The Financial Accelerator in Household Spending: Evidence from International Housing Markets*

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Abstract

This paper explores contractual features of housing finance and uses data from international housing markets to provide evidence supporting the "financial accelerator" (Bernanke et al. 1996, 1999). Among households whose housing demand is constrained by the availability of collateral, those who can borrow against a larger fraction of the housing value (achieve higher loan-to-value, or LTV ratio) have more procyclical debt capacity. This procyclicality in borrowing capacity is at the heart of the mechanism underlying the financial accelerator. Our empirical strategy uses international variation in maximum LTV ratios to show that housing prices as well as demand for new mortgages are more sensitive to income shocks in countries with higher LTV ratios, consistent with the dynamics of a collateral-based financial accelerator in household spending. We also find that the empirical relationship between maximum LTV ratios and income sensitivities is stronger in countries where housing prices are low relative to household income. Because collateral constraints are less likely to bind when housing is more expensive (an income constraint may bind instead), these latter results further suggest that a collateral-based accelerator is indeed behind the observed cross-country differences in income sensitivities.

Key words: Financial accelerator, household spending, housing prices, collateral constraint, income constraint.

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I Introduction

Recent theoretical research proposes that endogenous developments in financial markets can greatly amplify and propagate small income or interest rate shocks throughout the economy (Kiyotaki and Moore, 1997; and Bernanke, Gertler, and Gilchrist, 1996, 1999). Bernanke et al. (1996) call this amplification mechanism the "financial accelerator" or "credit multiplier." The key idea behind the financial accelerator is the notion that shocks to the net worth of firms and households have a procyclical effect on their borrowing capacity. This could happen either because the information cost wedge between external and internal finance moves countercyclically (Bernanke and Gertler, 1989), or because a procyclical change in the value of collateralizable assets changes the amount of collateralized external finance in the same direction (Kiyotaki and Moore, 1997). Following a positive income shock, agents should be able to raise more external finance and the increase in borrowing capacity would further boost investment spending. According to this view, financial mechanisms such as the endogenous procyclicality of external financing capacity can help explain important features of the business cycle and the transmission of monetary policy.

There is little direct evidence on the amplification mechanism which underlies the financial accelerator. Most empirical studies use firm data to explore one insight behind the accelerator: income shocks should affect corporate spending only when firms have imperfect (*constrained*) access to external finance. Empirically, the investment spending of financially constrained firms should be more sensitive to changes in net worth than the investment spending of unconstrained firms (Fazzari, Hubbard, and Petersen, 1988).[1] In the same vein, constrained firms' spending and borrowing should fluctuate relatively more in the aftermath of monetary and other macroeconomic shocks (Gertler and Gilchrist, 1993, 1994). Unfortunately, while comparisons between constrained and unconstrained firms may indicate whether one group's spending is more dependent on current income following an economic shock, they will not identify whether differences in spending stem from an endogenous financial amplification mechanism: because constrained firms are more dependent on current income for investment funding, they should be more sensitive to a shock that affects income even when the shock has no cyclical effect on their borrowing capacity.

So how can one identify whether there is an independent spending effect coming from an endoge-

[1] See Hubbard (1998) for a survey of the literature on financial constraints and investment-cash flow sensitivities.

nous change in borrowing capacity following a shock? The theory suggests that the quantitative effect of an aggregate income shock on constrained agents' spending would be greater when debt capacity is procyclical. Hence one testing approach consists of directly quantifying the overall magnitude of the amplification effect for constrained firms with procyclical net worth; this is the spirit of the simulation exercises in Bernanke et al. (1999). An alternative approach is to gauge the degree of procyclicality in agents' borrowing capacity and then pin down the dynamics of the financial accelerator by looking at *cross-sectional differences* in the spending responses to economic shocks among *strictly constrained, cyclical* agents. We pursue such an approach in this paper.

The housing sector is an ideal laboratory for conducting our proposed test of the theory. As suggested by Bernanke et al. (1996), households fit models of the financial accelerator particularly well; especially collateral-based versions of the accelerator. The crucial feature of housing finance contracts we explore in this paper is that the availability of mortgage credit to households is typically limited to a specific proportion of the value of the home they own or are about to purchase (the maximum loan-to-value, or LTV ratio). The maximum LTV ratio is, in effect, a credit *quantity constraint*. To see how the financial accelerator works in the housing market, suppose households receive a positive income shock that boosts their demand for housing. Clearly, the higher the LTV ratio that households can achieve the higher the increase in their borrowing capacity. Housing values should thus respond more to the initial income shock when the LTV is high. The procyclical increase in the housing value will itself allow households to further increase borrowing and the collateral-based spending cycle gets amplified. The relationship between LTV ratios and the income sensitivity of housing demand therefore provides for a direct test of the endogenous mechanism which underlies the financial accelerator. To wit, the impact of shocks to household income on housing spending is amplified by the higher marginal opportunity to borrow associated with a high loan-to-value ratio.

Testing this prediction requires some degree of (exogenous) variation in borrowing constraints (i.e., LTV ratios). Because LTV ratios vary widely around the world, data from international housing markets can be used to test our accelerator story.[2] To give a concrete example of what we have in mind, consider a country in which housing finance is not well-developed, such as Italy,

[2]We are not the first to explore the contrasts provided by international housing markets to make inferences about aggregate economic behavior. Jappelli and Pagano (1989, 1994), for example, have used international differences in LTV ratios to study consumption and savings behavior.

where historical maximum LTV ratios do not exceed 60%. Take, on the other hand, a country such as the UK, where LTV ratios average 90% in the last two decades. The accelerator argument would suggest that so long as the collateral constraint is binding in both countries the housing credit multiplier should be much stronger in the UK than in Italy.

Of course, a direct relationship between maximum LTV ratios and housing price fluctuations should only hold if housing demand is indeed constrained by the availability of collateral. In fact, it is possible that housing demand is limited by an alternative borrowing constraint: the *income constraint*. The income constraint stems from real-world features of mortgage contracts that limit the yearly amount of housing expenditures associated with the loan (loan payments plus property taxes) to a certain fraction of the household's yearly income. For our purposes, the key difference between the collateral and the income constraints is that only the former gives rise to a credit multiplier. If the income constraint binds, a household's marginal opportunity to borrow depends on its future income stream rather than on the current value of housing. The upshot of integrating both types of constraints on household spending in a financial accelerator model is the observation that whenever the income constraint binds the positive relationship between LTV ratios and the sensitivity of housing prices to income vanishes. Empirically, recognizing this additional constraint provides for yet another layer of contrasts for our panel data tests of the accelerator.

Disentangling the effects of the income and collateral constraints is not a trivial task. Our empirical strategy, however, explores well-known characteristics of international housing markets to identify situations in which the income constraint is more likely to bind in the first place. In particular, we conjecture that the income constraint is more likely to bind when the price of a typical housing unit is relatively high vis-à-vis household disposable income (high "price-to-income ratio"). Cross-country differences in price-to-income ratios — engendered, for example, by demographic and geographical factors — introduce variation in housing affordability. We predict that if the relationship between price sensitivities and the LTV ratio is driven by the collateral constraint, then it should be especially strong in countries with more affordable (cheaper) housing.

The evidence of this paper supports the financial accelerator. Our tests show that housing prices are indeed more sensitive to income shocks in countries with higher maximum LTV ratios. Our estimates indicate that in countries like the UK, where the LTV ratio is around 90%, housing prices decrease by more than 1.2% in the first year following a 1% decrease in per capita GDP.

On the other hand, in countries such as Italy, where the LTV ratio is around 60%, housing prices decrease by only some 0.8% following a 1% decrease in per capita GDP. These results indicate that the credit multiplier has a considerably greater impact on household spending in countries where the maximum LTV is high. Consistent with our conjectures about the joint role of income and collateral constraints, we also find that the relationship between LTV ratios and income sensitivities is stronger in countries where housing is cheaper relative to household income.

Our empirical analysis explicitly recognizes a number of alternative factors that could potentially influence the results we obtain. For example, we control for variables which are likely to be correlated with maximum LTV ratios and which could also explain the cross-country differences in income sensitivities, such as economic development and the propensity for homeownership. In particular, we find that the effect of the LTV ratio remains after expunging the component that is explained by economic development and homeownership. At the same time, the relationship between the LTV ratio and income sensitivities remains after instrumenting the LTV ratio with variables that absorb cross-country differences in overall financial development, such as the development of the judicial system and the quality of accounting standards. Our evidence suggests that financial development is a contributing factor to the real-side effects of the financial accelerator. As a final robustness check, we avoid looking at housing price responses altogether, focusing instead on the demand for new mortgages. Although we only have limited data on mortgages, we again find evidence that is consistent with the multiplier: new mortgages respond positively to household income shocks, and those responses are increasing in LTV ratios.

Our paper is related to several different strands of literature. Our empirical approach borrows from Jappelli and Pagano (1989, 1994), who study the relationship between financial development and macroeconomic variables such as savings growth and the sensitivity of the consumption to changes in income. Jappelli and Pagano use maximum LTV ratios as a measure of financial constraints on households exactly as we do: higher maximum LTV ratios are associated with higher debt capacity and less financial constraints on households. They find evidence that maximum LTV ratios help explain cross-country differences in key macroeconomic variables.

The sensitivity of housing prices to household income has been examined by Lamont and Stein (1999). Using data from the US, they find that housing prices are more sensitive to changes in city-level GDP in years when homeowners in a particular city have very high leverage. They interpret these results as evidence that households are likely to be liquidity-constrained when their leverage is high, which is consistent with the idea that constrained agents are more sensitive to income shocks than unconstrained ones. Our analysis, in contrast, uses international variation in maximum LTV ratios and in price-to-income ratios to identify procyclicality in debt capacity among strictly constrained agents.[3] While Lamont and Stein's goal is to examine the effects of liquidity constraints on asset pricing (with an application to housing), our paper aims at shedding some new light at the amplification mechanism implied by the financial accelerator.

There is also a large literature that uses micro-level data to test the effects of financial constraints on the housing market. This literature suggests that financial constraints help explain several housing variables, such as the propensity for homeownership (Linneman and Wachter, 1989; and Haurin et al., 1997), the type of mortgage chosen (Hendershott et al., 1997), mortgage refinancing and prepayments (Archer et al., 1996; and Caplin et al., 1997), gifts and intergenerational transfers (Engelhardt and Mayer, 1998) and owner-occupants' selling behavior (Genesove and Mayer, 1997). Most evidence pertains to the US market, with several of the papers analyzing the joint effect of the income and collateral constraints.[4]

The role of financial constraints in housing markets has also been studied by a few theoretical papers. Stein (1995) analyzes the impact of a down payment constraint on the equilibrium of the housing market and finds that the sensitivity of prices to shocks to fundamentals (such as income) is higher in the constrained equilibrium. Ortalo-Magne and Rady (1998, 1999) consider the effect of an interaction between household heterogeneity and a collateral-type constraint for housing price fluctuations. Their model features an amplification mechanism which relates to the one we emphasize in this paper: an income shock gets amplified through its effect on the ability of young households to afford down payments.[5] Neither of those papers analyzes the effect of changes in the down payment requirement (the LTV ratio), nor the independent effect of the income constraint.

[3] Notice also that the key housing finance variable we use (the maximum LTV ratio) is conceptually very different from household's existing leverage. The maximum LTV ratio represents the marginal opportunity to borrow as a function of the value of housing, while household's leverage is an endogenous variable determined by past borrowing decisions.

[4] There are very few international studies on housing markets, most of them using a small set of countries (such as Cutler et al., 1991). Englund and Ioannides (1997) is an exception in that the authors characterize housing price dynamics for a panel of 15 OECD countries. However, they do not focus on financial constraints. Malpezzi (1990) discusses the interactions between financial development and housing markets.

[5] One of their main implications is that since housing prices depend particularly on the income of young households, the income of young households might be a more appropriate aggregate variable to include in housing price regressions. Unfortunately, the international data we have do not allow us to account for such heterogeneity in our tests.

Even though our focus is mainly empirical, this gap motivates us to start the paper by laying out a very simple model where we introduce these considerations. We do this in the next section (Section II). In Section III we provide a detailed description of the international housing markets data we use in the study. In Section IV we present our empirical results. Section V concludes the paper.

II Collateral and income constraints in a model of housing demand

A Structure

We start our analysis of constrained housing demand using a simple model framework, based on Stein (1995). There are two goods in the economy, housing (H) and food (Z). The price of housing (P) is measured in units of food. There is a representative household endowed with total lifetime income equal to $W_1 + W_2$. There are two time periods in the model. The household only consumes in the final period (t_2), but it must choose at time t_1 how much to spend on housing. In contrast, food is purchased at the time it is consumed.[6] We assume throughout that the gross, riskless rate of interest in the economy is equal to 1.

At time t_1, the household only has access to current income W_1. It cannot borrow directly against future income W_2 because future income cannot be pledged to creditors, and thus the household might be constrained in its choice of housing. The household can raise mortgage debt against the value of its housing wealth.[7] The value of the mortgage loan (call it B_1) that can be raised is subject to two constraints. First, the loan cannot be higher than a certain fraction $\lambda \in [0, 1]$ of the value of the home, that is:

$$B_1 \leq \lambda PH \tag{1}$$

The parameter λ can be interpreted as the maximum loan-to-value ratio. The higher the λ, the easier it is for a household to borrow in order to finance spending.[8] In the real-world, this parameter depends on variables such as the costs of enforcing and disposing of collateral, regulations about housing finance, and the amount of information creditors have about borrowers.[9] The fact that the

[6] These assumptions eliminate intertemporal effects other than the fact that the household must purchase housing before consuming it fully.

[7] We are not explicitly considering the role of inherited leverage from past mortgages and other borrowings. However, existing leverage can be thought of as a reduction in household income W_1.

[8] When $\lambda = 1$, for example, the household will be financially unconstrained.

[9] See Japelli and Pagano (1994) for a detailed discussion.

parameter λ can be lower than 1 represents in effect a credit quantity constraint on households. An alternative approach would be to focus on the relative cost of funds, or more specifically, on the wedge between the borrowing rate in the mortgage market and an appropriate lending rate. As discussed by Jappelli and Pagano (1989, 1994), however, this wedge does not appear to be a viable explanation of the cross-country differences in the financial liabilities of households. Differences in interest rate wedges across countries seem negligible and there is no clear relation between lending volumes and wedges. For simplicity, we therefore assume that the household pays no interest rate premium when it borrows up to the limit λPH. We call Eq. (1) the household's "collateral constraint."

The other constraint faced by households in real-world mortgage contracts is the "income constraint." The income constraint essentially limits the yearly amount of housing expenditures associated with the mortgage contract (loan payments plus property taxes) to a certain fraction of the household's yearly income, which in the US is around 28%.[10] Stein's model does not incorporate the idea of an income constraint. In order to accommodate that constraint in the present model — which also lacks an explicit intertemporal component — we assume that the total value that must be repaid to creditors at t_2 (that is, B_1) must be lower than a certain fraction $k \in [0, 1]$ of the household's future income W_2, plus any amount saved from t_1 to t_2 (call it s_1):

$$B_1 \leq k(W_2 + s_1) \tag{2}$$

Finally, as in Stein, we assume that the household's utility function for housing and food is given by:

$$U = \alpha \ln(H) + (1 - \alpha) \ln(Z) \tag{3}$$

B Analysis

The household maximizes the utility function U subject to the following constraints:

$$PH + s_1 = W_1 + B_1 \tag{4}$$

$$Z = W_2 + s_1 - B_1 \tag{5}$$

$$B_1 \leq \min[\lambda PH, k(W_2 + s_1)] \tag{6}$$

[10]Unfortunately, we do not have data on the income limits for other countries.

where the savings s_1 must be nonnegative ($s_1 \geq 0$).

Some properties of the optimal solution are immediate from the examination of these conditions. If the constraint in Eq. (6) is binding, then the household cannot bring enough income from the future to the present in order to finance its optimal housing expenditures, which implies $s_1 = 0$. This is true even when the income constraint is binding, since $k \leq 1$. On the other hand, if constraint (6) is not binding, then savings and borrowing are not uniquely determined and will be related according to the budget constraint of period t_1:

$$s_1 = W_1 - PH + B_1 \tag{7}$$

Replacing this last equation in the budget constraint of period t_2, it is easy to see that the household whose borrowing is not constrained solves the following problem:

$$\max_{H,Z} \alpha \ln(H) + (1-\alpha)\ln(Z) \text{ s.t.} \tag{8}$$

$$PH + Z = W_1 + W_2 \tag{9}$$

Thus an unconstrained household chooses optimal housing and food consumption effectively using total lifetime income as its relevant wealth variable. The optimal unconstrained housing demand (as a function of housing price) is then given by:

$$H^U(P) = \alpha \frac{W_1 + W_2}{P} \tag{10}$$

The household will be constrained when the maximum amount that it can borrow to finance housing is not enough to finance the unconstrained demand $H^U(P)$. Let $B_1^{\max}$ be defined by:

$$B_1^{\max} = \min[\lambda P H^U(P), kW_2] \tag{11}$$

The household will be constrained when:

$$PH^U(P) > W_1 + B_1^{\max} \tag{12}$$

In this case, the optimal housing demand is determined directly from the constraints.[11] There are two possibilities to consider, depending on which constraint (collateral or income) is binding:

[11] Notice that if W_1 is low the household is more likely to be constrained. If we think of past leverage as a reduction in W_1, this effect is consistent with the main hypothesis tested in Lamont and Stein (1999): when leverage is high households are more likely to be constrained and the effect of an income shock on housing prices is larger than in the benchmark unconstrained case.

i) If the income constraint is binding, the maximum housing demand that the household can finance is given by:

$$H^I(P) = \frac{W_1 + kW_2}{P} \tag{13}$$

ii) If the collateral constraint is binding, then we have:

$$H^C(P) = \frac{W_1 + \lambda P H^C(P)}{P} \tag{14}$$

In either of these cases, the household consumes the rest of its lifetime income in food, that is, $Z = W_1 + W_2 - PH$.

Examination of Eqs. (13) and (14) reveals the key difference between the collateral and the income constraints and clarifies the role these constraints play in the financial accelerator. The collateral constraint is endogenous, in the sense that the household's capacity for external finance depends on the value of housing. Hence a shock to current income W_1 that changes housing demand will be amplified by the endogeneity of debt (as in Kiyotaki and Moore, 1997). When the income constraint binds, on the other hand, debt capacity only depends on future income and there is no natural amplification mechanism.

Considering the effect of a change in current income on housing demand (while taking the housing price as fixed) it is easy to see that:

$$\frac{\partial H^U}{\partial W_1} = \frac{\alpha}{P} \leq \frac{\partial H^I}{\partial W_1} = \frac{1}{P} \leq \frac{\partial H^C}{\partial W_1} = \frac{1}{(1-\lambda)P} \tag{15}$$

The reason for the first inequality is that the constrained household spends a greater fraction of current income on housing. In terms of the model, the optimal fraction to spend on housing is given by the parameter α. The constrained household is underinvesting in housing, and thus will direct the entire change in current income to housing.[12] The second inequality shows that the sensitivity of demand to income will be even higher when the collateral constraint binds, because of the amplification effect associated with the endogenous change in debt capacity.

C Model implications

Our simple analysis has a number of interesting implications. First, notice that the sensitivity of demand to income will depend on the loan-to-value ratio *if and only if* the collateral constraint

[12] If there was intermediate consumption in the model, then the constrained fraction spent on housing would also be higher than the unconstrained one, but it would no longer be optimal to spend all income in housing. The gist of our results, however, would be the same.

binds. So long as the household is collateral-constrained, an increase in the loan-to-value ratio will tend to increase the sensitivity of demand to income. Thus, the *less* constrained the household is, the *higher* the sensitivity of demand to current income will be. If the LTV ratio is so high that the constraint no longer binds, then the sensitivity falls either because the household becomes unconstrained or because the income constraint will bind instead.

From Eq. (6), the condition for the income constraint to bind is given by:

$$\frac{k}{\lambda} < \frac{PH}{W_2} \tag{16}$$

This condition indicates that the income constraint will bind when the value of housing is high relative to household income. If housing prices vary across countries due to factors such as geography and demography, then we should expect the income constraint to be more likely to bind in countries where housing is relatively expensive. This condition is intuitive. In some countries, housing can be so expensive in comparison to household income that it does not matter whether the maximum loan-to-value a household can achieve is 40% or 90%.

One difficulty that we face when taking this model to the data is that changes in housing demand for a particular country are not directly observable. In particular, the available international data consist primarily of housing price indices for different countries. One would need implications for the housing market equilibrium, and in particular for the sensitivity of housing prices to current income, in order to utilize those data. In our case, we need to assume some degree of rigidity in housing supply in order for our model implications to carry to price data. To see this in the simplest possible way, suppose that housing supply is perfectly inelastic. Then we can show that:

$$\frac{\partial P^U}{\partial W_1} = \alpha \leq \frac{\partial P^I}{\partial W_1} = 1 \leq \frac{\partial P^C}{\partial W_1} = \frac{1}{1-\lambda} \tag{17}$$

where P^U is the unconstrained price level, and P^I and P^C are, respectively, the price levels when the income or the collateral constraint binds. Clearly, the constrained sensitivities are higher than the unconstrained one, and the sensitivity is highest when the collateral constraint binds. Furthermore, if the collateral constraint binds the sensitivity is increasing in the loan-to-value ratio. If one can assume that housing supply is sufficiently inelastic in the short-run, then the properties we derived for housing demand should translate into housing prices. This particular supply-rigidity assumption is standard in the housing literature (see, e.g., Meen, 1996; Voith, 1996; Malpezzi and Mayo, 1997;

and Mayer and Sommerville, 2000) and seems to be reasonably well-supported in the limited data we have on housing starts.[13] Should housing supply be very elastic, on the other hand, then we should fail to uncover any evidence of the accelerator.

Another issue for our tests is that when we compute the effect of changes in W_1 we are effectively assuming that there is little correlation between changes in current income and changes in future income (W_2). If there is a strong empirical correlation between W_1 and W_2, the comparison between the sensitivities across cases (for example, constrained versus unconstrained) might not be as clean as what we had above. In order to see this, suppose that:

$$W_2 = \widetilde{W_2} + \rho W_1, \tag{18}$$

where ρ is a measure of the correlation between W_1 and W_2. It is easy to see that the sensitivities of price to current income will become:

$$\frac{\partial P^U}{\partial W_1} = \alpha(1 + \rho) \tag{19}$$

$$\frac{\partial P^I}{\partial W_1} = (1 + k\rho) \tag{20}$$

$$\frac{\partial P^C}{\partial W_1} = \frac{1}{1 - \lambda} \tag{21}$$

The most important change is that it is no longer clear that the sensitivity is highest when the collateral constraint is binding. It could also be the case that the unconstrained sensitivity is higher than the constrained ones. Yet, the implication that sensitivity increases in the loan-to-value ratio if and only if the collateral constraint is binding remains unchanged. Recall, this is the only theoretical result we need to support our claims about testing for financial accelerator effects *within* a set of financially *constrained* agents.

Finally, as in most papers dealing with measures of financial development, we need to ensure that our findings are not simply driven by economic development. In our particular case, it is possible that the sensitivity of prices to income increases with economic development even when households are unconstrained. This could happen if the fraction of income spent on housing (the parameter α) is strictly increasing in economic development. Since economic and financial development are correlated, it could be difficult to disentangle this story from our explanation based on collateral

[13] Regressing a measure of new dwellings (and, alternatively, a measure of the change in housing stock) on various lags of GDP, we find no evidence of a significant response of housing starts to current and recent lags of income.

constraints. In the empirical section, we shall verify that our results cannot be ascribed to economic development alone.

We can summarize the testable implications of our model as follows:

1. *If the collateral constraint is binding, then the sensitivity of housing prices to changes in current income should be increasing in the maximum LTV ratio available to households.*

2. *If the relationship between price-income sensitivities and the LTV ratio is driven by the collateral constraint, then it should be especially strong in countries where the value of the typical housing unit is low relative to household income (i.e., in countries where the income constraint is less likely to bind).*

We test both of these predictions in turn.

III Data description

We use data on housing price indices for the 26 countries listed in Table 2 for the period 1970-1999. The housing price data are summarized in Table 1 together with the data on per capita GDP (the main driving variable in the empirical specification) and annual new mortgages (which we use as an alternative endogenous variable). We use yearly changes in the logs of GDP and housing prices, deflating the data with consumer price index series taken from the IMF's *International Finance Statistics* database. New mortgages are expressed as a fraction of nominal GDP. The data on housing prices and new mortgages are hand-collected from different sources, while the GDP data are taken from the IMF financial statistics. We list all of our data sources as well as provide detailed information about the different indices used in the Appendix.[14]

– insert Table 1 here –

Table 2 displays country data on maximum LTV, price-income, and homeownership ratios. The maximum LTV ratio is the empirical counterpart of the parameter λ in the model of Section II. Most of these data are taken from Jappelli and Pagano (1989, 1994), who also use the maximum LTV ratio as a measure of the availability of credit to households in an international context. As they argue, the maximum LTV ratio is a direct and objective measure of liquidity constraints on

[14] The data used in this paper are available from the authors upon request.

households that is comparable across countries. We were able to augment the Jappelli and Pagano dataset using data from Chiuri and Jappelli (2000), and by looking at the sources cited therein. We also use a few other sources for LTV ratios (see the Appendix).

Notice from Table 2 that LTV ratios vary significantly around the world. Developing countries, such as Korea and Taiwan, generally have lower LTV ratios (as low as 30%). However, there is variability even among developed economies, as evidenced by the case of Italy, where LTV is 60% during the 1990's, versus 95% for the UK in that same period. LTV ratios vary less over time for the same country, with a few exceptions, such as Sweden and Spain.

The data on homeownership and price-income ratios were also hand-collected from several different sources. The homeownership ratio represents the proportion of home owners as a fraction of total households. The price-income ratio is the ratio of the typical price of a dwelling unit to yearly median household disposable income. It effectively represents the number of years it takes for the median household to "earn" the value of a typical home. Notice from Table 2 that both the homeownership and the price-income ratios remain relatively stable over time. It is clear from the table that in countries such as Switzerland and Singapore housing units are substantially more "expensive" than in other countries, such as the US and Canada. Our empirical analysis will use these cross-country differences in price-income ratios to gauge whether the income constraint introduced in Section II is likely to be binding in a given country.

− insert Table 2 here −

IV Empirical tests

Our main goal is to examine the empirical relationship between the sensitivity of housing prices to income shocks and maximum LTV ratios across countries. According to the financial accelerator hypothesis, that sensitivity should be especially strong if the maximum LTV ratio is high, because of the endogenous change in debt capacity following a positive shock to income. Since the collateral constraint is more likely to bind in countries with more affordable housing, the relationship between LTV ratios and sensitivities should be stronger in countries with cheap housing (i.e., low price-income ratios). Finding that these patterns are present in the data is consistent with evidence in favor of the financial accelerator in housing spending.

A Housing price dynamics

In order to test our hypotheses we need a benchmark empirical model of housing prices. The housing literature suggests a set of determinants (other than current income) to include in this model. For instance, there is ample evidence of a consistent autoregressive pattern in housing prices. There is positive autocorrelation at short lags (Case and Shiller, 1989; Poterba, 1991; and Lamont and Stein, 1999), but negative serial correlation at longer lags (Case and Shiller, 1990; and Lamont and Stein, 1999). This pattern has been shown to hold in international data as well (Englund and Ioannides, 1997). We experiment with the use of these lag structures in turn.

In Table 3 we pool the sample in a panel regression and search for an appropriate empirical model to fit the data on housing prices. All regressions include year effects. Column (1) shows that real housing prices are indeed correlated with real current income (proxied by real per capita GDP). Two additional lags of per capita GDP are also significant when no other variables are included in the regression, as shown in column (2). Columns (3) and (4) show that there is positive price autocorrelation at short lags, but negative autocorrelation at longer lags (long-term reversal). This is true both with and without the inclusion of country effects.[15] Our international data shows some of the same patterns of previous studies focusing on the US housing market.

– insert Table 3 here –

Column (5) adds other macroeconomic variables to the model of column (3). Both the real interest rate and the inflation rate have negative effects on housing prices, but their effects are not always significant. Finally, in columns (6) and (7) we use the empirical model proposed by Lamont and Stein (1999) in their study of housing price dynamics in US cities. Essentially, they replace longer lags of price and income changes with the start-of-period ratio of price to per capita income ($Price_{t-1}/Income_{t-1}$). As in Lamont and Stein, column (6) shows that longer lags of price and income become insignificant when we include the lagged ratio of price to per capita income. The more parsimonious specification of column (7) seems to capture well the effects of the longer lags.

In the next section we introduce the LTV ratio and the income constraint in the analysis, using, alternatively, the specifications in columns (1), (3), (4), (5), and (7) of Table 3. This verifies that

[15] Following the standard approach in the literature, most of our models are estimated via OLS and include both lagged dependent variables and fixed effects (see, e.g., Lamont and Stein, 1999). We however, recognize the potential for biases in this procedure, and later emphasize results from the Arellano-Bond dynamic panel GMM estimator.

our findings do not hinge on the selection of a particular specification for housing price dynamics.

B Financial constraints and the income sensitivity of housing prices

We introduce credit constraint effects in our analysis by allowing the price-sensitivity of income to vary according to the maximum LTV ratio. This amounts to augmenting our baseline empirical models by adding an intercept term for the LTV ratio and another term capturing the interaction between LTV and per capita GDP growth. When we use lags of GDP growth, we interact the LTV ratio with all of the lags of GDP change, besides the current change (lag 0). This approach will capture the effect of the accelerator even if it takes longer for it to feed through the economy. We then test whether an increase in LTV increases sensitivities by testing whether the parameters on those interaction terms are significantly greater than zero.

Table 4 presents one of the main set of results of the paper. Column (1) shows that the correlation between changes in prices and changes in income is indeed higher in countries with higher maximum LTVs. The positive effect of the LTV ratio remains after we include further lags of price and income in the specification, as shown in column (2). The sum of the interaction terms of the LTV with the current and past lags of the change in income is positive and significant at the 1% level. When we include country effects in the model the sum of the interaction terms increases (see column (3)). Column (4) shows that the inclusion of inflation and interest rates in the specification reduces the effect of the LTV ratio, but the sum of the interaction terms is still positive and significant. Finally, the interaction of the LTV ratio with the current change in income is also significant (at the 10% level) when we use the Lamont and Stein specification. This last specification makes it convenient to assess the implied magnitude of the effect of the LTV ratio on income sensitivities. The coefficient returned for $\Delta Log(Income)_t \times LTV_t$ suggests that if the LTV goes from 0.60 to 0.90, the income sensitivity increases nearly 50%, from 0.84 to 1.23. These estimates imply, for example, that a 2% drop in per capita GDP will depress housing prices by some 1% *more* in the UK than in Italy.

– insert Table 4 here –

Table 5 reports the results we obtain after imposing several modifications to our basic empirical models. For brevity, we use the specification with three lags of income and prices (columns (2) and

(3) of Table 4) as a benchmark.[16]

– insert Table 5 here –

Our interpretation of the positive correlation between the LTV ratio and the income sensitivity of housing prices is that this effect is driven by differences in the availability of mortgage finance to households in different countries. To provide further evidence that our results are indeed driven by differences in financial constraints as opposed to some sort of simultaneity bias, we instrument the LTV ratio with variables which we expect to be related to the overall level of financial development in different countries. In countries with higher financial development it should be easier for both firms and households to raise outside finance. In the context of mortgage finance, a higher level of financial development should be reflected in the availability of higher LTV ratios for households.[17] Our set of instruments includes the index of accounting standards computed by the Center for International Financial Analysis and Research. Accounting standards have been used as an instrument for financial development in Rajan and Zingales (1998), among others. The second variable included in our instrument set is a proxy for the effectiveness of the country's judicial system. This proxy is taken from LaPorta et al. (1998). The idea is that, the higher the standards of financial disclosure and the more advanced the judicial system in a country, the easier it is for firms to raise funds from a wider circle of investors. Assuming that similar variables influence the availability of finance to firms and households, accounting standards and judicial efficiency are appropriate instruments for the maximum LTV ratio.[18] The results on the first two columns of Table 5 show that the effect of the LTV ratio on income sensitivities actually increases after instrumenting for overall financial development. This is true both with and without the inclusion of country effects. These results suggest that our previous findings are indeed driven by underlying variables affecting the availability of finance.

To the extent that maximum LTVs and economic development might be correlated, one could argue that the results in Table 4 are primarily driven not by financial development, but simply by cross-country differences in *economic* development. The theoretical section suggests that if the

[16] Our conclusions are similar when we choose other specifications featured in Table 4 for these series of tests.

[17] Notice that *financial* development is in principle distinct from overall *economic* development; even though they are correlated.

[18] The first-stage regressions indeed show that our instruments and the maximum LTV are strongly positively correlated. The R^2 of the first-stage regression is 0.39.

fraction of wealth spent in housing increases with wealth, then it could be the case that richer countries have larger income sensitivities, even if financial constraints are never binding. This provides for an "unconstrained explanation" for the observed pattern in sensitivities. Another possible explanation for our results is that the relationship between maximum LTV ratios and income sensitivities is driven by cross-country differences in homeownership.[19] One could argue, for example, that countries with large rental markets have lower sensitivities and lower LTV ratios because the rental market helps absorb the effect of an income shock, or because only the wealthiest households own homes in countries with low LTV ratios. In particular, in economies with high LTV ratios demand for housing could be more cyclical simply because the marginal borrower in these economies is poorer, and thus more sensitive to current economic conditions. If this argument explains our results, then the cross-country differences in income sensitivities we observe should be absorbed by variations in the homeownership ratio.

In columns (3) through (6) we address the relevance of these competing stories by adding proxies for economic development (ten-year average values of per capita GDP in constant international prices)[20] and homeownership to our specification. In columns (3) and (4) we add the economic development proxy together with all of its interactions with lags of log income change (lags 0 through 2).[21] In columns (5) and (6) a similar approach is used to control for homeownership.[22] The results from these tests suggest that neither economic development nor homeownership are robustly related to income sensitivities, after controlling for the LTV ratio. The sum of the interactions with economic development are positive as hypothesized, but never significant. More importantly, the positive effect of LTV on sensitivities remains mostly unchanged after controlling for homeownership and economic development. The sum of the interaction terms of the income changes with the LTV ratio is positive (albeit smaller) and significant at better than 5% test level in 3 out of the 4 specifications. In one specification (with economic development and country effects) the sum of the interaction terms is only marginally significant (p-value of 11.9%).

Our model suggests a specific economic mechanism behind the relationship between financial

[19] Table 2 shows that there is substantial variation in homeownership ratios around the world.

[20] The averaging is intended to match the frequency of the LTV series.

[21] The coefficients returned for these controls are mostly insignificant and are thus omitted from Table 5.

[22] Results are similar if we use both of these variables and all of their interaction terms together in one specification. The same applies if we use a more parsimonious approach where we use only the LTV and its interactions with income change in the specification after expunging economic development and homeownership main effects from LTV (i.e., using the "residual LTV").

constraints and price-income sensitivities. If the household is financially constrained, the effect of a change in income is amplified by the associated increase in borrowing capacity; and this amplification effect is higher the higher is the LTV ratio. If this argument is correct, the income sensitivity of new borrowings by households should also be higher in countries with high LTV ratios. In columns (7) and (8) of Table 5 we use total annual new mortgages divided by nominal GDP as an alternative dependent variable in the empirical model. In the absence of priors for the dynamics of new mortgages, we use a more parsimonious specification which includes two lags of income changes besides the current change. Even though the sample is considerably smaller, we do find evidence that new mortgages respond more to changes in income when the LTV is high. The interaction between income and the LTV ratio is positive, and statistically significant when we do not add country dummies.

In column (9) we estimate our baseline model using the GMM estimator for dynamic panel data proposed by Arellano and Bond (1991). More precisely, we implement the one-step Arellano-Bond estimator with each of the base model variables instrumented by two of their own lags (in levels). The Arellano-Bond estimator returns coefficients that are smaller than those from the OLS regression. Yet, the effect of the maximum LTV ratio on income sensitivities is still positive and statistically significant.[23]

Finally, recognizing the limitation of our sample size, we provide for a direct check of the argument that our results could driven by the data from one specific country. We do this check by performing a series of GMM estimations of our baseline model, where we disregard data from one of the sample countries at each run. The lowest point estimate we obtain for $\sum_{j=0}^{2} \Delta Log(Income)_{t-j}$ $\times LTV_t$ equals 0.56, which is returned when we exclude Japan from the sample. That estimate is statistically significant at the 3% level. Eliminating any of the other countries returns coefficients which are significant at better than the 1% level.

C The income constraint

The theoretical arguments in Section II suggest that the effect of the LTV ratio on income sensitivities should only be significant if the collateral constraint is binding. As we pointed out, it is also

[23] The Sargan test statistic associated with the Arellano-Bond estimator of Table 5 ($\chi^2_{(403)}$=392.1, p-value=64.2%) reveals that the null of instrument validity cannot be rejected. Also supporting the adequacy of the estimator is the high p-value (=83.5%) associated with the test of the null of no second-order autocorrelation in the residuals.

possible that the income constraint is binding instead, which should eliminate (or at least reduce) the positive association between maximum LTV ratios and income sensitivities. Identifying which of those constraints will bind first in each of the countries studied is not an obvious task. Arguably, however, the income constraint is more likely to bind in countries where the price of a typical home is high when compared to household disposable income. Table 2 shows that there is indeed some variability across countries in the ratio of housing prices to disposable income. These differences seem to be driven by geographical and demographic factors, such as country size and population, and seem to convey information about how affordable is housing in different countries.

In the final set of tests of the paper, we rank countries according to the distribution of the price-disposable income ratio and classify as "expensive" ("cheap") those in the top (bottom) third of this ranking.[24] We then run separate regressions for the two subsamples. The results from the subsample regressions are shown in Table 6. To demonstrate the robustness of our results, the table reports outputs from OLS and GMM estimations of the model with three lags of income and prices as well as the results pertaining to the Lamont and Stein specification.

– insert Table 6 here –

Consistent with our predictions, the association between the LTV ratio and income sensitivities is only significant in countries with relatively cheaper housing. This result is consistent across estimation procedures and empirical specifications. We interpret this last set of results as further evidence that increases in the maximum LTV ratio increase the sensitivity of housing prices to income because the financial accelerator is stronger when the LTV is higher and households are collateral-constrained.

V Concluding Remarks

In this paper we use the specific features that characterize housing finance contracts and international housing markets to provide fresh evidence supporting the "financial accelerator" introduced by Bernanke et al. (1996). Specifically, we use international variation in maximum loan-to-value (LTV) ratios to identify within a group of arguably constrained agents those with more procyclical

[24] Our conclusions are mostly insensitive to whether we partition the data according to the median income-price ratio or, alternatively, according to quartiles. As should be expected, the latter partition produces stronger but noisier coefficients.

borrowing capacity. Since the procyclicality in the borrowing capacity of constrained agents is the amplification mechanism at the heart of the financial accelerator, our empirical strategy allows us to provide a direct test of the endogenous mechanism that underlies the accelerator. Our results show that housing prices are more sensitive to aggregate income shocks in countries with higher maximum LTV ratios, indicating that debt capacity is more strongly procyclical in such countries. Furthermore, the empirical relationship between LTV ratios and income sensitivities is stronger in countries where housing is cheaper relative to household income. Because the collateral constraint is more likely to bind in such countries, this result is consistent with the idea that a collateral-based financial accelerator is behind the cross-country differences we observe in income sensitivities. Our empirical analysis explicitly addresses a number of factors that could potentially influence the results we obtain. All of our results are consistent with an important role for the financial accelerator in household spending.

Besides being a nice laboratory to study the economic effects of the financial accelerator, the housing market is also one of the markets where the significance of such effects is likely to be high. Previous literature has shown that consumer spending is intimately linked to housing wealth (see, e.g., Case et al., 2001; and Engelhardt, 1996), and that housing investment plays a major role in the business cycle (Mishkin, 1977, 1978; and Bernanke and Gertler, 1995). This paper shows that the effect of the financial accelerator in household spending and housing prices may help characterize the mechanism through which shocks get amplified and transmitted throughout the economy.

Finally, the results in this paper may have interesting implications for the welfare effects of financial development. Previous research has identified excessive volatility in housing prices (Poterba, 1991), and has argued that, within OECD countries, those with more liberal financial markets experienced undesirably high levels of housing price volatility during the 1980's and 1990's (Stephens, 1995). Our results suggest a mechanism through which financial development and liberalization could magnify fluctuations in housing prices. When financial development is associated with higher maximum LTV ratios collateral constraints are relaxed and the financial accelerator becomes stronger. Whether the financial accelerator and other theories stemming from financial imperfections can account for the excess volatility of housing prices is an important matter for public policy and for future research.

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A Data Appendix

This appendix describes in detail several of the data items we use in the paper.

A Housing Price Indices

Most of the data for developed countries are supplied by Peter Englund, which is the same data used in Englund and Ioannides (1997). Below we refer to this source as "EIO". Their data covers the period 1970-1992. We update their data set using the Annual Reports from the Bank of International Settlements (BIS), which give information on the same indices used by Englund and Ioannides. For countries not included in the Englund and Ioannides data set, we use other sources described below. 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. Updated using the AUEHPI index from the Australian Bureau of Statistics.

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. Updated using the New House Price Index from the Statistics Canada, available at http://cansim2.statcan.ca.

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 homes, 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.

Hong Kong. Index constructed by the Rating and Valuation Department, from the Hong Kong Property Review, data from Chou and Shih (1995), updated using data on the same index available at http://www.info.gov.hk.

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 (data used in Bar Nathan et al., 1998), updated using data from the Israel Central Bureau of Statistics (www.cbs.gov.il/srcer.cgi)

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. Urban Residential Land Price Index, from the Japanese Real Estate Institute, available at www.reinet.or.jp.

Korea. Land Price of Housing, from the Korea Appraisal Board, Appraisal Research & Development Center, available at www.kreic.com.

Malaysia. IHRM (Malaysian House Price Index % change from previous year). Data provided by Steve Malpezzi and used in Malpezzi and Mayo (1997), updated using data from the Countrywide's Sourcebook 2000.

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

New Zealand. Data from Dalziel and Lattimore (1999), Valuation New Zealand Housing Price Series, average prices of free-hold house sales, adjusted for quality, updated using BIS data.

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.

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. Updated using the SIPRIRES index of the Singapore Department of Statistics.

Spain. Data provided by O. Bover. Prices per square meter of new dwellings in Madrid, used in Bover (1993). Updated with the Price Index for Existing Dwellings, from Hypostat 1999.

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. Real estate price index for 3-5 bedroom single family homes, from the Swiss National Bank (http://www.snb.ch/e/search/index.html).

Taiwan. Median of Housing Prices in Taipei, provided by Shiawee Yang.

Thailand. Real housing price index used in Malpezzi and Mayo (1997). Data provided by S. Malpezzi covering the period from 1970-1986. Updated using the series on Land Price Increases in Bangkok, from the Agency for Real Estate Affairs.

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.

B New Mortgages

Data for net new mortgage lending for Belgium, Denmark, Germany, Ireland, Finland, Netherlands and Spain is from Hypostat *1989-1999*, and data for Canada, France, Italy, Japan, Norway, Sweden, UK and US is from the OECD, also used by Girouard and Blondal (2001), and kindly provided to us by Nathalie Girouard.

C Maximum LTV Ratios

Data is from Jappelli and Pagano (1994), updated with data from Chiuri and Jappelli (2000). The data is given in 10-year averages. We extended this data as follows: for Denmark, Japan, New Zealand and Norway we assumed the Jappelli and Pagano 1980-1987 data extends to 1990. We took 1991-1999 data for Denmark and Norway from MacLennan, Muellbauer and Stephens (1998). Singapore 1991-1999 data is from Phang and Wong (1997). The data for Chile, Hong Kong, Korea (1980-1999), Japan (1991-1999), New Zealand (1991-1999) and Switzerland is from the Countrywide's Sourcebook, 1995 and 2000. Malaysia and Thailand 1991-1999 data is from the Asian Development Bank, 1999.

D Homeownership Ratios

Data for Australia, Belgium, Canada (1970-1989), France (1970-1980), Germany (1970-1980), Italy (1970-1980), Netherlands (1970-1980), Spain (1970-1980), and Taiwan is from Chiuri and Jappelli (2000). Data for Chile, Denmark, Finland, France (1981-1999), Germany (1981-1999), Hong Kong, Ireland, Italy (1981-1999), Japan, Netherlands (1981-1999), Norway, Sweden and Spain (1981-1999) is from the Countrywide's Sourcebook *2000.* Data for Korea and Malaysia is from the Asian Development Bank, 1999. Data for Canada (1991-1999), New Zealand, Singapore, Switzerland, Thailand, UK and US is from the Euromonitor (available at www.euromonitor.com).

E Price-Income Ratios

The data on personal disposable income is from the Economic Outlook No 70: Annual and Semi-annual data (Source: OECD), with the following exceptions: the data for Denmark and Thailand is from DRI-Wefa (http://www.dri-wefa.com/), the data for Taiwan is taken from the Government statistics at http://www.stat.gov.tw. We collected the nominal housing price for a particular year, and then we used the housing price index described above to extrapolate the series for all years. The data for Belgium, Denmark, Finland, France, Italy, Netherlands, Spain and Sweden represents the typical price for a flat of 150 square meters in 1999, and is taken from the Countrywide's Sourcebook 2000. The data for Canada (average price of all dwellings, 1995-1999), Ireland (average new house price for the whole country, 1996-1998), Korea (median price of typical 710 square feet apartment in Seoul in 1990), New Zealand (median price of a home, 1999), UK (Mix-adjusted average house price in 1999), and the US (average existing single family house price from 1990-1999), are also taken from the Countrywide's Sourcebook 2000. Below we list the sources and definitions for the remaining countries:

Australia - typical house price in 1999, from http://www.amp.com.au/au/ampweb.nsf/Content.

Chile - price of an standardized dwelling in selected areas of Santiago, 1975-1998, from Morande and Soto (1992).

Germany - price of existing detached houses, 1970-1993, from Muelder and Wagner (1998).

Hong Kong - price of a 100 square meter flat, 1982-1992, from Chou and Shih (1995).

Israel - typical apartment price in 1999, from www.jpost.com

Japan - typical apartment price in 1999, from www.pricechecktokyo.com

Malaysia- typical price of a single-story detached home in 1998, from www.jpph.gov.my

Norway - average price of a 150 square meter flat, from Statistics Norway (www.ssb.no).

Singapore - 1999, average house price from Asia Week, www.asiaweek.com

Switzerland - price of an average 4 bedroom semi-detached house with parking in 1999, from www.expatacess.com

Taiwan - actual average housing purchase price, 1981-1989, from Lin (1993).

Thailand - 1994-97 average house price, from the Asian Development Bank.

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Table 1: Summary Statistics of Housing Price Changes, Income Growth, and New Mortgages

This table displays summary statistics for housing prices chages, income growth, and new mortgages for 26 countries over the 1970-1999 period. $\Delta Log(Price)$ is the log change in the real housing price index. $\Delta Log(Income)$ is the log change in real per capita GDP. New mortgages are net new lending against mortgage in residential property divided by nominal GDP. GDP, population and inflation data are from the IMF's *International Financial Statistics*. The housing price and new mortgage data are described in the Appendix.

	Mean	Std. Dev.	Pct 5	Pct 25	Median	Pct 75	Pct 95	N. Obs
$\Delta Log(Price)$	0.020	0.116	-0.150	-0.034	0.015	0.072	0.210	718
$\Delta Log(Income)$	0.030	0.045	-0.033	0.007	0.027	0.051	0.102	754
$New\ Mortgages$	0.030	0.022	0.002	0.015	0.027	0.040	0.069	278

Table 2: Maximum Loan-to-Value (LTV), Homeownership, and Price-Income Ratios by Country-Decade, 1970-1999

Maximum LTV ratios represent the highest mortgage loan that households can get from lenders as a fraction of the value of the property owned. The homeownership ratio is the proportion of homeowners as a fraction of total households. The price-income ratio is the nominal price of a typical home divided by personal disposable income per capita. All data items are described in the Appendix.

Country	LTV Ratio			Homeown. Ratio			Price/Income Ratio		
	70's	80's	90's	70's	80's	90's	70's	80's	90's
Australia	0.70	0.80	0.80	0.70	0.70	0.70	10.5	8.5	9.5
Belgium	0.65	0.75	0.80	0.66	0.66	0.66	9.4	7.5	8.4
Canada	0.75	0.80	0.80	0.63	0.63	0.64	8.9	7.8	8.6
Chile	N/A	N/A	0.78	N/A	0.63	N/A	N/A	9.0	13.0
Denmark	0.85	0.95	0.80	N/A	0.55	0.52	N/A	8.8	7.6
Finland	0.80	0.85	0.80	0.61	0.65	0.62	16.4	15.3	10.1
France	0.80	0.80	0.80	0.57	0.53	0.54	8.9	8.4	9.8
Germany	0.65	0.65	0.80	0.43	0.43	0.41	22.3	18.0	15.7
Hong Kong	N/A	0.90	0.70	0.18	0.33	0.47	N/A	21.8	34.0
Ireland	0.80	0.90	0.80	N/A	0.77	0.79	9.6	9.0	9.1
Israel	0.50	0.70	N/A	0.70	N/A	0.80	N/A	19.0	25.1
Italy	0.50	0.56	0.60	0.63	0.67	0.73	17.2	14.4	10.7
Japan	N/A	0.60	0.55	0.60	0.62	0.60	22.2	22.1	20.4
Korea	0.30	0.40	0.40	0.59	0.52	0.52	41.6	42.4	32.3
Malaysia	0.65	N/A	0.85	N/A	N/A	0.67	N/A	21.9	24.2
Netherlands	0.75	0.75	0.75	0.48	0.46	0.51	12.2	9.5	11.0
New Zealand	0.66	0.80	0.80	N/A	0.71	0.73	7.4	7.0	8.8
Norway	0.75	0.80	0.80	0.74	0.78	0.76	13.8	13.6	9.6
Singapore	N/A	N/A	0.85	N/A	0.90	0.88	N/A	32.4	43.2
Spain	0.60	0.80	0.80	0.74	0.73	0.78	10.3	10.6	13.2
Sweden	0.90	0.95	0.75	0.50	0.54	0.60	15.1	11.2	9.6
Switzerland	N/A	N/A	0.90	0.30	0.31	N/A	N/A	36.5	27.1
Taiwan	0.40	N/A	N/A	0.77	0.78	0.84	7.2	7.6	4.5
Thailand	0.65	N/A	0.75	0.89	0.86	0.82	17.4	16.5	29.4
UK	0.81	0.87	0.95	0.56	0.61	0.67	10.4	10.6	8.6
US	0.80	0.89	0.80	0.66	0.64	0.65	7.4	7.3	6.9

Table 3: Housing Price Dynamics

The dependent variable is $\Delta Log(Price)$, the log change in the real housing price index. $\Delta Log(Income)$ is the log change in real per capita GDP. $Price_{t-1}/Income_{t-1}$ is the start-of-period ratio of the real housing price index to real per capita GDP. Real interest rate is the nominal long-term interest rate on a government bond (usually 10-year benchmark government bond yield), from the IMF's *International Financial Statistics* or from the OECD's *Economic Outlook*, minus the inflation rate in the same year. Inflation rate is the change in the consumer price index for the current year, taken from the IMF's *International Financial Statistics*. The estimation period is 1970-1999. The estimations correct the error structure both for heterosckedasticity using the White-Hubber estimator. t-stats (in parentheses).

Indep. Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\Delta Log(Income)_t$	1.187	0.942	0.942	1.125	1.061	1.009	1.022
	(9.07)***	(6.61)***	(6.36)***	(7.17)***	(6.94)***	(7.13)***	(7.49)***
$\Delta Log(Income)_{t-1}$		0.510	0.409	0.555	0.214	0.356	
		(3.38)***	(2.52)***	(3.47)***	(1.44)	(2.40)**	
$\Delta Log(Income)_{t-2}$		0.248	0.083	0.342	0.171	0.176	
		(2.23)**	(0.58)	(2.15)**	(1.13)	(1.17)	
$\Delta Log(Price)_{t-1}$			0.241	0.193	0.347	0.278	0.348
			(3.33)***	(2.61)***	(4.84)***	(3.76)***	(5.34)***
$\Delta Log(Price)_{t-2}$			−0.099	−0.111	−0.169	0.045	
			(−1.62)	(−1.80)*	(−2.46)***	(0.85)	
Interest Rate					−0.289		
					(−2.41)**		
Inflation Rate					−0.109		
					(−1.06)		
$Price_{t-1}/Income_{t-1}$						−0.253	−0.246
						(−7.67)***	(−7.50)***
$\sum_{j=0}^{2} \Delta Log(Income)_{t-j}$		1.700	1.434	2.022	1.446	1.541	
Summation Test p-value		0.00	0.00	0.00	0.00	0.00	
Exclusion Test p-value		0.00	0.00	0.00	0.00	0.00	
Country Effects?	No	No	No	Yes	No	Yes	Yes
Year Effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	718	679	666	666	616	666	692
Adj-R^2	0.226	0.265	0.310	0.317	0.381	0.408	0.378

***,**,* indicate statistical significance at 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 4: House Prices and the Multiplier Effect: Baseline Regressions

The dependent variable is $\Delta Log(Price)$, the log change in the real housing price index. $\Delta Log(Income)$ is the log change in real per capita GDP. $Price_{t-1}/Income_{t-1}$ is the start-of-period ratio of the real housing price index to real per capita GDP. Real interest rate is the nominal long-term interest rate on a government bond (usually 10-year benchmark government bond yield), from the IMF's *International Financial Statistics* or from the OECD's *Economic Outlook*, minus the inflation rate in the same year. Inflation rate is the change in the consumer price index for the current year, taken from the IMF's *International Financial Statistics*. LTV_t is the maximum LTV ratio for year t. The estimation period is 1970-1999. The estimations correct the error structure both for heterosckedasticity using the White-Hubber estimator. t-stats (in parentheses).

Indep. Variables	(1)	(2)	(3)	(4)	(5)
$\Delta Log(Income)_t$	−0.437	−0.787	−0.622	−0.273	0.051
	(−0.96)	(−1.31)	(−1.00)	(−0.42)	(0.10)
$\Delta Log(Income)_{t-1}$		1.174	1.029	0.132	
		(1.11)	(1.03)	(0.17)	
$\Delta Log(Income)_{t-2}$		−0.470	−0.199	0.504	
		(−0.62)	(−0.24)	(0.91)	
$\Delta Log(Price)_{t-1}$		0.228	0.174	0.299	0.332
		(3.01)***	(2.08)**	(4.21)***	(4.88)***
$\Delta Log(Price)_{t-2}$		−0.070	−0.081	−0.089	
		(−1.35)	(−1.47)	(−1.71)*	
Interest Rate				−0.287	
				(−1.39)	
Inflation Rate				−0.092	
				(−0.69)	
$Price_{t-1}/Income_{t-1}$					−0.231
					(−8.71)***
LTV_t	−0.065	−0.037	−0.214	0.007	−0.068
	(−1.52)	(−0.81)	(−2.40)**	(0.16)	(−0.82)
$\Delta Log(Income)_t \times LTV_t$	2.276				1.315
	(3.58)***				(1.80)*
$\sum_{j=0}^{2} \Delta Log(Income)_{t-j}$		2.152	2.414	1.420	
$\times LTV_t$		(2.45)***	(1.95)**	(1.75)*	
Country Effects?	No	No	Yes	No	Yes
Year Effects?	Yes	Yes	Yes	Yes	Yes
Observations	611	567	567	531	589
Adj-R^2	0.220	0.297	0.316	0.342	0.362

***,**,* indicate statistical significance at 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 5: House Prices and the Multiplier Effect: Alternative Specifications

The dependent variable in columns (1) through (6) and (9) is $\Delta Log(Price)$, the log change in real housing price index. The dependent variable in columns (7) and (8), New Mortgages, is the net new lending against mortgage in residential property divided by GDP. $\Delta Log(Income)$ is the log change in real per capita GDP. $Price_{t-1}/Income_{t-1}$ is the start-of-period ratio of the real housing price index to real per capita GDP. In columns (1) and (2) we instrument LTV_t with proxies for the quality of accounting standards and judicial efficiency. Judicial efficiency is an assessment of the efficiency and integrity of the legal environment as it affects business, compiled by the Business International Corporation, taken from LaPorta et al. (1998). Acounting standards is the index of accounting standards computed by the Center for International Financial Analysis and Research, data from LaPorta et al. (1998). In columns (3) and (4) we control for the level of economic development (PPP-ajusted per capita GDP) by including the intercept variable as well as its interactions with each of the lags of $\Delta Log(Income)$ (coefficients omitted). Likewise, in columns (5) and (6) we add intercept and interaction terms for homeownership and $\Delta Log(Income)$. The data for per capita GDP in constant prices is from *Penn World Tables*, taken from the Barro and Lee (1994) dataset, and augmented with data from the Global Development Finance & World Development Indicators. The homeownership ratio is the proportion of homeowners as a fraction of total households. In column (9) we use the GMM estimator for dynamic panel data proposed by Arellano and Bond (1991). The estimation period is 1970-1999. The OLS estimations correct the error structure both for heterosckedasticity using the White-Hubber estimator. t-stats (in parentheses).

Indep. Variables	IV Fin. Develop. (1)	(2)	Added Controls for Econ. Develop. (3)	(4)	Added Controls for Homeownership (5)	(6)	Dep. Variable: New Mortgages (7)	(8)	GMM (9)
$\Delta Log(Income)_t$	−2.940	−2.717	−0.671	−0.512	−0.971	−0.900	−0.632	−0.584	−0.471
	(−2.51)**	(−2.36)**	(−1.17)	(−0.85)	(−0.88)	(−0.79)	(−1.82)*	(−1.75)*	(−0.94)
$\Delta Log(Income)_{t-1}$	1.802	1.884	1.194	1.054	1.044	0.828	0.266	0.195	1.968
	(1.04)	(1.13)	(1.13)	(1.07)	(0.86)	(0.68)	(0.86)	(0.82)	(2.75)***
$\Delta Log(Income)_{t-2}$	−1.583	−1.357	−0.411	−0.187	−0.113	0.001	−0.219	−0.176	−1.766
	(−1.35)	(−1.09)	(−0.53)	(−0.23)	(−0.13)	(0.01)	(−0.64)	(−0.63)	(−3.73)***
$\Delta Log(Price)_{t-1}$	0.227	0.188	0.230	0.184	0.233	0.164			1.051
	(2.86)***	(2.14)**	(3.05)***	(2.21)**	(2.90)***	(1.77)*			(23.80)***
$\Delta Log(Price)_{t-2}$	−0.088	−0.099	−0.076	−0.091	−0.049	−0.068			−0.315
	(−1.64)	(−1.49)	(−1.45)	(−1.64)	(−0.83)	(−1.08)			(−7.45)***
LTV_t	−0.077	−0.079	−0.056	−0.175	−0.038	−0.217	0.052	0.059	−0.025
	(−0.97)	(−1.01)	(−1.17)	(−2.10)**	(−0.79)	(−2.40)**	(3.88)***	(2.62)***	(−2.23)**
$\sum_{j=0}^{2} \Delta Log(Income)_{t-j}$	6.078	5.924	2.085	2.275	2.048	3.214	0.947	0.765	0.754
$\times LTV_t$	(3.66)***	(2.83)***	(2.04)**	(1.56)	(2.15)**	(2.60)***	(1.85)*	(1.48)	(3.37)***
Country Effects?	No	Yes	No	Yes	No	Yes	No	Yes	Yes
Year Effects?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	540	540	567	567	510	510	265	265	567
Adj-R^2	0.313	0.322	0.307	0.323	0.289	0.316	0.231	0.512	52.05$^{(a)}$

Table Notes: $^{(a)}$ F-statistic. ***,**,* indicate statistical significance at 1%, 5%, and 10% (two-tail) test levels, respectively.

Table 6: The Income Constraint Effect

For each country, we use the average price-income ratio for the period 1970-1999 (subject to data availability) to classify countries in the "cheap" and "expensive" categories. The price-income ratio is the nominal price of a typical home divided by personal disposable income percapita. Cheap (expensive) housing countries are those ranked in the bottom (top) third of the cross-country distribution of the ratio of house prices to per capita GDP. The countries in the cheap housing category are: Australia, Belgium, Canada, Denmark, France, Netherlands, New Zealand, Tawain, and the US. The expensive housing countries are: Hong Kong, Israel, Japan, Korea, Malaysia, Singapore, Switzerland, and Thailand. The estimation period is 1970-1999. The baseline-OLS specification is the one in column (3) of Table 4, including three lags of income and housing price changes, as well as the interactions of the LTV ratio with the income changes. The baseline-GMM specification uses the GMM estimator for dynamic panel data proposed by Arellano and Bond (1991), as in column (7) of Table 4. The Lamont and Stein specification is the one in column (5) of Table 4, which includes the current change in per capita GDP and its interaction with the LTV ratio. The OLS estimations correct the error structure both for heterosckedasticity using the White-Hubber estimator. t-stats (in parentheses).

	Baseline–OLS $\sum_{j=0}^{2} \Delta Log(Income)_{t-j} \times LTV_t$	Baseline–GMM $\sum_{j=0}^{2} \Delta Log(Income)_{t-j} \times LTV_t$	Lamont-Stein $\Delta Log(Income)_t \times LTV_t$
Cheap Housing Countries	8.497	2.808	9.742
	(1.64)*	(2.59)***	(3.92)***
Expensive Housing Countries	2.508	0.227	1.001
	(1.38)	(0.45)	(0.93)

***,**,* indicate statistical significance at 1%, 5%, and 10% (two-tail) test levels, respectively.