Loan-to-value limits and house prices[*]

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Abstract

This study evaluates the effect of loan-to-value (LTV) limits on house prices. The identification strategy exploits variation in LTV limits induced by Hong Kong Monetary Authorities' decision to introduce differentiated LTV limits anchored on the value of the property, which allows us to observe the counterfactual house price development. We estimate that a one-percentage-point decrease in LTV limits reduces the house price growth by 0.8 percentage points. Overall, our results document that macro-prudential policies, which regulate access to financing, are an effective policy tool to control house price growth.

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"I have nothing to disclose"

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The global financial crisis in the late 2000s demonstrated that monetary policy and traditional regulation of banks and financial institutions are insufficient to prevent a build-up of systemic risk. Among policy-makers and academics exists a growing consensus that macro-prudential policies should supplement existing policy frameworks to address systemic risk. A key focus area for new macro-prudential policies is the housing market, because real estate and mortgages are the largest assets and liabilities on households' balance sheets. As a result, more than 40 countries—for example, Brazil, Canada, China, India, the Netherlands, Spain, and Sweden—have recently adopted or changed loan-to-value (LTV) limits on mortgages to control the house price growth and reduce systemic risk in the financial sector.[1] Despite the recent popularity of such policies, evidence about how LTV limits affect house prices is scant.

LTV limits directly affect households' ability to finance purchases of real estate, as tighter (looser) LTV limits require more (less) equity. Whether such policies are effective depends on how sensitive house prices are to access to financing. Assessing this question is difficult, because macro-prudential policies are hardly random and tend to affect all houses in a given market, which implies that the counterfactual development in house prices is unobserved. In addition, policy interventions might shift demand for housing, raising the need to control for the quality of houses that are sold. Consequently, the ideal experiment is one in which we can estimate the effect of LTV limits while controlling for individual heterogeneity in house prices as well as for macroeconomic development.

This study estimates the effect of LTV limits on house prices using variations in LTV limits that arise from the decision of the Hong Kong Monetary Authority (HKMA) to anchor LTV limits on house values. A total of six policy changes between 2001 and 2015 changed the LTV limits for houses with a value in a

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[1] Appendix A shows that the number of policy changes to LTV limits have been increasing from 2000 to 2015, while appendix B provides a list of markets in which monetary authorities have regulated the LTV limit to control house price growth.

specific range, while keeping these limits unchanged for houses with a value outside the range. This setting closely resembles the ideal experiment, because at a given time, we can observe the effect of LTV limits on houses that were affected by the policy change as well as the counterfactual development in house prices for houses that were unaffected by the policy change. Using comprehensive transaction data, we estimate the effect of LTV limits on house price growth while controlling for time-invariant heterogeneity by including unit fixed effects as well as controlling for macroeconomic development by including year-month fixed effects. This specification ensures that the effectiveness of LTV limits as a macro-prudential tool is evaluated while controlling for the counterfactual development in house prices as well as for unobserved heterogeneity in house prices.

Our results demonstrate that macro-prudential policies are effective in controlling house price growth. We estimate that a one-percentage-point decrease in LTV limits reduces house price growth by 0.8 percent. Considering that monetary authorities tend to change LTV limits by 5 to 10 percentage points, a typical policy intervention reduces house price growth by 4 to 8 percentage points. We further show that the effectiveness of LTV limits is weaker for luxury housing, where financial constraints are less likely to be binding, and that LTV limits are more effective when households face high-opportunity cost of capital, which makes equity financing more expensive. Overall, our results demonstrate that LTV limits have a large effect on house prices, which corroborates with the recent popularity of this policy among monetary authorities and regulators.

Our study contributes to the growing literature that evaluates the effectiveness of macro-prudential policies in controlling house price growth. The focus on LTV limits rather than debt-to-income (DTI) limits or other macro-prudential tools is motivated by the fact that LTV limits are by far the most widely used macro-prudential tool (Claessens, 2015). Prior studies find that a one percent decrease in LTV limits leads

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to a 1 to 1.5 percent lower house price growth using cross-country data on LTV limits and house price indices (Crowe, Dell'Ariccia, Igan, and Rabanal, 2013; Kuttner and Shim, 2016; Akinci and Olmstead-Rumsey, 2018). Other studies have used panel data from a single country to examine the relationship between LTV limits and house prices. For instance, Duca, Muellbauer, and Murphy (2011) examine the relationship between mortgage borrowers' LTV ratios and future house prices in the United States and conjecture that credit standards are an important determinant of house prices. While these studies provide suggestive evidence of the effectiveness of macro-prudential policies, they cannot assess the causal impact because the counterfactual development of house prices is unobserved. The problem arises because changes to LTV limits in most markets apply to all properties (Appendix B shows that this condition applies in 32 out of 41 markets that have changed the LTV limit between 2000 and 2015), making separating the effect of LTV limits from macroeconomic conditions difficult. Appendix B also reveals that monetary authorities have introduced differentiated LTV limits in nine markets based on property location, size, and value. With differentiated LTV limits, the ability to estimate the causal effect of LTV limits on house price growth while controlling for macroeconomic conditions is econometrically possible.

The closest study to ours is Igan and Kang (2011), who study the effect of regional variation in LTV limits on regional house prices indices in Korea. Igan and Kang (2011) find that tightening of LTV limits reduces house prices by around 1 to 2 percent, but also recognize the difficulty in identifying a causal effect in their setup because differentiated LTV limits arise with classifying specific areas in Seoul as speculative zones. The regulatory approach in Hong Kong offers a cleaner experiment because LTV limits are anchored on house values; leading to differentiated LTV limits that allows us to control for unobserved heterogeneity in the quality of houses through inclusion of unit fixed effects and to control for time-varying location fixed effects through inclusion of high-dimensional location-time fixed effects. To this end, our study exploits the

institutional setting in Hong Kong's residential real estate market to provide a causal estimate of the effectiveness of LTV limits in controlling house price growth.

This study also contributes to a growing theoretical literature that stresses that house prices are a function of credit constraints as well as household income and housing characteristics (Muellbauer and Murphy, 1997; Meen, 2001; Cameron, Muellbauer, and Murphy, 2006). The interaction between credit constraints and household income implies that positive income shocks have a larger effect on house prices when LTV limits are higher (Lamont and Stein, 1999; Almeida, Campello, and Liu, 2006; Benito 2006; Andrews, 2010), and that macro-prudential policies can affect the monetary transmission mechanism (Iacoviello, 2005; Calza, Monacelli, and Stracca, 2013). Credit constraints or LTV limits also affect the house price-to-rent ratio (Kim, 2007), the accumulation of household debt, bank losses during a housing bust, and the general macro-economy and financial markets (Claessens, Ghosh, and Mihet, 2013; Krznar and Morsink, 2014; Lim et al., 2011; Zhang and Zoli, 2016; Cerutti, Claessens, and Laeven, 2017; and Favilukis, Ludvigson, and Van Nieuwerburgh, 2017). In comparison to these studies, we provide casual evidence that LTV limits are a more effective policy tool when credit constraints are binding.

An important question is the external validity of the results. This study's focus on the housing market in Hong Kong is motivated by the identification challenge described above. The housing market in Hong Kong is described by real estate economists as being one of the most volatile markets in the world, with a standard deviation of 14.8 on the real annual house price growth during the 2000s, compared to 11.3 for the 20 largest cities in the United States. The performance of Hong Kong's housing market is also widely believed to be influenced by market sentiment, given Hong Kong's status as an international financial center with free capital mobility. While the current study controls for overall market conditions, including the

macroeconomic development and market sentiment, its main caveat relates to the estimated effect of LTV limits on house price growth, which might be influenced by factors that are specific to Hong Kong.

The rest of the study is organized as follows. Section I details the policy changes affecting the LTV limits of houses in Hong Kong. Section II presents the data and provides descriptive statistics; Section III outlines the identification strategy. The empirical design and the results are presented in Section IV, while Section V considers alternative specifications. Finally, Section VI summarizes the conclusions.

I. Policy changes affecting LTV limits

Following the global financial crisis monetary, authorities around the world have introduced new macro-prudential policies to reduce systemic risk. Monetary authorities in more than 40 countries have introduced or changed the LTV limits in an attempt to control house price growth and mortgage lending (see list in Appendix A). Most policy interventions, however, impose a uniform LTV limit across all houses, making separating the effect of LTV limits from the macroeconomic development (see list in Appendix B) difficult. In a few markets, policy interventions have introduced differentiated LTV limits based on location, value, or size. From an econometric perspective, policy interventions that differentiate LTV limits are ideal, as they allow the researcher to observe a counterfactual development in prices for unaffected houses.

Among the monetary authorities that have intervened in the housing market by changing the LTV limits, nine have introduced differentiated LTV limits between 2000 and 2015 (see Appendix C). China, Korea, and Taiwan have introduced differentiated LTV limits based on location. China, Hong Kong SAR, India, Malaysia, Philippines, and Thailand have introduced differentiated LTV limits anchored on house value, while China and Indonesia have introduced differentiated LTV limits based on house size. Appendices

A, B, and C provide an overview of these policies, including the number and timing of interventions. Appendix C shows that a study of the effect of LTV limits in Hong Kong is particularly suitable for overcoming the identification problem. The HKMA has made six policy interventions between 2000 and 2015 that change the LTV limit for houses with a value within a given range, while holding the LTV limit constant for houses with a value outside the range.

Table 1 provides a chronological list of policy changes of the LTV limit by HKMA. Policy changes are announced in press releases and are effective immediately.[2] The changes are as follows. The LTV limit on properties priced above HKD 12 million was reduced from 70 to 60 percent on January 28, 1997, before being restored to 70 percent on October 10, 2001. In 2009, the 60 percent LTV limit was re-introduced for properties above HKD 20 million, followed by the decision to move the 60 percent LTV threshold to HKD 12 million on August 13, 2010. Later the same year, the HKMA decided to reduce the LTV limit to 50 percent for properties above 12 million, and to 60 percent for properties between 8 and 12 million. On June 10, 2011, these thresholds were again adjusted, resulting in a LTV limit of 50 percent for properties above 10 million, and a LTV limit of 60 percent for properties between HKD 7 and 10 million. The last policy event occurred on February 27, 2015 when the LTV limit was reduced to 60 percent for properties below 7 million.

Figure 1 illustrates the LTV limit over time depending on the value of the property. The sample period is restricted by the availability of data, as explained in the following section.

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[2] An important institutional detail is that policy changes are effective on the announcement day, which ensures that the policy changes have no announcement effect.

II. Data

The residential real estate market in Hong Kong consists of both private and public sectors. This study focuses on the private sector, which represents around 50 percent of the market share. We exclude the public sector, because large government subsidies and sales restrictions distort property values.

Our data cover all private residential real estate transactions in Hong Kong between 2000 and 2015. The data are maintained by EPRC Ltd., a commercial real estate agency in Hong Kong, and include the property address and characteristics, transaction date, and price. Table 2 provides descriptive statistics on the 1,058,938 property transactions, equivalent to around 66,000 transactions per year.

The average unit in Hong Kong costs 4.23 million HKD (543,700 USD), and has an interior size of 606.4 square feet (56.3 square meter), making Hong Kong one of the most expensive cities in the world: units yield an average price of 6,208 HKD (798 USD) per square foot, equivalent to 75,100 HKD (9,700 USD) per square meter. Around half of all transactions occur in the New Territories, followed by 27.7 percent in Kowloon and 22.4 percent on Hong Kong Island. Panel C shows that seasonality is limited; transactions are almost uniformly distributed across quarters of the year. Finally, Panel D shows the LTV limit. We conclude that most of the transactions have a 70 percent LTV limit because, for half of the sample period (from October 2001 to October 2009), the LTV limit was 70 percent irrespective of the house value. More than 32,000 transactions have a LTV limit of 50 percent, and more than 58,000 transactions have a LTV limit of 60 percent.

Table 3 details how the six policy changes affect the LTV limit and number of transactions by comparing the number of transactions with LTV limits of 50, 60, and 70 percent one year before and one year after each policy change. A simple way of measuring the impact of the policy changes is by comparing

the fraction of transactions in the affected LTV limits. For instance, policy change 1 increases the LTV limit from 60 to 70 percent for properties with a value above 12 million. One year before the change, 1.8 percent of the transactions had a LTV limit of 60 percent, compared to 0 percent one year after the policy change. Thus, policy change 1 affects 1.8 percent of all transactions. In a similar fashion, policy change 2 decreases the LTV limit from 70 to 60 percent for properties with a value above 20 million. Table 3 shows that the fraction of transactions with a LTV limit increases from 0 to 2.6 percent, implying that 2.6 percent of the transactions are affected. While policy changes 1 and 2 affect a relatively modest number of transactions, policy changes 3 to 6 affect an increasingly larger proportion of all property transactions. Affected properties increase to 4.6 percent for policy change 3.[3] Policy change 4 affects 9.2 percent of all transactions, while policy changes 5 and 6 affect 9.9 and 70.2 percent of all transactions. Finally, and notably, the number of transactions generally move in the same direction as the policy changes. For policy change 1, the total number of transactions increases, whereas the total number of transactions decreases for policy changes 3, 4, 5, and 6. The main exception is policy change 2, for which the number of transactions increase despite the decision to lower the LTV limit for transactions with a value above 12 million.

Although the transaction data clearly indicates that the policy changes affect the LTV limit of a significant number of transactions, the policy is only effective if the LTV limit is binding for some households. To illustrate the impact of the policy changes, we examine the LTV ratio on new mortgages during the sample period. HKMA compiles a monthly survey of new mortgages issued by mortgage banks.

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[3] Based on the observed number of transactions, policy change 1 increases the LTV limit for 1.8 percent of transactions, while policy change 2 increases the LTV limit for 2.6 percent of the transactions. Policy change 3 increases the fraction of transactions with a LTV limit from 2.6 percent to 7.2 percent, resulting in 4.6 percent of the transactions being affected.

These data include basic information about the loan terms (interest rate, maturity, etc.) as well as the LTV ratio.

Figure 2 shows the mapping between the average LTV limit based on transactions during the month and the average LTV ratio in HKMA's survey of new mortgages. The impact of the policy changes that restrict access to financing by reducing the LTV limit is clearly visible. The average LTV ratio declines from around 65 percent in 2009 to 50 percent by the end of 2015. The LTV ratio decreases from 65 to 55 percent following policy changes 2 to 5, while the decrease from 55 to 50 percent occurs after policy change 6. Collectively, the decline in the average LTV ratio suggests that the policy changes reduce access to financing.

Figure 3 shows the development of the average price per square foot at a quarterly frequency and the timeline of the six policy changes to the LTV limit between 2000 and 2015. Figure 3 highlights the two identification challenges, when evaluating the effect of LTV limits on house prices using a house price index. First, the counterfactual development in house prices is unobserved, making it difficult to gauge the effect of policy changes on house prices. Second, policy changes that tighten the access to financing (policy changes 2 to 6) tend to occur after sharp house price growth, implying that the difference in house price growth around a policy change might be confounded by the policy intervention. Finally, the underlying quality of houses is unobserved, resulting in a potentially biased estimate of LTV limits on prices.[4]

To overcome these challenges, we study the effect of LTV limits on prices using micro data on property transactions. The micro data allow us to observe the counterfactual development in house prices and control for the quality of houses being sold. To illustrate the advantage of micro data, Figure 4 compares

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[4] Note that while differences in unobserved heterogeneity in house prices (e.g., quality) can be controlled for using a repeated sales index (e.g., Case-Shiller for the United States), the counterfactual development in house prices remains unobserved unless differenced LTV limits exist.

changes in the average price per square feet around the LTV policy changes. For each policy change, we

calculate the change in the price per square foot for a sample of houses that are close to the threshold on

house value. For instance, for policy change 1, we calculate the change in price per square foot for houses

with a value between 12 and 14 million HKD and compare this change to the change in the price per square

foot for houses with a value between 10 and 12 million. The difference in house price growth captures the

effect on prices of increasing the LTV limit by 10 percent for houses valued above 12 million. We note that

while house prices decline, the decline is smaller for houses with a value above 12 million. The difference in

the change in the average price per square foot suggests that increasing the LTV limit by 10 percentage points

increases the house price growth by 3 percentage points. Similarly, for policy events 2 to 5, where the LTV

limit declined, we find that house prices increase by less than do houses for which the LTV remained

unchanged. For all 5 policy changes that restrict the access to financing, we find a negative effect on prices.

Collectively, Figure 4 suggests that increasing (decreasing) the LTV limit increases (reduces) house

price growth by around 4 percent (2 to 6 percent). Unfortunately, this simple method leads to biased results

as it fails to control for the effect of policy changes on the quality of houses. If limiting access to financing,

as a consequence of budget constraints, reduces the quality of houses sold, it follows that the results in Figure

4 underestimate the effect of LTV limits on prices. In the following section, we therefore perform a much

more careful analysis that evaluates the effect of LTV limits on house prices.

III. Identification strategy

We estimate the relationship between the price of houses and their characteristics using a hedonic

regression, which is a standard approach in real estate economics. The main equation for estimating the

effect of loan to value limits on house prices is specified in Equation (1), where the dependent variable is the log. price, y_{it}, of house i in year t:

$$y_{it} = \alpha_i + \alpha_t + \beta' X_i + \gamma' LTV\ limit_{it} + \epsilon_{ijt}, \tag{1}$$

where α_i captures unit fixed effects, α_t captures year-month fixed effects, X_i is a vector of time-varying property characteristics, and $LTV\ limit_{it}$ is measured in percentage points. Property characteristics include: interior size, building age, an indicator for primary transactions, and whether the property is sold with a carpark. Note that interior size can be time-varying, due to subdivisions (or extension of houses), and that carparks can be sold separately.

The main benefit of this specification is that the inclusion of unit fixed effects allows us to control for unobserved heterogeneity in house prices while exploiting the variation in LTV limits to estimate the effect on house prices. The identification strategy effectively compares the development of house prices depending on changes to the LTV limit, while controlling for the overall development of house prices and individual heterogeneity. The main disadvantage of this identification strategy is that the effect of LTV limits on house prices is estimated using properties with repeated sales and variation in LTV limits. The institutional setting of Hong Kong's residential real estate market alleviates this limitation because the market is liquid. As a result, repeated sales occur frequently during our sample period. Figure 5 shows the distribution of sales for units with at least one transaction during the sample period from 2000 to 2015. Around 45 percent of all units have repeated sales, and of these units, almost 20 percent have three or more sales. In addition to satisfying the repeated sales requirement, we also need variation in LTV limits. Table 4 shows the mapping between the LTV limits for first and second sales in Panel A, while Panel B shows the difference in LTV

limits between the first and second sale.[5] We note that a large number of repeated sales have variation in LTV limits between the first and the second sale. For close to 10,000 repeated sales, the LTV limit decreases by 20 percentage points. In addition, the LTV limit decreases by 10 percentage points for 25,000 repeated sales, while the LTV limit increases by 10 percentage points for more than 500 repeated sales. We conclude that a sufficient number of repeated sales with variation in the LTV limit appear to exist to estimate the effect of LTV limits on house price growth.

IV. Empirical results

Table 5 reports results from the regression of LTV limits on house prices. In column 1, we include the LTV limit in percentage points and find a positive and statistically significant effect on house prices. A ten-percentage-point increase in the LTV limit results in 8.2 percent higher house price growth. We also note that the control variables have the expected sign. Property size is positively related to house prices, while building age is negatively related to house prices. New apartments are sold at 14.7 percent higher prices, 1-exp(-0.1598) = 14.7%, whereas a carpark increases the property price by 6.1 percent.

In column 2, we include indicators for LTV limits of 50 and 60 percent, while the reference group has LTV limits of 70 percent. We note that properties that are sold with a LTV limit of 50 percent have 14.8 percent lower price growth, while properties with a LTV limit of 60 percent have 8.5 percent lower prices. Finally, column 3 includes indicators for LTV increases and decreases. We find a positive coefficient of 0.1715 for LTV limit increases, corresponding to 15.8 percent higher price growth. The coefficient of -0.0829 for LTV limit decrease reveals that houses are sold at 8 percent lower prices when the LTV limit has decreased. In column 4 of Table 5, we complement the prior analysis by estimating the elasticity between

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[5] Note that for properties with, for example, 3 sales, Table 3 both reports the mapping of the LTV limit for the first and second sale, and the mapping for the second and third sale.

access to financing and house prices. The variable of interest is log. of the LTV limit. We find an elasticity of 0.5, implying that reducing access to financing by 10 percent reduces the house price growth by 5 percent. The estimated elasticity of 0.5 between access to financing and house prices reinforces the conclusion that LTV limits are an effective way of controlling house price growth. In summary, the results in Table 5 reveal that LTV limits have a strong influence on house price, which suggests that macro-prudential policies in the form of LTV limits are effective at controlling house price growth.

In Table 6, we investigate the effect of LTV limits on house prices further by considering whether the effectiveness of LTV limits depends on the opportunity cost of capital and whether the property is a luxury unit where pricing might be less sensitive to access to financing.

In column 1 of Table 6, we include an interaction term between the LTV limit and the interest rate. The coefficient on the interaction term is positive and statistically significant, indicating that the effectiveness of LTV limits increases with the interest rate. Thus, changes to the LTV limit have a stronger effect on house prices when the opportunity cost of capital is high. In column 2, we interact the LTV limit with an indicator for high interest rates, defined as months in which the interest rate is above the median interest rate during the sample period. Again, we note that the interaction term is positive and statistically significant.

To further shed light on the effect of opportunity cost of capital and the effectiveness of LTV limits, columns 3 and 4 look into the effect of luxury units where the effect of LTV limits is expected to be smaller. In column 3, we focus on properties on Hong Kong Island, which is the most exclusive territory in Hong Kong. Column 3 shows that the effect of LTV limits is weaker for properties located on Hong Kong Island, compared to properties located in Kowloon or the New Territories. In column 4, we go one step further by interacting the LTV limit with an indicator for luxury units. Luxury units are identified in an auxiliary hedonic regression model of house prices per square foot on observable property characteristics. Based on the

residual from this regression, we define properties that have a price per square foot that is 50 percent above the predicted level in the auxiliary hedonic regression model as a luxury unit. To avoid spurious correlation, the specification in column 4 includes both the interaction term between LTV limit and luxury units as well as the indicator for luxury units. Consistent with our conjecture, the effect of LTV limits on the house price of luxury units is smaller than for ordinary units. It follows that the effect of LTV limits is weaker for luxury units, because high-net-worth individuals are unlikely to be constrained by access to mortgage financing.

V. Alternative specifications

In this section, we address concerns related to the identification strategy and the hedonic pricing model. A potential concern with the specification in equation (1) is that houses affected by policy changes to the LTV limit are located in different areas than are houses that are unaffected. If the demand for houses and/or the supply of houses in these locations are different, time-varying location effects might drive the results.

For instance, one might be concerned about the staggered nature of LTV limits anchored by house prices potentially affecting houses in expensive districts before affecting houses in less expensive districts. If the house price growth is stronger in less expensive districts, this effect might confound the estimated effect of LTV limits on house prices. We address such concerns by introducing high-dimensional fixed effects to control for time-variant location effects. Table 7 reports the results when we change the estimation by considering variation in house prices in location j at time t:

$$y_{ijt} = \alpha_{ij} + \alpha_{jt} + \beta' X_{ijt} + \gamma' LTV\ limit_{ijt} + \epsilon_{ijt}, \tag{2}$$

where the dependent variable is the log. of value of unit i in location j at time t, α_{ij} captures unit fixed effects, α_{jt} captures location-time fixed effects, X_{ijt} is a vector of time-varying property characteristics, and $LTV\ limit_{ijt}$ captures the loan-to-value limit of unit i in location j at time t.

In column 1 of Table 7, we include territory-year fixed effects to absorb time-varying differences in house prices in the three territories: Hong Kong Island, Kowloon, and New Territories. We note that the coefficient on LTV limit increases from 0.0082 to 0.0090 after the inclusion of territory-year fixed effects, and remains statistically significant at the one percent level. In columns 2 and 3, we increase the dimension of the location-time fixed effects by including territory-year-quarter fixed effects and territory-year-month fixed effects, respectively. Again we note that the estimated effect of LTV limits increases when we absorb heterogeneity in house prices driven by differences in local market conditions.

In columns 4, 5, and 6, we further increase the dimension of the location-time fixed effects by moving the location level from territories to districts (see map of Hong Kong in Appendix D). In total, Hong Kong consists of 18 districts (four on Hong Kong Island, five in Kowloon, and nine in New Territories), implying that the specification in columns 4, 5, and 6 includes 288 district-year fixed effects, 1,152 district-year-quarter fixed effects and 3,456 district-year-month fixed effects, respectively. We note that the results are robust to controlling for high-dimensional location-time fixed effects. When we absorb heterogeneity in house prices in the same location at the same time, we find a robust relationship between the LTV limit and house prices. We conclude that our results are unaffected when we include high-dimensional fixed effects that effectively control for the development in house prices at the district level at a given time.

Another concern relates to the possibility that the policy interventions also affect house prices in the control group if the reduction in LTV limits shifts demand from units that are affected (treatment group) to units that are unaffected (control group). If households respond to changes to the LTV limit by shifting their

demand to units in the control group, the estimated coefficients might overstate the effectiveness of LTV limits. To address this concern, we exploit the fact that the potential bias depends on the fraction of units that are treated. Table 3 shows the fraction of units affected by each policy change. We note that the potential bias is larger for policy events 4, 5, and 6 than for policy events 1, 2, and 3. Thus, by comparing the effect of policy changes that affect few units to policy changes that affect many units, we can assess how large the potential bias is. Table 8 report the results.

To facilitate a comparison, column 1 in Table 8 reports the baseline results from column 1 of Table 5. In column 2, we include an interaction term between LTV limits and an indicator for units that are affected by policy events 1, 2, and 3. The magnitude of the coefficient on the interaction term thus provides an estimate of the difference in the treatment effects between policy events 1, 2, and 3 and policy events 4, 5, and 6. This difference is informative about the potential bias to estimated effectiveness of LTV limits caused by households shifting their demand to unaffected units in the control group. We note that the coefficient on LTV limits equals 0.0955, while the coefficient on the integration term between LTV limits and policy events 1, 2, and 3 equals -0.0020. Although the interaction term is statistically significant at the one percent level, the effect is economically insignificant, which indicates that the potential bias from shifting of demand is small.

In column 3, we go one step further, analyzing the effect of policy changes 1 to 5 by excluding transactions that occur after February 25, 2015 (policy change 6). Motivating the exclusion of policy change 6 is its effect on the largest fraction of the housing market of potentially shifting more demand to the control group: Table 3 shows that policy event 6 affects 70 percent of the housing market, compared to less than 10 percent for policy events 1 to 5. We note that the estimated coefficient of 0.0080, when we exclude policy

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event 6 in column 3 of Table 3, is close to the estimated coefficient of 0.0082 in the baseline specification. We conclude that the potential bias from shifts in demand is small.

VI. Conclusions

This study evaluates the effectiveness of LTV limits in controlling house price growth. The study exploits an identification strategy based on Hong Kong Monetary Authority's decision to differentiate LTV limits based on the value of the house, which allows us to observe the counterfactual development in house prices.

Our results demonstrate that macro-prudential policies are effective in controlling house price growth. We estimate a coefficient of 0.8 between LTV limits and house prices: a one-percentage-point decrease in LTV limits reduces the house price growth by 0.8 percentage points. Considering that monetary authorities tend to change LTV limits by 5 to 10 percentage points, it follows that a typical policy intervention will reduce house price growth by 4 to 8 percentage points.

Overall, our results demonstrate that LTV limits have a large effect on house prices, which corroborates with the recent popularity of this policy among monetary authorities and regulators.

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Table 1: Timeline of changes of loan-to-value (LTV) limits

This table outlines the timing of the changes of the loan-to-value (LTV) limit for residential real estate mortgages by the Hong Kong Monetary Authority (HKMA). All LTV limits are effective on the announcement date. Two LTV policy changes (November 2, 1995 and January 28, 1997) occur before, and six policy changes occur within, the sample period covering transaction prices on residential real estate transaction from 2000 to 2015. Policy changes within the sample period are numbered chronologically from 1 to 6. Policy change 1 increases the LTV limit from 60% to 70% for houses with a value above 12 million HKD. Policy change 2 decreases the LTV limit from 70% to 60% for houses with a value above 20 million HKD. Policy change 3 decreases the LTV limit from 70% to 60% for houses with a value between 12 and 20 million HKD. Policy change 4 decreases the LTV limit from 60% to 50% for houses with a value above 12 million HKD, and from 70% to 60% for houses with a value between 8 and 12 million HKD. Policy change 5 decreases the LTV limit from 60% to 50% for houses with a value between 10 and 12 million HKD, and from 70% to 60% for houses with a value between 7 and 8 million HKD. Policy change 6 decreases the LTV limit from 70% to 60% for houses with a value below 7 million HKD. One USD equals 7.78 HKD.

Policy change #	Date	House value	LTV limit
-	November 2, 1995	All	70%
-	January 28, 1997	<12M	70%
		>12M	60%
1	October 10, 2001	All	70%
2	October 23, 2009	<20M	70%
		>20M	60%
3	August 13, 2010	<12M	70%
		>12M	60%
4	November 19, 2010	<8M	70%
		8-12M	60%
		>12M	50%
5	June 10, 2011	<7M	70%
		7-10M	60%
		>10M	50%
6	February 27, 2015	<7M	60%
		7-10M	60%
		>10M	50%

Table 2: Descriptive statistics

This table reports descriptive statistics for residential real estate transactions between January 1, 2000 and December 31, 2015. Panel A reports the following transaction characteristics: *Price* is in million HKD (one USD equals 7.78 HKD); *size* is measured in square feet (one square meter equals 10.76 square feet); *price per square foot* is in HKD; *building age* is measured in years; *primary transaction* is an indicator for new developments; and *carpark* is an indicator for whether a carpark is sold together with the property. Panels B, C, and D report the distribution of transactions on territory (i.e., region), season (i.e., quarter of sale), and loan-to-value (LTV) limit, respectively.

A. Transaction characteristics	Mean	Median	Std. dev.
Price (million HKD)	4.23	2.66	7.00
Size (square feet)	606.4	517.0	367.0
Price per square foot (HKD)	6,207.7	5,053.2	4,203.8
Building age (years)	14.2	13.0	12.4
Primary transaction (%)	0.176	0.0	0.380
Carpark (%)	0.065	0.0	0.247
B. Territory (%)	**N**	**%**	
Hong Kong Island	236,734	22.4	
Kowloon	292,982	27.7	
New Territories	529,222	50.0	
C. Season (%)	**N**	**%**	
First quarter	272,297	25.7	
Second quarter	272,984	25.8	
Third quarter	261,310	24.7	
Fourth quarter	252,347	23.8	
C. Loan-to-value limit	**N**	**%**	
50%	32,118	3.0	
60%	58,287	5.5	
70%	968,533	91.5	

Table 3: Number of transactions by loan-to-value limit around policy changes

We report the number and composition of transactions by the loan-to-value (LTV) limit one year before and one year after for each of the six policy changes between 2000 and 2015. Policy changes are numbered chronologically from 1 to 6. Policy change 1 increases the LTV limit from 60% to 70% for houses with a value above 12 million HKD. Policy change 2 decreases the LTV limit from 70% to 60% for houses with a value above 20 million HKD. Policy change 3 decreases the LTV limit from 70% to 60% for houses with a value between 12 and 20 million HKD. Policy change 4 decreases the LTV limit from 60% to 50% for houses with a value above 12 million, and from 70% to 60% for houses with a value between 8 and 12 million. Policy change 5 decreases the LTV limit from 60% to 50% for houses with a value between 10 and 12 million, and from 70% to 60% for houses with a value between 7 and 8 million. Policy change 6 decreases the LTV limit from 70% to 60% for houses with a value below 7 million HKD. One USD equals 7.78 HKD.

| | | Loan-to-value limit | | | | | |
| | 50% | | 60% | | 70% | | All |
	N	%	N	%	N	%	N
Policy change 1							
Before	-	-	887	1.8	47,189	98.2	48,076
After	-	-	-	-	60,417	100.0	60,417
Policy change 2							
Before	-	-	-	-	86,205	100.0	86,205
After	-	-	2,687	2.6	101,089	97.4	103,776
Policy change 3							
Before	-	-	2,762	2.6	102,061	97.4	104,823
After	-	-	6,061	7.2	77,890	92.8	83,951
Policy change 4							
Before	-	-	6,475	6.0	100,848	94.0	107,323
After	5,443	8.1	4,767	7.1	57,552	84.9	67,552
Policy change 5							
Before	6,645	6.8	5,739	5.9	98,051	87.4	98,051
After	6,417	11.6	5,497	9.9	43,594	78.5	55,508
Policy change 6							
Before	7,905	14.3	8,611	15.6	38,832	70.2	55,348
After	5,466	16.7	27,243	83.3	-	-	32,709

Table 4: Changes in loan-to-value (LTV) limits for units with repeated sales

This table maps the LTV limit for repeated sales. Panel A reports the number of observations conditional on the LTV limit for the first and second sales, respectively. Panel B reports the number and fraction of total observations conditional on the change in the LTV limit from first to second sale. *Decease by 20 (10) percentage points* summarizes the number of observations in which the LTV limit for the second sale is 20 (10) percentage points lower than the first sale. *Unchanged* summarizes the number of observations in which the LTV limit remained the same for the first and second sale, while *increase by 10 percentage points* summarizes the number of observations in which the LTV limit increased by 10 percentage points from the first to the second sale.

A. Mapping between LTV limits for first and second sales

First sale	Second sale			
	50%	**60%**	**70%**	**All**
50%	861	0	0	861
60%	1,027	843	572	2,442
70%	9,725	24,191	405,647	439,563
All	11,613	25,034	406,219	442,866

B. Change in LTV limits from first to second sale

	N	**%**
Decrease by 20 percentage points	9,725	2.2
Decrease by 10 percentage points	25,218	5.7
Unchanged	407,351	92.0
Increase by 10 percentage points	572	0.1
All	442,866	100

Table 5: LTV limits and house prices

This table reports the effect of loan-to-value limits on house prices. We estimate the following equation:

$$y_{it} = \alpha_i + \alpha_t + \beta' X_{it} + \gamma' LTV\ limit_{it} + \epsilon_{it},$$

where the dependent variable y_{it} is log. of value of house i at time t, X_{it} is a vector of time-varying house characteristics, and $LTV\ limit_{it}$ captures the loan-to-value limit of house i at time t. In addition, the specification controls for unit fixed effects, α_i, as well as for year-month fixed effects, α_t. In specification (1), the *LTV limit* is measured in percentage points. In specification (2), we include indicators for LTV limits of 50% and 60%, respectively. In specification (3), we include indicators for *LTV limit increases* and *decreases*. In specification (4), the *LTV limit* is measured in log. terms, implying that γ estimates the elasticity between LTV limits and house prices. All specifications include the following time-variant house characteristics: *size* is measured in square-feet; *building age* is measured in years; *primary transaction* is an indicator for new developments; and *carpark* is an indicator for whether a carpark is sold together with the property. Standard errors clustered at the year-month level are reported in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
LTV limit	0.0082***			
	(0.0011)			
LTV limit of 50%		-0.1607***		
		(0.0022)		
LTV limit of 60%		-0.0884***		
		(0.0015)		
LTV limit increase			0.1715***	
			(0.0147)	
LTV limit decrease			-0.0829***	
			(0.0156)	
Log. of LTV limit				0.4943***
				(0.0065)
Size	0.0002***	0.0002***	0.0002***	0.0002***
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Building age	-0.0037	-0.0039	-0.0034	-0.0037
	(0.0114)	(0.0114)	(0.0111)	(0.0114)
Primary transaction	0.1598***	0.1592***	0.1591***	0.1599***
	(0.0091)	(0.0091)	(0.0091)	(0.0091)
Carpark	0.0632***	0.0626***	0.0566***	0.0634***
	(0.0073)	(0.0073)	(0.0058)	(0.0073)
Unit fixed effects	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes
Adj. R²	0.974	0.974	0.974	0.974
N	1,058,938	1,058,938	1,058,938	1,058,938

Table 6: LTV limits, opportunity costs of capital and house prices

This table reports the effect of loan-to-value limits on house prices. We estimate the following equation:

$$y_{it} = \alpha_i + \alpha_t + \beta' X_{it} + \gamma' LTV\ limit_{it} + \epsilon_{it},$$

where the dependent variable y_{it} is log. of value of house i at time t, X_{it} is a vector of time-varying house characteristics, and $LTV\ limit_{it}$ captures the loan-to-value limit of house i at time t. In addition, the specification controls for unit fixed effects, α_i, as well as for year-month fixed effects, α_t. In all specifications, the $LTV\ limit$ is measured in percentage points. Specifications (1) to (4) interact the LTV limit with the following variables, respectively: *interest rate* measured in percentage points, indicator for *high interest rate* based on the median interest rate in the time period, an indicator for location on *Hong Kong Island*, and an indicator for being a *luxury unit*. Luxury units are defined as units that have a price per square foot that is 50% above the level explained by property characteristics (see Section IV). All specifications include the following (unreported) time-variant house characteristics: *size, building age, primary transaction, and carpark*. Standard errors clustered at the year-month level are reported in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)
LTV limit	0.0072***	0.0080***	0.1000***	0.0095***
	(0.0011)	(0.0011)	(0.0011)	(0.0010)
LTV limit * Interest rate	0.0036***			
	(0.0055)			
LTV limit * High interest rate		0.0165***		
		(0.0034)		
LTV limit * Hong Kong Island			-0.0039***	
			(0.0007)	
LTV limit* Luxury unit				-0.0030***
				(-0.0008)
Luxury unit				0.4512***
				(0.0812)
Controls variables	Yes	Yes	Yes	Yes
Unit fixed effects	Yes	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes	Yes
Adj. R^2	0.974	0.974	0.974	0.976
N	1,058,938	1,058,938	1,058,938	1,058,938

Table 7: LTV limits and house prices controlling for high-dimensional fixed effects

This table reports the effect of loan-to-value limits on house prices, with additional high dimensional fixed effects capturing variation in house prices related to location and time. We estimate the following equation:

$$y_{ijt} = \alpha_i + \alpha_{jt} + \beta' X_{ijt} + \gamma' LTV\ limit_{ijt} + \epsilon_{ijt},$$

where the dependent variable y_{ijt} is log. of value of house i in location j at time t, X_{it} is a vector of time-varying house characteristics, and $LTV\ limit_{ijt}$ captures the maximum loan-to-value limit of house i at location j at time t. variables. In all specifications, the $LTV\ limit$ is measured in percentage points, while α_i captures unit fixed effects. In specifications (1) to (6), the following high-dimensional fixed effects are included to control for variations in house prices driven by location and time: specification (1) includes territory-year fixed effects; specification (2) includes territory-year-quarter fixed effects; specification (3) includes territory-year-month fixed effects; specification (4) includes district-year fixed effects; specification (5) includes district-year-quarter fixed effects; and specification (6) includes district-year-month fixed effects. All specifications include the following (unreported) time-variant house characteristics: *size, building age, primary transaction*, and *carpark*. Standard errors clustered at the year-month level are reported in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
LTV limit	0.0090***	0.0103***	0.0107***	0.0088***	0.0102***	0.0107***
	(0.0009)	(0.0009)	(0.0010)	(0.0008)	(0.0008)	(0.0008)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes
Unit fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Territory-year fixed effects	Yes	No	No	No	No	No
Territory-year-quarter fixed effects	No	Yes	No	No	No	No
Territory-year-month fixed effects	No	No	Yes	No	No	No
District-year fixed effects	No	No	No	Yes	No	No
District-year-quarter fixed effects	No	No	No	No	Yes	Yes
Adj. R²	0.973	0.976	0.978	0.975	0.979	0.980
N	1,058,938	1,058,938	1,058,938	1,058,938	1,058,938	1,058,938

Table 8: Alternative specifications

This table reports the effect of loan-to-value limits on house prices using alternative specifications. We estimate the following equation:

$$y_{it} = \alpha_i + \alpha_t + \beta'X_{it} + \gamma'LTV\ limit_{it} + \epsilon_{it},$$

where the dependent variable y_{it} is log. of value of house i at time t, X_{it} is a vector of time-varying house characteristics, and $LTV\ limit_{it}$ captures the maximum loan-to-value limit of house i at time t. variables. In addition, the specification controls for unit fixed effects, α_i, as well as year-month fixed effects, α_t. Specification (1) reports the baseline from column 1 of Table 5. Specification (2) includes an interaction term between LTV limits and policy changes 1, 2, and 3. Specification (3) excludes transactions that occur after February 23, 2015 (i.e., policy change 6). All specifications include the following time-variant house characteristics: *size* is measured in square-feet; *building age* is measured in years; *primary transaction* is an indicator for new developments; and *carpark* is an indicator for whether a carpark is sold together with the property. Standard errors clustered at the year-month level are reported in parentheses. ***, **, * indicate coefficients that are significant at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)
LTV limit	0.0082***	0.0955***	0.0080***
	(0.0011)	(0.0012)	(0.0010)
LTV limit * Policy changes 1, 2, and 3		-0.0020***	
		(0.0007)	
Control variables	Yes	Yes	Yes
Unit fixed effects	Yes	Yes	Yes
Year-month fixed effects	Yes	Yes	Yes
Adj. R^2	0.973	0.974	0.974
N	1,058,938	1,058,938	1,026,229

Figure 1: Loan-to-value limit by house value, 2000–2015

This figure shows the timeline of the six policy changes to the loan-to-value (LTV) limit between 2000 and 2015. Policy changes are numbered chronologically from 1 to 6. Policy change 1 increases the LTV limit from 60% to 70% for houses with a value above 12 million HKD. Policy change 2 decreases the LTV limit from 70% to 60% for houses with a value above 20 million HKD. Policy change 3 decreases the LTV limit from 70% to 60% for houses with a value between 12 and 20 million HKD. Policy change 4 decreases the LTV limit from 60% to 50% for houses with a value above 12 million, and from 70% to 60% for houses with a value between 8 and 12 million. Policy change 5 decreases the LTV limit from 60% to 50% for houses with a value between 10 and 12 million, and from 70% to 60% for houses with a value between 7 and 8 million. Policy change 6 decreases the LTV limit from 70% to 60% for houses with a value below 7 million HKD. One USD equals 7.78 HKD.
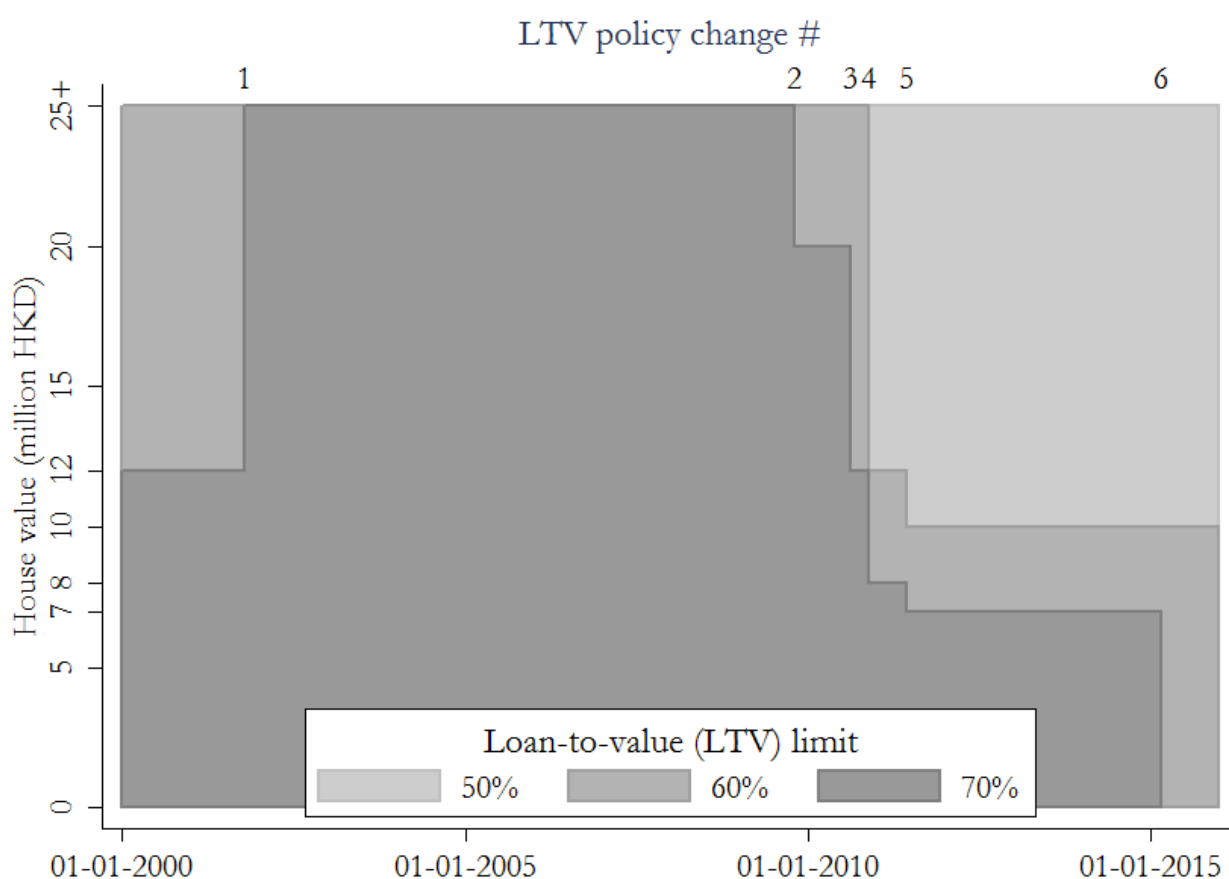
Figure 2: Average loan-to-value limit and actual loan-to-value ratio, 2000–2015

This figure compares the average loan-to-value ratio from the Hong Kong Monetary Authorities' monthly surveys of new loans to the average loan-to-value (LTV) limit based on transaction records in the same month. The average loan to value limit is calculated as average LTV limit for all transactions in each month. Policy changes are numbered chronologically from 1 to 6. Policy changes that increase (decrease) the LTV limit are represented with a blue (red) horizontal line. Policy change 1 increases the LTV limit from 60% to 70% for houses with a value above 12 million HKD. Policy change 2 decreases the LTV limit from 70% to 60% for houses with a value above 20 million HKD. Policy change 3 decreases the LTV limit from 70% to 60% for houses with a value between 12 and 20 million HKD. Policy change 4 decreases the LTV limit from 60% to 50% for houses with a value above 12 million, and from 70% to 60% for houses with a value between 8 and 12 million. Policy change 5 decreases the LTV limit from 60% to 50% for houses with a value between 10 and 12 million, and from 70% to 60% for houses with a value between 7 and 8 million. Policy change 6 decreases the LTV limit from 70% to 60% for houses with a value below 7 million HKD. One USD equals 7.78 HKD.
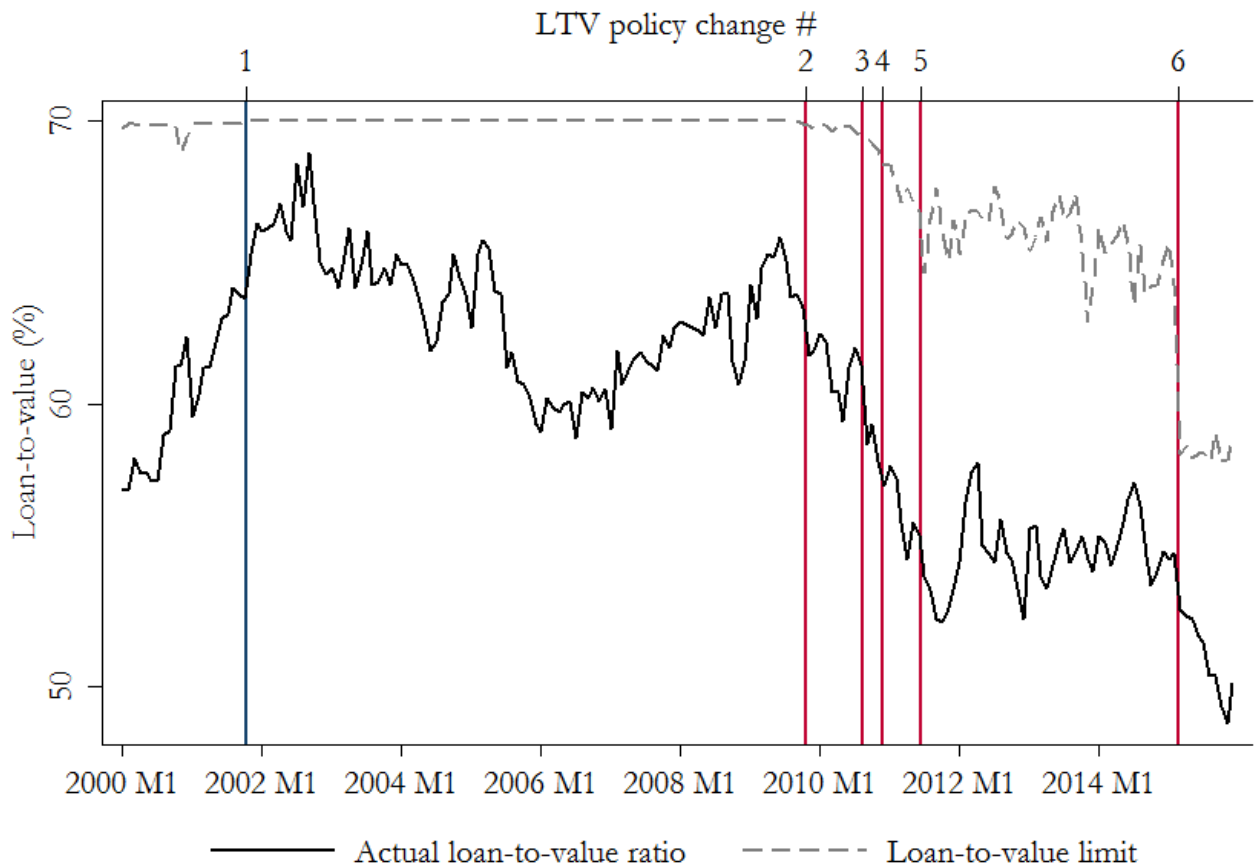
Figure 3: Average price per square foot and loan-to-value (LTV) policy changes, 2000–2015

This figure shows the average price per square foot and the timeline of the six policy changes to the loan-to-value (LTV) limit between 2000 and 2015. Each quarter, we calculate the average price per square feet in 1,000 HKD. Policy changes are numbered chronologically from 1 to 6. Policy changes that increase (decrease) the LTV limit are represented with a blue (red) horizontal line. Policy change 1 increases the LTV limit from 60% to 70% for houses with a value above 12 million HKD. Policy change 2 decreases the LTV limit from 70% to 60% for houses with a value above 20 million HKD. Policy change 3 decreases the LTV limit from 70% to 60% for houses with a value between 12 and 20 million HKD. Policy change 4 decreases the LTV limit from 60% to 50% for houses with a value above 12 million, and from 70% to 60% for houses with a value between 8 and 12 million. Policy change 5 decreases the LTV limit from 60% to 50% for houses with a value between 10 and 12 million, and from 70% to 60% for houses with a value between 7 and 8 million. Policy change 6 decreases the LTV limit from 70% to 60% for houses with a value below 7 million HKD. One USD equals 7.78 HKD.
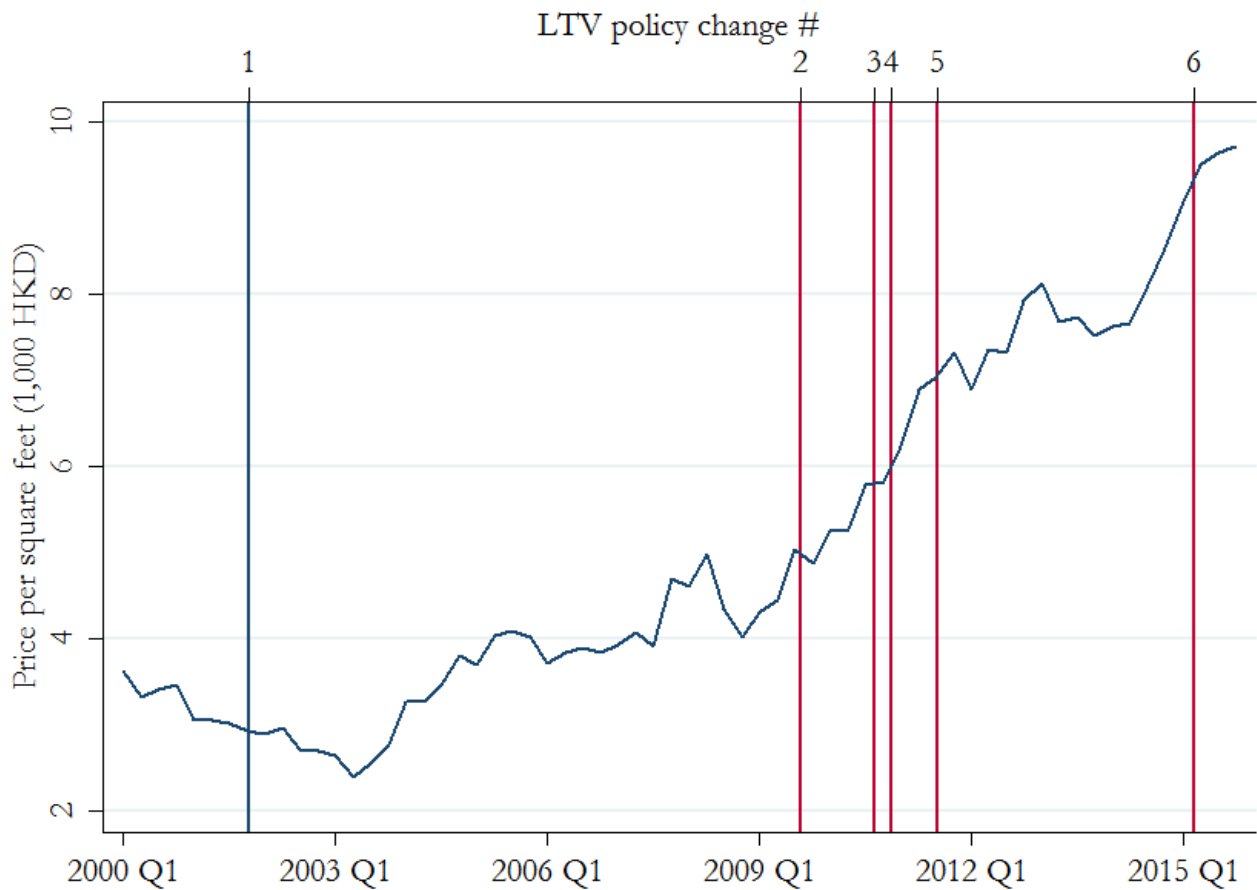

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Figure 4: Changes in average price per square foot around loan-to-value (LTV) policy changes

This figure shows the changes in average price per square foot around LTV policy changes. For each policy change, the sample consists of houses with a value +/- 2 million that are sold in a window from 6 months before to 12 months after the policy change. For instance, for policy event 1, which increases the LTV limit for houses with a value above 12M, the sample includes houses with a value between 10M and 14M that are sold between March 10, 2001 and October 10, 2002, where October 10, 2001 is the date of the policy event. The blue (red) bar reports change in price per square foot for houses subject to a LTV limit increase (decrease) of 10% around the policy change (6 months before to 12 months after), whereas the light gray bar reports the price change for houses that are unaffected by the policy change. Finally, the dark gray bars show, for each policy event, the *difference* in the change in price per square foot between affected and unaffected houses.
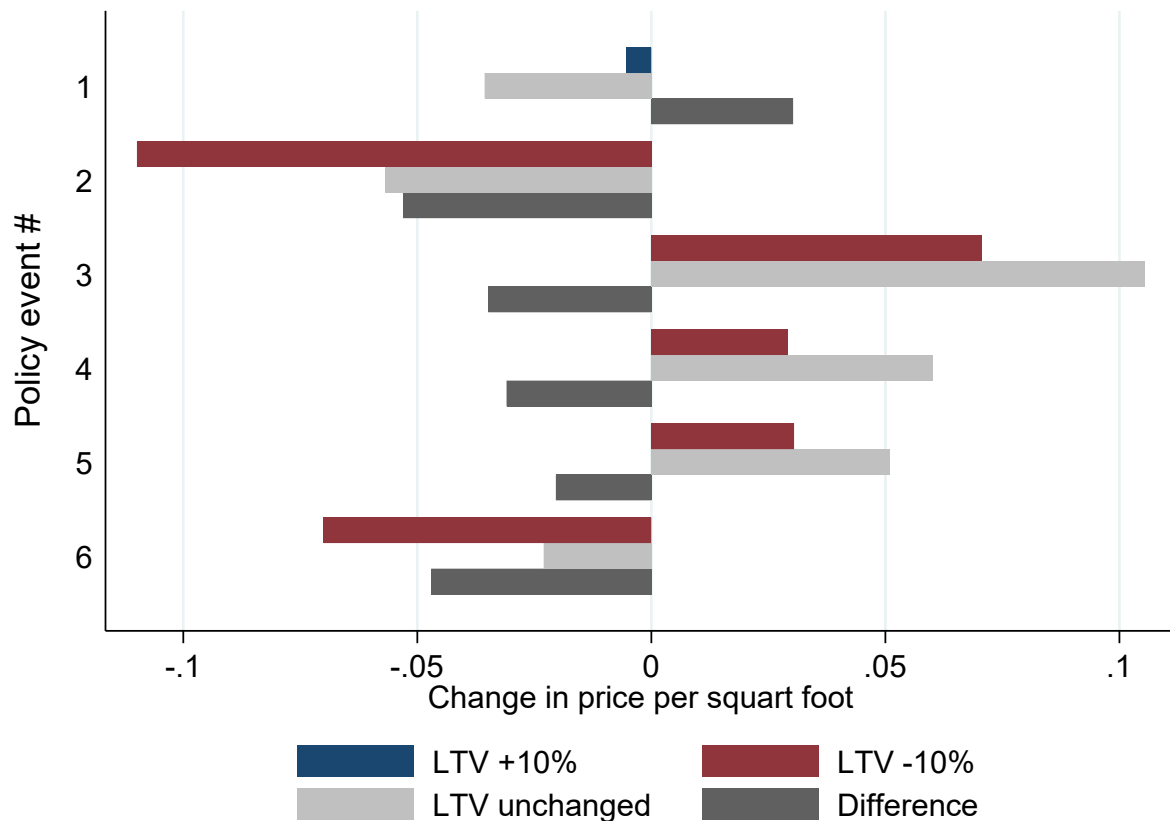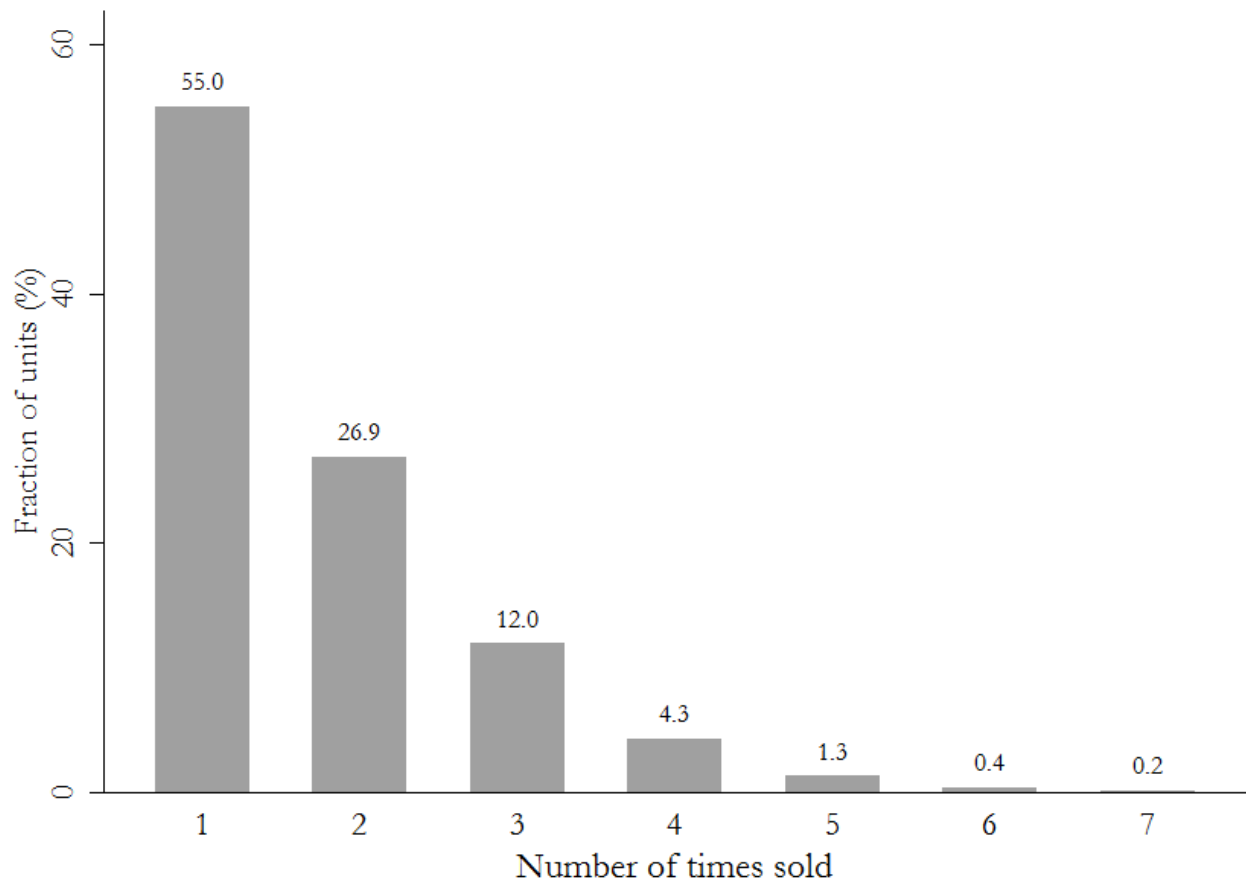
Figure 5: Fraction of units with repeated sales 2000–2015

This figure shows the distribution of units on the number of times sold during the sample period from 2000 to 2015; i.e., for each unit, we count the number of times the unit sold during the sample period and plot the distribution.

Appendix A: Macro-prudential regulation of loan-to-value (LTV) limits, 2000–2015

This figure shows the timing of policy interventions by monetary authorities that regulate LTV limits among markets that adopted or changed the LTV limit for residential real estate between 2000 and 2015. For brevity, the table excludes policy changes that differentiate LTV limits between a) domestic or foreign currency, b) short- and long-term mortgages, and c) domestic or foreign house buyers.
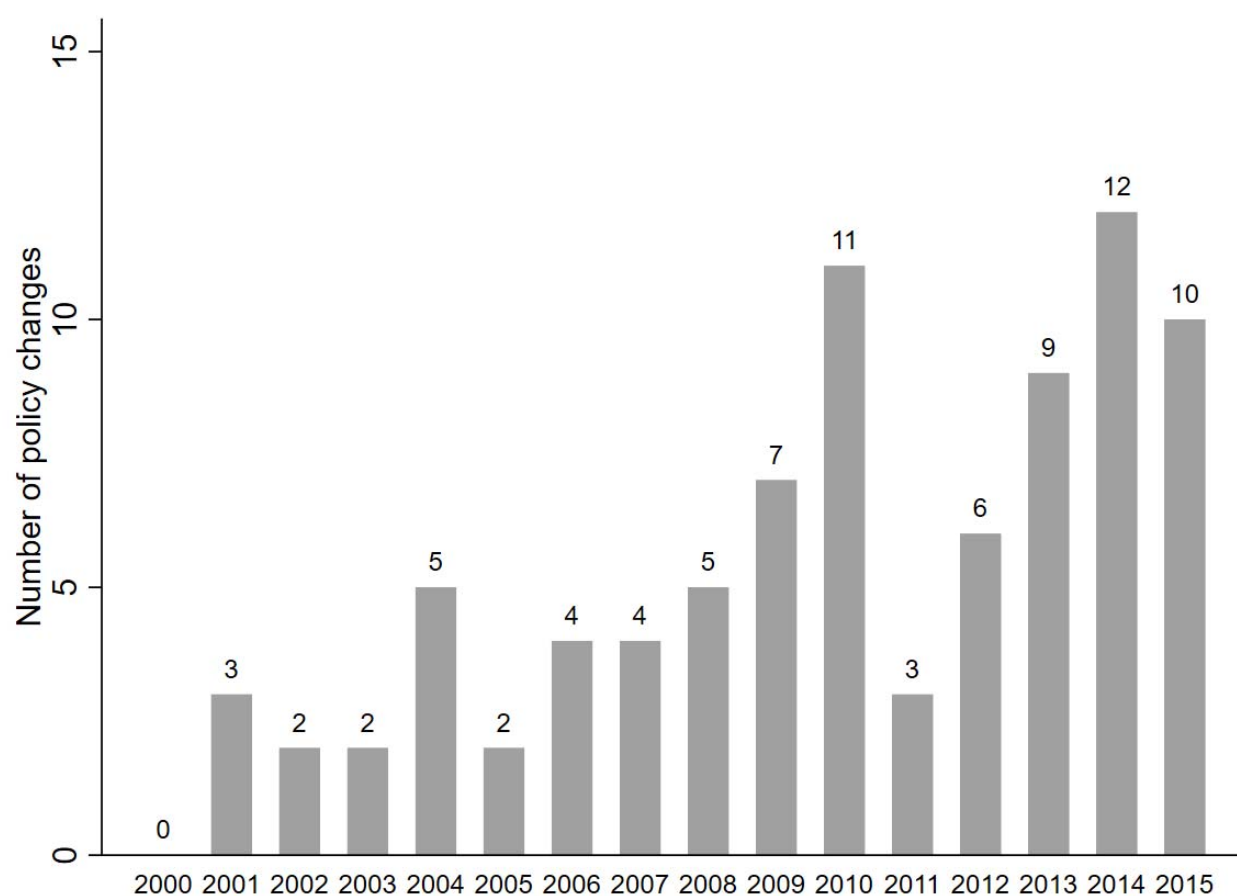
Sources: IMF (2012, 2013), Shim et al. (2013), Cerutti et al. (2016), and own research.

Appendix B: Macro-prudential regulation of loan-to-value (LTV) limits by monetary authorities, 2000–2015

This table shows the timing of policy interventions by monetary authorities that regulate LTV limits in markets that either adopted or changed the LTV limit between 2000 and 2015. *Number of policy changes* counts the number of changes. *Differentiated LTV limits* indicate whether the macro-prudential policy change in a given year differentiates LTV limits based on house characteristics (location, size, or value). For brevity, the table excludes policy changes that differentiate LTV limits between a) domestic or foreign currency, b) short- and long-term mortgages, and c) domestic or foreign house buyers. Year ranges indicate stepwise policy changes to LTV limits.

	Number of policy changes	Differentiated LTV limits	
		Yes	No
Argentina	1	2006	
Bahamas	1		2004
Brazil	1		2013
Bulgaria	1		2004
Canada	1		2008
Chile	1		2009
China	7	2005, 2006, 2010, 2013, 2015	2003, 2008
Croatia	1		2006
Cyprus	1		2009
Denmark	1		2015
Estonia	1		2015
Hong Kong SAR	6	2001, 2009, 2010 (x2), 2011, 2015	
Hungary	2		2010, 2012
Iceland	4		2001, 2004, 2006, 2007
India	2	2010, 2013	
Indonesia	1	2012	
Ireland	2		2001, 2015
Israel	1		2012
Korea	7	2009 (x2), 2010, 2012	2002, 2004, 2014
Latvia	3		2007, 2008, 2014
Lebanon	1		2008
Lithuania	2		2011, 2015
Luxembourg	1		2008
Malaysia	1		2014
Nepal	1		2009
Netherlands	5		2010, 2012-2015
Norway	2		2010, 2013
Oman	1		2014
Philippines	2		2002, 2014
Poland	3		2013-2015
Romania	1		2004
Saudi Arabia	1		2014
Singapore	2		2005, 2010
Slovakia	1		2014
Spain	1		2007
Sweden	2		2010, 2013
Taiwan	7	2012 (x2), 2014 (x2), 2015	2010, 2014
Thailand	2	2003, 2009	
Tunisia	1		2007
Turkey	1		2011
UAE	2	2013	2013

Sources: IMF (2012, 2013), Shim et al. (2013), Cerutti et al. (2016), and own research.

Appendix C: Differentiated loan-to-value (LTV) limits by source of variation

This table shows the timing and direction of policy interventions by monetary authorities that differentiate LTV limits based on location, value, or size of the unit. *Unit characteristics* indicates the characteristic that differentiate the LTV limits: *location* indicates differentiated LTV limited based on location, *size* indicates differentiated LTV limits based on the size of the unit, while *value* indicates differentiated LTV limits based on transaction value. Finally, the last two columns indicate whether the policy change increased or decreased the LTV limit as well as the year of the policy change. For brevity, the table excludes policy changes that differentiate LTV limits between a) domestic or foreign currency, b) short- and long-term mortgages, and c) domestic or foreign house buyers.

	Unit characteristic	LTV limit	
		Increase	**Decrease**
Argentina	Value	2006	
China	Location	2015	2005, 2013
	Size		2006, 2010
Hong Kong	Value	2001	2009, 2010 (x2), 2011, 2015
India	Value		2010, 2013
Indonesia	Size		2012
Korea	Location	2012	2009, 2010
	Value		2009
Taiwan	Location	2015	2012, 2014
	Value		2012, 2014
Thailand	Value	2009	2003
UAE	Value		2013

Sources: IMF (2012, 2013), Shim et al. (2013), Cerutti et al. (2016), and own research.

Appendix D: Administrative map of Hong Kong

This figure shows the subdivision of Hong Kong into districts. The three main territories, Hong Kong Island, Kowloon and New Territories, are subdivided into 18 districts. New Territories consists of districts 1 to 9 (Islands, Kwai Tsing, North, Sai Kung, Tai Po, Tsuen Wan, Tuen Mun, and Yuen Long), Kowloon consists of districts 10 to 14 (Kowloon City, Kwun Tong, Sham Shui Po, Wong Tai Sin, and Yau Tsim Mong), and Hong Kong Island consists of districts 15 to 18 (Central and Western, Eastern, Southern, and Wan Chai).