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Is Leverage a Determinant of Asset Price? Evidence from real estate transaction data

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Abstract

By exploiting the correlation between the legal type of a property purchased as collateral and the loan to value (LTV), particularly the positive correlation between the use of the property as revolving collateral and LTV as a strong and valid instrumental variable, we identify the positive effect of LTV on the property price with the observed negative reverse causality. We also find that the effect of LTV on the property price is far greater when unleveraged property transactions purchased with 100% equity financing are excluded than when they are included.

Keywords: Bank lending; Asset price; Collateral; Loan to value

JEL classification: G01, G10, G12, G21, R32

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1. Introduction

The rise and the fall of mortgage markets are well-documented facts that are widely observed during financial crises. In the United States, average home price as measured by the composite Case–Shiller index for ten major Metropolitan Statistical Areas monotonically increased until it reached its peak in April 2006, more than twice the index level at the beginning of 2000. This dramatic rise was followed by equally spectacular falls in home prices. The index monotonically decreased and lost about one-third of its peak value as of June 2009. The cyclical rise and fall in home prices coincided with the similarly cyclical credit expansion and its contraction, ultimately leading to the devastating global financial crisis of 2008 and 2009. As Mian and Sufi (2011) report, mortgage lenders accelerated lending in response to sharp home price appreciation, hoping that increased lending would be secured by the increased value of homes taken as collateral. Dell'Ariccia et al. (2012) show evidence that the expansion of mortgage demand and home price appreciation lead to rapidly deteriorating lending standards. Demyanyk and Van Hemert (2011) also present evidence that lending standards deteriorated year by year from 2001 through 2007. When home prices stopped rising and began to fall in 2007, lending standards tightened and the supply of mortgages decreased.

Indeed, as Reinhard and Rogoff (2009) summarize, it is not an overstatement that this boom-bust cycle of credit supply and asset price is a staple of financial crises. Most crises that took place in various parts of the world at various points in time exhibit similar cyclical patterns in credit and asset prices. One such instance of a crisis whose magnitude is comparable to the abovementioned global financial crisis is found in Japan.

In Japan, booming real estate prices during the bubble period of the second half of the 1980s reached their peak in 1991, and continued a roller coaster slide for more than a decade. As was well documented by Hoshi and Kashyap (2004), rapidly expanding mortgages, particularly those collateralized by commercial real estate, coincided with monotonically rising real estate prices in the 1980s, whereas these patterns were exactly reversed as real estate prices stopped rising and began to plummet in 1991. As empirical studies such as those by Woo (2003) and Watanabe (2007) document, banks incurred large capital losses when regulators urged them to clean non-performing loans off their books; they then responded to eroding capital by curtailing lending so as to prop up their regulatory capital ratio.

The macroeconomic literature incorporating the so-called collateral constraint into the dynamic general equilibrium model as pioneered by Kiyotaki and Moore (1997) assumes that firms can borrow up to the value of their assets (resources) available as collateral that are pledgeable to their lenders. Such a model advocates the positive effects of asset prices on the quantity of collateralized loans, while dismissing any causality that may run in the reverse direction. In these types of macroeconomic general equilibrium models, the price of asset determined in the equilibrium itself depends on the future productivity of assets that the firm employs as capital input to produce its output or on the future return on an endowment. Among these models, Kiyotaki and Moore (1997) specifically derive an expression for the equilibrium land price as the present value of the sum of discounted future marginal productivities of land. Put differently, in these mainstream macroeconomic models, the price of the asset is determined at its fundamental value.

As we will discuss shortly, changes in the price of an asset such as real estate have profound macroeconomic implications, both as a constraint on a firm's borrowing ability and as a result of a change in credit supply. This presumably is because the mainstream theoretical literature sheds light on the role of an asset as a constraint on borrowing. Empirical studies using micro data such as the study by Mian and Sufi (2011) test the causal effect of the price of an asset on a loan collateralized by the asset, while largely overlooking the reverse causality; that is, the causal effect of a loan collateralized by an asset on its price.

Regarding the relationship between the price of asset and a loan collateralized by the asset, however, views of practitioners engaged in asset trading and views of macroeconomists are starkly different. The consensus shared by practitioners is that this disrespected reverse causality is widely observed in asset markets. Their agreed view, indeed, is that a rapid increase in asset price during a bubble period and a sharp fall in the price after the bubble's burst are instigated by lenders' aggressive expansion of credit supply to asset buyers, followed by its rapid contraction. This is because asset buyers during a credit boom period who are able to borrow more can afford more assets at higher prices; they increase asset purchases if they expect assets to generate positive returns. Asset buyers during a period of credit contraction who are not able to borrow as much as during the boom are forced to buy fewer assets at lower prices.

Most academic economists, however, have been skeptical about the effect of lending on asset prices. The theory that lies behind this skepticism is the efficient market hypothesis advocated by most financial economists. According to the hypothesis, stronger asset demand would not cause the equilibrium price of asset to rise above its fundamental value; neither would weaker demand cause it to fall below the fundamental value.

Traders who think the price of an asset is too high relative to its fundamental value or those who think it is too low have incentives to act as arbitragers. Under such circumstances, if arbitragers can short sell assets they think overpriced, they can quickly sell these overpriced assets until prices of assets revert (fall) to their fundamental values. Conversely, if they can make leveraged purchases of assets they think underpriced, again their prices immediately revert (rise) to their fundamental values. The efficient market hypothesis critically hinges on the assumption that asset traders are able to engage in unlimited arbitrage. As Shleifer and Vishny (1997) discuss, when this assumption is violated, the hypothesis does not hold true. It is well known that shorting certain assets, particularly real estate properties, is generally infeasible.

Geanakoplos (2010) departs from this “fundamental value” theory of asset pricing by assuming that beliefs about a future asset price held by asset traders are heterogeneous; that is, people are either optimistic or pessimistic about the future asset price. This causes optimistic traders to become leveraged asset buyers who borrow from pessimistic traders, enabling them to buy an asset at a price higher than its fundamental value. Because pessimistic traders are constrained to short selling, the arbitrage that would revert the price of the asset to its fundamental value does not take place, causing its price to remain higher.

In this study, using a unique dataset of downtown Tokyo property transactions, where the run-up of real estate prices was sharper and the subsequent falls in these prices more dramatic than anywhere else in Japan, we examine the effect of an asset buyer’s leverage on the price of the purchased asset that is pledged as collateral to her lender. We believe that our approach to compiling the data used in our empirical analyses is itself a substantial contribution to the literature. The data are constructed by combining the data about property transactions, which are extracted from a privately available database to which we have special access through a private property trading firm, with the data about mortgages borrowed to purchase these properties as well as identities of each transaction's buyer and seller, which are extracted from a publicly available government database. We then run the regression of the property price adjusted for the regional trends on the loan to value ratio (LTV), which we use interchangeably with leverage.

As Adrian and Shin (2011) show, the effect of asset price appreciation (depreciation) on leverage varies depending on the type of asset buyers. They show that different sectors of the economy respond differently to a change in the price of an asset used as collateral when borrowing a loan. Non-financial firms, commercial banks, and investment banks employ an aggressive investment strategy in response to asset price appreciation that relaxes collateral constraints by accelerating leveraged asset purchases, which either raises their leverage or keeps it static. However, households take a passive approach and do not increase leveraged asset purchases. This reduces their leverage. Therefore, when running the regression, we test the often-overlooked causal effect of asset price on leverage, while taking into account the reverse causality that has been the main focus of previous research.

To the best of our knowledge, this is the first study using transaction level data to identify directly the effect of an asset purchaser's leverage on the price of the asset by utilizing valid instrumental variables. We construct instrumental variables for LTV by exploiting the fact that the level of LTV is associated with a loan's type of collateral. In practice, we employ two dummy variables to explain LTV. The first dummy variable is to indicate that the purchased property is used as joint collateral along with other assets. The second dummy variable indicates that the purchased property is used as revolving collateral: that is, the asset is used not only to collateralize the current loan but also to secure loans borrowed in the future. We find that these dummy variables used to indicate type of collateral pledged to a creditor by an asset buyer are very strongly correlated with LTV, thereby ensuring their validity.

Our findings are threefold. First, we find that the estimated coefficient of LTV for the regression of the regional trend adjusted property price is positive and significant when LTV is instrumented by the abovementioned variables, but is insignificant when the regression is run using ordinary least squares (OLS). Second, the legal type of a purchased property as collateral, in particular whether it is used as revolving collateral, provides us with strong and valid instrumental variables that allow us to identify the effect of LTV on property price. Third, the effect of LTV on the adjusted property price is far greater when unleveraged property transactions purchased with 100 percent equity financing are excluded. On the basis of our regression results, the adjusted property price increases by 15 percentage points in response to an increase in LTV by 10 percentage points. Thus, the effect is not only statistically significant but also economically significant.

The remainder of this paper is organized as follows. Section 2 reviews relevant theoretical and empirical studies. Section 3 explains how we constructed the data and our empirical methodology. Section 4 reports and interprets empirical results. Section 5 concludes.

2. The Related Literature

Regarding the relationship between the price of an asset used as collateral and the loan borrowed by (credit available to) its purchaser, depending on the direction of causality, one is able to view the relationship between these two variables either as a causal relationship from asset price to credit or as a causal relationship in the reverse direction.

The literature employing the first view of the effect of credit (loans) on the price of assets is represented by the strand of macroeconomic literature pioneered by Kiyotaki and Moore (1997). The principal contribution of Kiyotaki and Moore (1997) to the macroeconomic literature is to shape the general equilibrium model of the aggregate economy wherein firms (producers) produce using land (assets) as a capital input while pledging land as collateral to secure their loans borrowed from external creditors. They further assume the so-called collateral constraints faced by firms that take loans to purchase land so that the amount borrowed by a firm cannot exceed the value of assets a firm holds. The theoretical approach employed by Kiyotaki and Moore can be referred to as the “fundamental value” view, because in their models the equilibrium price of an asset is determined at its fundamental value, prevent emergence of an asset price bubble. Kiyotaki and Moore show that the price of productive land indeed equals the present value of discounted future user costs or, equivalently, the present value of discounted future flows of productivity. This means that, for example, a negative (positive) exogenous shock to a firm’s future productivity depresses the price of land, which then tightens (relaxes) a firm’s collateral constraint so that the firm is able to borrow less (more) from external creditors. Macroeconomic general equilibrium models in which agents face collateral constraints are also discussed by Caballero and Krishnamurthy (2001), Jeanne and Korinek (2010), and Bianchi (2011).

The "fundamental value" view not only ignores the reverse causality that runs from credit availability to asset price but also inevitably rules out the possible development of an asset price bubble; that is, the rise of the price of an asset above its fundamental value. However, there is an evolving theoretical literature that models an asset buyer's leverage or her borrowing as a source of the asset bubble. Allen and Gale (2001) develop a model in which a loan borrowed by an asset buyer creates the asset bubble. In their model, the limited liability of a leveraged asset buyer, which allows her to default on a loan she borrows from external creditors when the realized return of the risky asset is low, makes the buyer bid up the risky asset above its fundamental value. On the other hand, in the model developed by Geanakoplos (2010), beliefs about the return on the risky asset are heterogeneous within the population; those who are optimistic about the return buy risky assets by borrowing from those who are pessimistic—who become sellers of these assets. He further discusses that the run-up of the risky assets occurs because optimistic investors with access to credit from pessimistic investors are able to bid up these assets, and that the crash of the asset price occurs because pessimists curtail credit to optimists. Because pessimists are constrained to short selling these assets, the arbitrage that would equalize the price of an asset with its fundamental value does not take place. Other studies that discuss investors' leverage by assuming investors' heterogeneous beliefs include those by Fostel and Geanakoplos (2008, 2012).

On the empirical front, several studies provide evidence that asset prices affect the quantity of (bank) credit. Peek and Rosengren (2000) find that financial distress of Japanese banks caused a reduction in real estate lending by their branches in the United

States. They argue that sharp falls in commercial real estate values are a cause of the banks' distress. In a related study, Peek and Rosengren (1997) find that the flow of loans extended by branches and subsidiaries of Japanese banks is negatively associated with a fall in aggregate (nationwide) land prices in Japan.

Using data of publicly traded Japanese firms, Gan (2007a) finds that aggregate (nationwide) land prices have a positive effect on credit availability to a firm as measured by the firm's long-term borrowing, empirically showing that Japanese firms face collateral constraints. Using the same dataset as the one used by Gan (2007a), Gan (2007b) finds that a bank's exposure to real estate loans at the peak of the real estate bubble had a positive effect on a firm's borrowing from the bank.

Using individual-level data from the United States, Mian and Sufi (2011) find that the average homeowner borrows 25 cents for every dollar increase in house price. When running the regression of the leverage growth with house price growth as an independent variable, they instrument the independent variable by the elasticity of housing supply at the zip code level.

There is also recently evolving literature that draws implications about the effects of mortgages on real estate prices. The pioneering empirical work along this line is the study by Mora (2008). Using prefecture level data from Japan, she uses an increase in the local (prefecture level) share of *keiretsu* loans among total loans outstanding as an instrumental variable for an endogenous independent variable, the local share of real estate loans among total loans, as this independent variable and the employed instrument are negatively correlated. She finds that an increase in the share of real estate loans by one percentage point results in an increase in local land prices by 15% to 20%.

Using county-level data of the United States during the farm price boom and the following bust before the Great Depression, Ramcharan and Rajan (2011) find that greater credit availability in a county is associated with higher farm land prices in the same county.

Mian and Sufi (2009) used U.S. zip code level data of home prices over the period from 1996 through 2007. They find that, within the same county, the average home price growth is faster in zip code areas where the fraction of subprime mortgage borrowers is initially greater than in zip code areas where the fraction of subprime borrowers is smaller.

Using county-level data of the United States, Favara and Imbs (2010) employ the index of inter-state branching deregulation as an instrumental variable for a key independent variable, a measure of mortgages borrowed by home buyers in the regression, for home price on the ground that banks are more active in supplying mortgages in a county where branching regulation is not tight. They find that an increase in the supply of mortgages leads to increases in home prices.

Using United States property transaction data for the period from 1998 through 2008, Adelino et al. (2012) find that the price of the property is cheaper when the price is substantially greater than the conforming loan limit (CLL); a buyer is more borrowing constrained, that is, experiences a loan limit up to which government-sponsored enterprises including Fannie Mae and Freddy Mac can purchase and securitize, than when the price is closer to CLL, when the buyer is less borrowing constrained.

Using Metropolitan Statistical Area (MSA) level data over the period from 1998 through 2008, Glaeser et al. (2012) run OLS regressions to find that an increase in the local aggregate LTV by 10% raises the local home price by 3.6%.

It is noteworthy that the empirical papers exploring the effects of mortgages on real estate prices mentioned above either do not use micro data of property transactions or do not successfully identify the effects of an exogenous change in mortgages (LTV), both of which we successfully do in our empirical exercise.

3. Data and Empirical Methodology

3.1. Empirical Model

In practice, we run the following cross sectional regression:

$$RP_i = \alpha_0 + \alpha_1 LTV_i + \alpha_2 BIND_i + \varepsilon_i$$

where RP_i is defined as the transaction price per square meter of property *i*, P_i divided by the average price of residential land in ward *j* in year *t*, P_{jt}. LTV_i is a loan to value ratio of property *i*, and $BIND_i$ is a dummy variable to indicate that a property's buyer is an individual rather than a company.

Regarding the regression equation, several issues are worth mentioning. First, we construct the dependent variable by dividing the price of a property (per square meter) by the average land price (per square meter) in the year and in the ward of Tokyo in which the property transaction took place. This allows us to control for the local trend of the property price when running the regression. Second, our key independent variable, *LTV,* is defined as the amount of the mortgage borrowed to purchase a property divided by the price of the property at the time of its purchase (the transaction price). A dummy variable, *BIND*, is meant to control for possible inherent differences between an asset buyer's behavior when she is an individual and when it is a company.

3.2. Instrumental Variables

In order to identify the effect of LTV on the property price from the opposite causal effect, we construct valid instrumental variables for LTV by exploiting the relationship between the legal type of mortgage and LTV (the credit that finances the property purchase). More precisely, we employ the dummy variable to indicate that the purchased property is used as joint collateral along with other assets (JMORT), and to indicate that the purchased property is used as revolving collateral (RMORT); that is, the asset is used not only to collateralize the current loan but also to secure loans borrowed in the future.

As we will see later, these dummy variables, JMORT and RMORT, are very strongly correlated with LTV. The two dummy variables indicate that real estate buyers offer to their bank preferable legal types of collateral for the mortgagees. Therefore, the higher LTV is plausible for property whose legal type takes the form of joint collateral or revolving collateral. On the other hand, whether a buyer offers joint collateral, revolving collateral, or only ordinal collateral will have no effect on the transaction price other than affecting the amount of money the buyer can borrow from the bank. Therefore, JMORT and RMORT meet sufficient conditions as valid instrumental variables because they will increase the LTV while having no direct effect on real estate prices.

3.3 The meaning of the price effect of LTV in cross-sectional analysis

Our empirical model assumes that a buyer with a high LTV will purchase real estate at a higher price. Although real estate has individual characteristics and each transaction is segmented from the others, cross-sectional arbitrage will narrow the price difference to a large extent. Therefore, if our empirical model detects a positive effect of LTV on the transaction price despite the presence of the mechanism of the cross-sectional arbitrage, we believe that the effect of LTV on the property price would be much greater if the average LTV for all buyers hiked.

3.4. Data

In our empirical analyses, we use Tokyo wards area land transactions data. The data are constructed from two sources: transaction data and registry data. The transaction data are processed by Star Mica Co., and were originally collected from the database of Real Estate Information Network for East Japan. This database covers all real estate transactions advertised to the public, meaning that the buyers are assumed to be individuals and small businesses. The transaction data contains date of transaction, price, land size, address, parcel number of the land, and other characteristics. The parcel number is the identifier of the real estate. No information about buyers' attributes or about the mortgages themselves is included in this realtors' database.

The registry data come from the real estate registry book, which is processed by government registry deeds and can be publicly accessed via the Internet.[1] The registry book of each piece of land consists of three parts. The first part associates a parcel number with size of the land, use of the land, and location of the land. The second part of the registry book records the history of ownership changes of each piece of real estate, including dates of ownership changes and names of past and present owners, but does not contain the price of the transaction. The third part of the registry book records the

[1] The registration data are obtainable at http://www1.touki.or.jp, the service and the data are in Japanese only.

history of mortgages associated with the real estate, including the order of each mortgage, type of collateral, amount of loan, and names of mortgagers and mortgagees.

We match observations from the transaction database with those from the registry database by using three identifiers: parcel number, land size, and date of transaction. The registry book records each piece of real estate by its parcel number, not by its mailing address. Because the parcel number is used only by the office of registry deeds, while realtors usually use mailing address to locate a real estate parcel, the matching process of the transaction database and the registry database requires great care. Although the matching is not very efficient, we believe that our matching process does not generate a selection bias, because whether we can find the parcel number for the land does not depend on the amount of the loan that the buyer of the land borrows from banks.

We drop observations where either the property price (per square meter) or LTV is not less than the 99 percentile of the respective variable, thereby ensuring that the results are not distorted by outliers. This reduced sample size from 1620 to 1586. Table 1 presents descriptive statistics of the sample of properties we used in regression analyses. The property price per square meter is on average around 500,000 yen. The average LTV is 0.58.[2] Thirty-seven percent of the properties in our sample are used as joint collateral along with other assets. Likewise, 24 percent of sample properties are used as revolving collateral.

[2] We need to bear in mind that the average LTV reported on Table 1 is calculated on the basis of a sample that includes a large number of properties that are purchased without a mortgage (LTV = 0). Properties purchased without a mortgage constitute 36 percent of our sample. Thus, the average LTV conditional on a borrowed mortgage is 0.91.

4. Results

Table 2 reports OLS and two-stage least squares (2SLS) regression results of equation (1). The coefficients of LTV estimated using OLS (columns 1 and 2) are negative and statistically insignificant. However, the same coefficients estimated using 2SLS (columns 3 and 4), are positive and statistically significant at the one percent significance level. This implies that when the coefficient of LTV is estimated using OLS, the negative effect of the property price on LTV as reported by Adrian and Shin (2011) and the positive effect of LTV on the property price offset each other. The estimated 2SLS coefficient is greater when BIND is included as an independent variable (column 4) than when it is not (column 3), but the results are qualitatively similar regardless of inclusion of this variable. The point estimate of 0.199 when BIND is included also is economically significant. This means that a ten percentage point increase in LTV raises the property price by two percentage points.

The first stage results of the 2SLS regressions indicate that employed instrumental variables are very strongly correlated with LTV. The extremely large F statistics of excluded instrumental variables, along with the J statistic reported at the bottom, ensures the validity of our instrumental variable results, at least statistically.[3] [4]

One characteristics of our sample is the presence of a large number of properties purchased without a mortgage, while other properties are purchased with a high LTV.[5] This bipolarization may occur partly because the buyers who are not credit constrained

[3] The coefficients of both two instrumental variables are positive and statistically significant (not reported).

[4] One may, nonetheless, question the validity of the two instrumental variables on the ground that the tendency of the buyers to accept joint collateral or revolving collateral may depend on a buyer's attributes. Including the dummy variable that a buyer is an individual aimed at controlling for a buyer's attributes. We also divided the sample into subsamples of individuals and firms, and run the 2SLS regressions for two groups separately and found the results unchanged. Results are not reported.

[5] Please see footnote 1 for a detail.

will choose to purchase the property with 100 percent equity financing, and partly because even ordinary collateral provides a strong legal right for the mortgagees, encouraging banks to be willing to allow for higher LTV for buyers who need to borrow more.

Thus, we run the regression using the sample of only properties purchased with a mortgage. The results are reported in Table 3. The results are even sharper than the full sample results. First, the OLS coefficients of LTV are negative and statistically significant, suggesting that the relationship between LTV and property price is negative for leveraged property buyers. Second, while the full sample results of Table 2 reports that the 2SLS coefficient of LTV is 0.199, the LTV coefficient becomes 1.53, seven times larger, when the sample is limited to the leveraged buyers. This coefficient with leveraged buyers implies that a 10 percentage point increase in LTV raises the property price by 15.3 percentage points.[6]

The difference between the two coefficients from the full sample and from the leveraged sample deepens our understanding of asset price determination and finance. Our finding implies that if the asset markets are populated by leveraged participants, an increase in bank lending boosts asset prices, which then relaxes the banks' collateral constraints, and further increases their lending, etc. The extent of this instability in mortgage markets is greatly reduced to about one seventh because the real estate market includes a considerable portion of unleveraged participants.

[6] Another change from the results reported in Table 2 to those reported in Table 3 is that, in the first stage, the coefficient of the dummy variable to indicate that the property is used as joint collateral along with other assets is now statistically insignificant (not reported).

5. Conclusion

Many countries experience boom–bust cycles of credit supply and asset prices that cause financial crises. Recently developed economic theories try to explain this cycle, and suggest that credit supply will cause asset prices to rise above fundamental values. Using micro data of real estate property transactions, this study is the first attempt to identify the direct effect of the asset purchaser's leverage on the price of the asset by utilizing legal types of collateral as valid instrumental variables. We also find that the effect of LTV on the property price is far greater when unleveraged property transactions are excluded than when they are included.

The implications for policy planners are as follows. First, the central bank and financial regulators should pay much greater attention to prices and LTV in the asset markets. Second, our results suggest that the regulatory requirement to keep LTV sufficiently low, a conventional policy during the real estate boom, is effective in containing the asset price boom (asset price bubble). Third, as the presence of unleveraged buyers stabilizes the fluctuation of asset prices, policies to encourage asset acquisition with low or no leverage would also be effective in order to prevent asset prices to increase or decrease sharply. Fourth, the ongoing legal properties of collateral should be well investigated, because that collateral may increase the average LTV for real estate purchasers and cause instability in asset prices and ultimately the financial system.

An important future research agenda is to study how banking regulations and banks' financial health influence the discovered relationship between credit supply and asset price.

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Table 1. Descriptive Statistics of Variables Used in Regressions

Variable	Definition	N	Mean	Median	Std. error	Min.	Max.
P	Property price per square meter (ten thousand yen)	1586	50.19	45.34	27.32	3.75	201.01
RP	P divided by the average price of residential land in the ward the property is located and in the year the transaction took place.	1586	1.10	1.03	0.51	0.14	4.71
LTV	Loan to value Ratio	1586	0.58	0.62	0.53	0.00	2.45
MORT	The amount of mortgage borrowed (ten thousand yen)	1586	28.10	22.29	32.79	0.00	314.22
BIND	The dummy variable that takes a value of one if the property is purchased by an individual and zero otherwise.	1586	0.62				
JMORT	The dummy variable that takes a value of one if the property is used as joint collateral with other assets.	1586	0.37				
RMORT	The dummy variable that takes a value of one if the property is used as revolving collateral.	1586	0.24				

Table 2. Results of the Regressions for the Adjusted Property Price Trend: the Full Sample

Variable	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS
LTV	–0.037	−0.016	0.127 ***	0.199 ***
	(0.025)	(−0.610)	(0.042)	(0.045)
BIND		0.137 ***		0.176 ***
		(0.028)		(0.029)
Constant	1.118 ***	1.021 ***	1.023 ***	0.871 ***
	(0.019)	(0.029)	(0.025)	(0.038)
N	1586	1586	1586	1586
R-squared	0.0015	0.0183		
J statistics			0.379	2.381
			(0.538)	(0.123)
F statistics for excluded instruments			481.017	444.771
t statistic for endogeniety of LTV			−5.3	−6.65

A dependent variable, RP, is the property price per square meter, P divided by the average price of residential land in the ward the property is located and in the year the transaction took place. Variable definitions are described in Table 1. ***, **, and * show that the coefficient is statistically significant at the 1 percent level, the 5 percent level and the 10 percent level, respectively. The Huber–White heteroskedasticity robust standard error is in parenthesis below the corresponding estimated coefficient. Excluded instrumental variables employed for the 2SLS regressions whose results are reported in columns 3 and 4 are JMORT and RMORT, respectively. The number below the J statistic is the corresponding p value. The t statistic for endogeneity of COLLATERAL is computed in the following two steps. First, LTV is regressed on all the exogenous variables including instrumental variables using OLS. The predicted residual from the LTV regression is added as an independent variable to a set of independent variables in the OLS regression for RP. The t statistic is that of the coefficient of the predicted residual

Table 3. Results of the Regressions for the Adjusted Property Price Trend: the Sample of Properties That Are Purchased with a Mortgage

Variable	(1) OLS	(2) OLS	(3) 2SLS	(4) 2SLS
LTV	−0.164 ***	−0.123 **	0.331 *	1.530 ***
	(0.051)	(0.055)	(0.177)	(0.439)
BIND		0.119 ***		0.454 ***
		(0.036)		(0.100)
Constant	1.254 ***	1.146 **	0.801 ***	−0.565 ***
	(0.049)	(0.065)	(0.158)	(0.449)
N	1011	1011	1011	1011
R-squared	0.0143	0.0261		
J statistics			7.904	1.953
			(0.005)	(0.162)
F statistics for excluded instruments			40.702	13.351
t statistic for endogeniety of LTV			−3.14	−5.78

A dependent variable, RP, is the property price per square meter, P divided by the average price of residential land in the ward the property is located and in the year the transaction took place. Variable definitions are described in Table 1. ***, ** and * show that the coefficient is statistically significant at the 1 percent level, the 5 percent level and the 10 percent level, respectively. The Huber–White heteroskedasticity robust standard error is in parenthesis below the corresponding estimated coefficient. Excluded instrumental variables employed for the 2SLS regressions whose results are reported in columns 3 and 4 are JMORT and RMORT, respectively. The number below the J statistic is the corresponding p value. The t statistic for endogeneity of COLLATERAL is computed in the following two steps. First, LTV is regressed on all the exogenous variables including instrumental variables using OLS. The predicted residual from the LTV regression is added as an independent variable to a set of independent variables in the OLS regression for RP. The t statistic is that of the coefficient of the predicted residual