089 (0.11)		0.152 (0.22)		-0.224 (0.27)
Obs	24	23	27	22	24	21	23	20
Adjusted R2	0.03	0.10	-0.04	-0.05	-0.05	0.28	-0.01	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. Home ownership ratio is the percentage of dwellers who own their own house (see appendix). 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 23. Interaction with financial development, no Israel

	FD = HFD index	FD = LTV ratio	FD = HFD index	FD = LTV ratio
dY _t	-0.921 (1.04)	-5.302 (1.62)	-0.318 (0.60)	-2.740 (1.49)
dP _{t-1}			0.488 (11.90)	0.484 (11.63)
P _{t-1} /Y _{t-1}			-0.160 (7.40)	-0.161 (6.89)
dY _t *FD	3.965 (3.08)	9.456 (2.24)	2.193 (3.11)	5.214 (2.24)
No of Obs	538	516	527	506
Adjusted R2	0.27	0.26	0.52	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.

All the observations from Israel have been dropped from the regressions.

Robust t-statistics in parenthesis.

Table 24. Explaining the individual coefficients with instrument for financial development (no Japan, no Italy, no Israel)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
HFD	2.281 (2.55)				4.273 (2.34)		2.381 (2.55)	
LTV		2.450 (2.66)				3.781 (2.21)		2.324 (2.08)
Income			0.178 (0.25)		-4.030 (1.91)	-2.414 (1.45)	-2.337 (2.05)	-1.557 (1.34)
Home Ownership				0.080 (0.09)			0.019 (0.03)	-0.320 (0.37)
Obs	23	22	26	21	23	22	20	19
Adjusted R2	0.00	0.05	-0.04	-0.05	-0.05	-0.05	0.25	-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. Home ownership ratio is the percentage of dwellers who own their own house (see appendix). Income is the 1970-1990 average GDP percapita measured in constant international prices, from Barro and Lee (1994). The observations for Japan, Italy and Israel 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

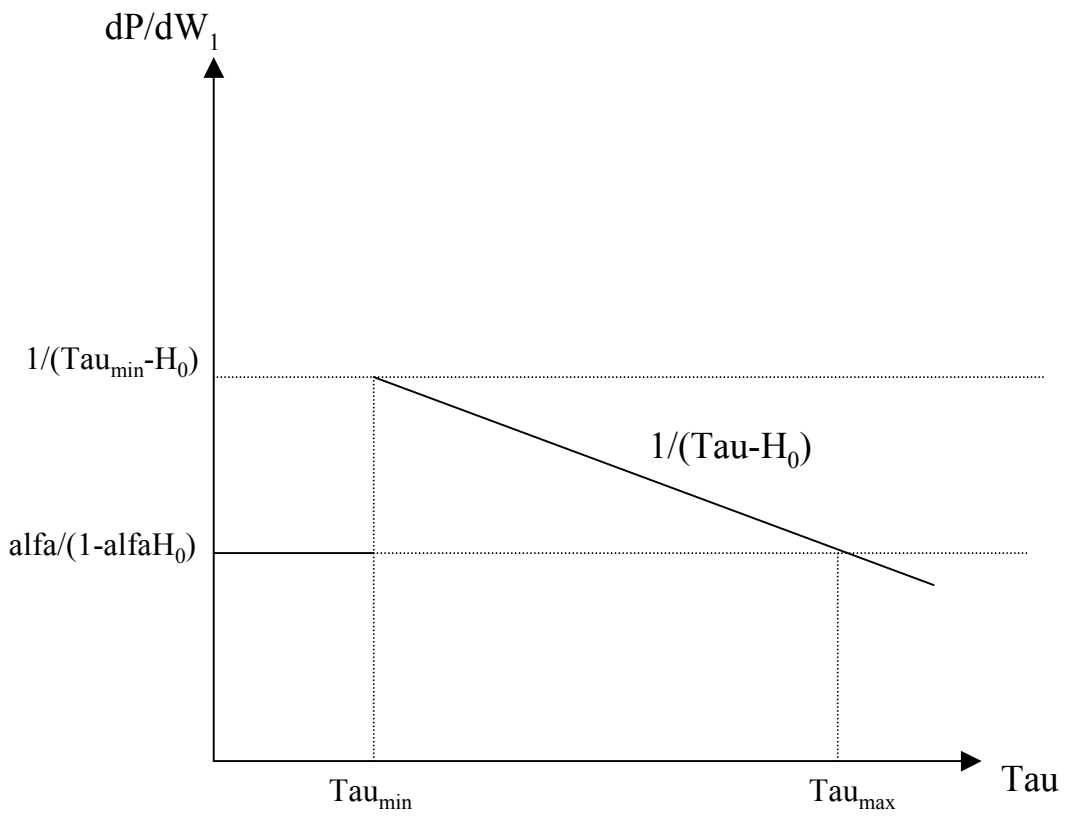
	Japelli and Pagano (1989) Housing Mortgage Loans, as % of total consumption	Kim (93) Housing Loans outstanding as % of GNP	Boleat (1985) Mortgage Debt as % of National Income	Holmans (1994) House purchase debt as % of GDP	Guiso, Japelli and Terlizzese (1994) Mortgage Debt as % of GNP	Muelbauer et al (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
Hong 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
Netherlands	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
Switzerland	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
Hong 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
Netherlands	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
Switzerland	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 - Financial Development and Price
Income Elasticities**

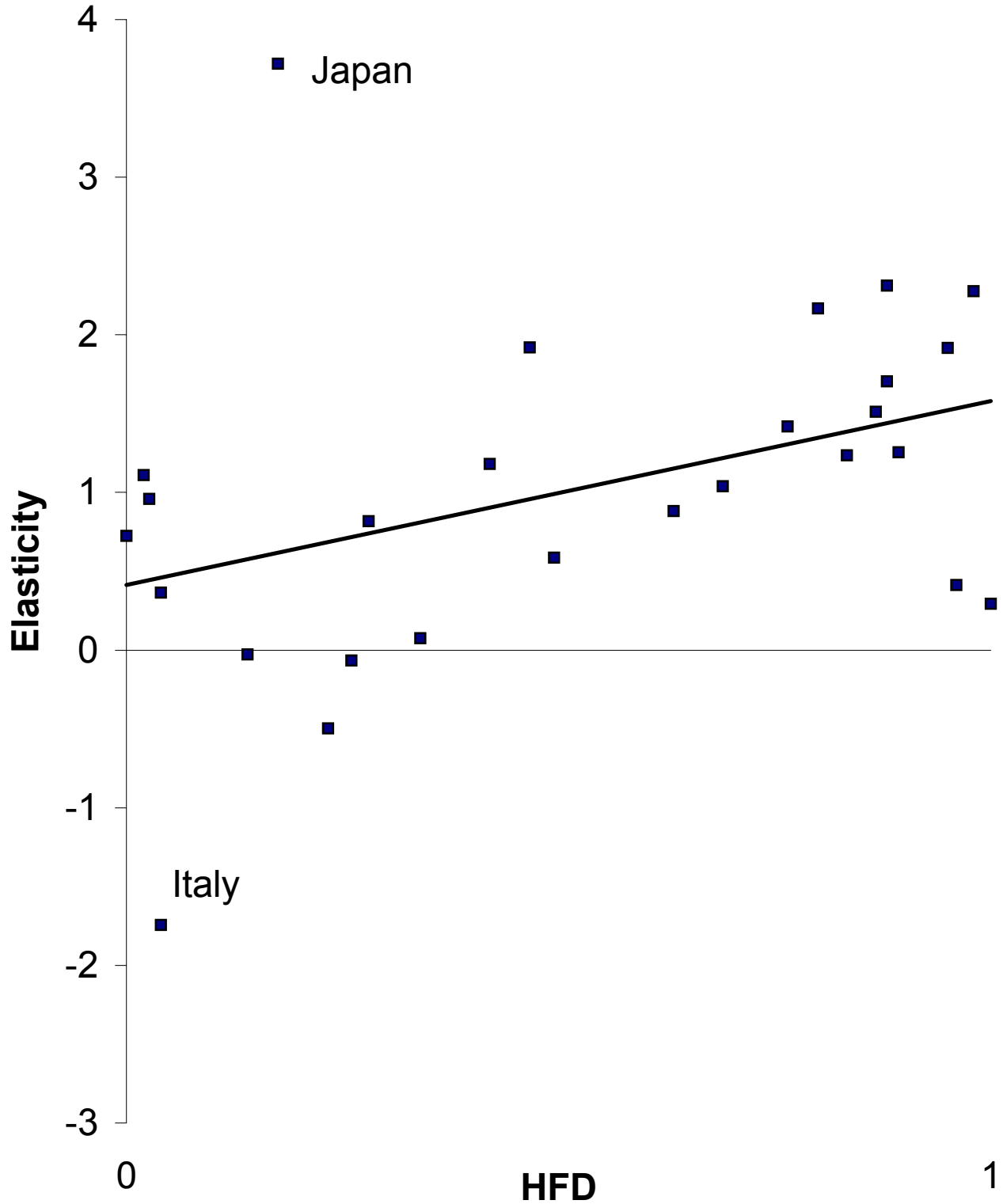


Figure 3

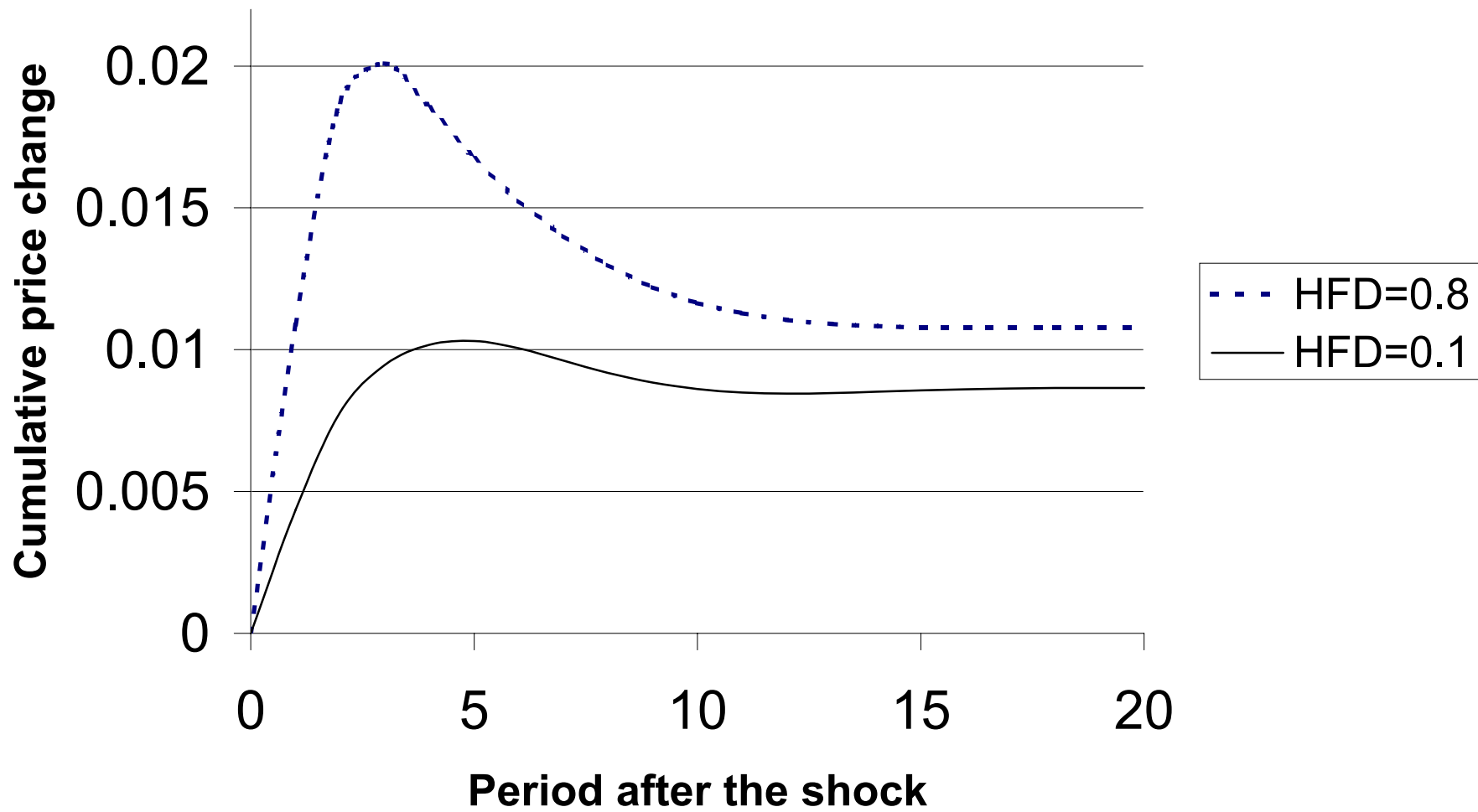


Figure 4

