The Effect of Investor Credit Supply on Housing Prices*

Christian Gillitzer
The University of Sydney

Nalini Prasad
UNSW Sydney

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Abstract

What is the effect of investor credit supply on housing prices? We provide causal evidence using quasi-experimental variation in credit supply to investors caused by two macroprudential policies implemented in Australia. The first policy placed a bank-level cap on mortgage credit growth to investors. The second policy placed a bank-level cap on interest-only lending, which is predominantly used by investors. Both policies caused a large and sharp reduction in new investor lending relative to new owner-occupier lending. We examine the effect of these policies on the housing market using unit-record data on property sales and listings. We show that the restrictions on investor lending reduced the share of properties purchased by investors and reduced the relative price of properties in investor segments of the market.

Keywords: macroprudential policy, credit conditions, house prices, investor lending
JEL codes: E44, E5, G21, G28, R21

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Christian Gillitzer, The University of Sydney, Sydney, Australia. Email address: christian.gillitzer@sydney.edu.au. Nalini Prasad, UNSW Sydney, Sydney, Australia. Email: nalini.prasad@unsw.edu.au.

1 Introduction

What is the effect of changes in the supply of credit to housing investors on dwelling prices? It is widely accepted that shocks originating from the housing market in the United States in the early 2000s contributed to the Great Recession. There is increasing evidence that housing investors played an important role in amplifying the housing market boom and bust. Increased investor activity led to stronger price growth during the boom and larger falls in incomes and employment during the bust, which slowed the recovery from the recession.[1] Despite the large economic costs associated with this housing cycle, the mechanisms through which increased investor activity affect the housing market remains contested. This in turn makes it difficult to understand what role policymakers should play. Our contribution is to examine the effect of changes in the supply of credit to housing investors on the housing market. We document sharp and large quasi-experimental reductions in credit supply for investors relative to owner occupiers and study its effects on investor participation and prices in the housing market. This is important because empirical evidence on the sensitivity of house prices to *investor* credit supply is scarce.

Empirically, it is challenging to measure the effect of changes in investor credit on the housing market because of reverse causality. We address this issue by using quasi-experimental variation in credit supply to investors caused by two macroprudential policies implemented in Australia. These policies were introduced during a period of rapid investor credit growth. The value of new housing loans to investors accounted for 40 per cent of the value of all new housing loans and was growing at 25 per cent on an annual basis in the year before the policies were introduced.[2] The macroprudential policies directly targeted investors and were implemented to limit speculative lending to investors but were not aimed at housing prices (RBA, 2018). A key strength of our analysis is the large and sharp policy-induced fall in new lending to investors that we are able to exploit.

[1] See for example Albanesi, Giorgi and Nosal, 2017, Chinco and Mayer (2016), DeFusco, Nathanson and Zwick (2017), Gao, Sockin and Xiong (2020), Haughwout et al. (2011), Mian and Sufi (2022) and Nathanson and Zwick (2018).

[2] By way of comparison, in Las Vegas, a boom market during the housing upturn in the United States in the early 2000s, purchases of non-occupant homes accounted for 30 per cent of home purchases.

More specifically, the first macroprudential policy we study placed a bank-level cap on credit growth to investors of 10 percent, on a six-month annualized basis. Its introduction was unexpected. The policy placed no restrictions on lending to owner-occupiers. Prior to the introduction of the cap, investor credit growth was above or close to the cap for each of the four major banks that dominate the mortgage market in Australia. The policy led to a sharp fall in new lending to investors; within a year of the introduction of the policy, growth in the value of new lending to investors relative to owner-occupiers halved.

The second macroprudential policy, introduced two years later, placed a bank-level cap of 30 percent on the share of new housing lending that could be interest-only. Like the first policy, the introduction of the cap on interest-only lending was unexpected and designed to limit perceived risky lending. The share of interest-only lending exceeded the cap prior to the policy but fell sharply after the introduction of the cap. Both owner-occupier and investor borrowers can use interest-only loans. However, interest-only lending comprised a much larger share of total lending for investors, at 63 percent, than owner-occupiers, at 24 percent. Required repayments are 30-40 percent higher on a representative principal and interest loan than on an equivalent interest-only loan (Kent, 2018). The evidence indicates that a large fraction of prospective investor borrowers found it difficult to substitute from interest-only to principal and interest loans. We find that the second policy had a sustained negative effect on lending to investors; growth in new lending to investors relative to owner occupiers was 20 percentage lower within a year of the policy coming into effect and continued to decline two years after the policy.

We examine the effect of the relative contraction in investor credit on the housing market using unit record data on rental listings and the universe of property sales for capital cities in Australia. We construct a novel measure of investor participation in the housing market. We classify a property as being purchased by an investor if there is a rental listing for the property appearing within 6 months of the transfer of ownership post sale. This is an important contribution to the literature because existing work has relied on mortgage data to measure investor activity (see for example Bhutta (2015), Gao, Sockin and Xiong (2020) and Mian and Sufi (2022)). These mortgage-based measures ignore the activity of debt-free investors. International evidence indicates a significant fraction of investors purchase a property without a mortgage (Bracke, 2021, DeFusco, Nathanson and Zwick, 2017). Our measure includes investors that are not constrained by changes in the supply of credit. Others papers have compared a buyers mailing address to that of the purchased property to measure investor activity (Chinco and Mayer, 2016). A difficulty of implementing this approach is that in most locations data on a buyer's mailing address is unavailable.

We find a close correspondence between our measure of the share of properties purchased by investors and the investor share of new lending. We find that the share of properties purchased by investors fell following both macroprudential policies, in line with falls in investor lending. This tells us that, despite a non-trivial fraction of investors not requiring a mortgage, investor credit supply affects investor participation in the housing market.

We then look at the effect of reduced investor participation on prices. Our identification strategies rely on partial segmentation of investor activity across property characteristics and locations. Our first strategy exploits variation in the investor purchase propensity across property types within a city. We show that property characteristics have significant explanatory power for the probability a property will be purchased by an investor. Investors are relatively more likely to purchase apartments than houses and to purchase properties with fewer bedrooms and bathrooms. There is also significant within-city geographic variation in the investor purchase propensity. We find that the decline in investor credit following both policies caused a relative decline in housing prices in those segments of the market where investors are the most active. The bulk of the price changes occur within a year of the implementation of each policy and are economically and statistically significant. We find that cumulatively – 4 years after the first policy was implemented and 2 years after the second – that moving from the bottom quartile to the top quartile of properties likely to purchased by investors is associated with price growth being 13 percent lower. This indicates, given the relative fall in new lending to investors over this period, that a one percentage point fall in the value of new lending to investors leads to a 0.25 percentage point fall in the price of housing more likely to be owned by investors.

Our second identification strategy exploits variation in investor activity and prices across Australian capital cities. The results from this analysis support our previous findings. Cities in which the investor share of new lending was initially high experienced larger declines in housing prices following both macroprudential policies relative to those cities in which the investor share of lending was initially low.

Non-price indicators of housing market strength support our findings. The mean time-to-sale lengthened and the listings clearance rate (the share of listings selling within 6 months) declined immediately after the introduction of each macroprudential policy in high relative to low investor propensity segments of the property market. In addition, we find no evidence of confounding movements in housing price growth expectations, giving us confidence that the relative falls in prices we observe are being caused by changes in the supply of credit to investors.

Related literature: Our paper is related to a growing literature which finds that investors played an important role in explaining the housing cycle in the United in the early 2000s (Chinco and Mayer, 2016; DeFusco, Nathanson and Zwick, 2017; Gao, Sockin and Xiong, 2020; Mian and Sufi, 2022). However, work on understanding the mechanisms through which investor activity affects the housing market has been more limited, owing to the difficulty in identifying exogenous variation in investor activity. Our contribution is to provide casual evidence on the effect of changes in the supply of credit to investors on investor participation and prices in the housing market. A benefit of our setting is that the macroprudential policies we study were unanticipated and directly affected the supply of lending to investors. In contrast, other papers rely on instruments to look at the effects of changes in investor activity (see for example Gao, Sockin and Xiong (2020) and Mian and Sufi (2022)). Our also paper contributes to a small literature using clearly-identified shocks to credit supply in a cross-sectional setting (Adelino, Schoar and Severino, 2012; Di Maggio and Kermani, 2017; Favara and Imbs, 2015; Loutskina and Strahan, 2015; Mian, Sufi and Verner, 2017). Finally, an open question for policymakers is whether investor mortgages should be regulated (see for example Albanesi, Giorgi and Nosal (2017)). Our paper is related to the literature on the effects and efficacy of macroprudential policies (Acharya et al., 2020; Igan and Kang, 2011; Cerutti, Claessens and Laeven, 2017). Our contribution is to provide evidence on the effects of changes in the supply of credit for *investors*. The literature has focused on changes in the supply of credit that affect both investors and owner occupiers (or a subset of investors) or macroprudential policies that were targeted towards owner occupiers. We discuss the relationship between our paper and other papers in the literature in greater detail in Section 6.

We explore the broader macroeconomic implications of our findings by linking them to the theoretical literature. Quantitative models of the housing market differ in their predictions about the the importance of the credit channel in determining house price growth. Authors such as Justiniano, Primiceri and Tambalotti (2019) and Favilukis, Ludvigson and Van Nieuwerburgh (2017) find that changes in credit availability were a key driver of house prices around the Great Recession.[3] In contrast, Kaplan, Mitman and Violante (2020) and Kiyotaki, Michaelides and Nikolov (2011) find that changes in credit have little effect on house prices. Models where changes in credit have a limited effect on prices are those in which the marginal buyer is an unconstrained investor whose housing valuation is unaffected by changes in credit supply. These models are typically calibrated to match moments from household balance sheet data. Hence, our main finding that a negative shock to investor credit supply has a negative effect on housing prices suggests that inferring the sensitivity of the marginal investor to credit supply from household balance sheet data can be misleading.

In summary, we make three main contributions to the literature. First, we document two policy-induced episodes with sharp and large reductions in *investor* lending supply. Second, we construct a novel measure of investor participation in the housing market which includes investors who purchase a property without a mortgage. We use it to show that there is a close correspondence between investor lending and participation in the housing market. Third, we show that reduced investor credit supply lowers housing prices. The sharpness, significance and timing of the effects we estimate provide compelling evidence on the effects of investor credit supply on the housing market.

[3] See also Garriga, Manuelli and Peralta-Alva (2019), Greenwald and Guren (2020), Guren, Krishnamurthy and Mcquade (2021), Landvoigt, Piazzesi and Schneider (2015) and Liu, Wang and Zha (2019).

The remainder of the paper is organized as follows: Section 2 provides background on the macroprudential policies and institutional setting; Section 3 provides a formal analysis of the effect of the macroprudential policies on lending; Section 4 investigates the effect of the lending restrictions on investor participation in the housing market; Section 5 looks at the effect on housing prices; Section 6 relates our findings to the literature and Section 7 concludes. A supplementary appendix contains additional results referred to the in the paper.

2 Macroprudential policy changes

2.1 Background

Australia has a national banking market. Legislation governing the banking sector is set by the federal government.[4] The Australian Prudential Regulation Authority (APRA) is responsible for prudential regulation and banking supervision. APRA has strong statutory powers to regulate and intervene in the operations of banks, including the power to revoke a bank's license.

The residential lending market in Australia is dominated by four large banks whose loans account for around 80 percent of total housing credit in Australia (Table A1). Variable interest rate loans account for around 80 percent of new housing loans in Australia. The most common home loan maturity is 25 to 30 years (Stewart, Robertson and Heath, 2013).

2.2 Description of regulatory changes

We study two macroprudential polices introduced by APRA affecting mortgage lending by banks. The first policy, introduced in December 2014, capped six-month annualized investor credit growth for any individual bank at 10 percent. The second policy, introduced in March 2017, restricted the share of interest-only loans to be less than 30 percent of an individual bank's new lending. Both policy changes were unanticipated and took effect soon after they were announced.[5] These

[4]This includes laws governing foreclosures.

[5]The first policy change was announced on 9 December 2014 and came into effect on 1 January 2015. The second policy change was announced on 31 March 2017 and immediately came into effect. See (APRA, 2014) and (APRA, 2017).

regulations were introduced during a period in which APRA viewed investor credit growth as being strong (APRA, 2019). APRA was concerned about the systemic risk posed by strong growth in investor lending. In an information paper discussing its prudential measures APRA (2019, pp 7-11, 16) noted:

> "In this environment of rising household debt, APRA observed a loosening of mortgage lending standards as lenders competed for market share…The more significant risks appeared to be the unprecedented share of interest-only lending and loans for potentially speculative investment purposes, and that low interest rates in conjunction with lending methodologies were allowing larger loans to be extended relative to a borrower's income."

and more specifically on interest-only loans:

> "The high level of interest-only lending was a particular concern in an environment of rising household indebtedness, modest wage growth and with the prospect of interest-rate rises at some point in the future, which could leave these borrowers particularly exposed ... In addition, interest-only borrowers may face 'repayment shock' when interest-only periods expire and higher principal and interest payments begin... This repayment shock is largest when interest rates are low, as they are currently in Australia."

These macroprudential policies were designed to provide a "brake on growth in forms of lending that were contributing most to systemic risk" (APRA, 2019, p. 10). Banks who did not comply with the investor lending and interest-only caps would face more intense supervisory action by APRA, including being subject to higher capital requirements (see APRA (2014) and APRA (2017)).

The first policy did not change regulations affecting lending to owner occupiers, providing a clear reduction in credit supply to investors relative to owner occupiers. The second policy affected interest-only lending to both owner occupiers and investors. Investor credit growth declined relative to owner-occupier credit growth following the second policy because interest-only lending comprised a much larger share of total lending for investors than owner occupiers

Mortgage interest payments on investor loans are tax deductible. While some investors may have taken out interest-only rather than principal and interest loans for tax minimization purposes, APRA assessed the unprecedented level of interest-only lending prior to the cap to be a reflection of speculative housing investment rather than tax planning (APRA, 2019).[6] Supporting this, even before the rise in interest-only lending in the mid-2010s, arrears rates had been persistently higher for interest-only compared with principal and interest housing investor loans, which is inconsistent with interest-only loans being used primarily by wealthy investors for tax planning purposes (RBA, 2006).

2.3 Evidence from aggregate data

To measure changes in the supply of credit to investors and owner occupiers, we use data on the value of new loan approvals, equivalent to originations in the United States. This data shows the flow of new borrowed funds used to purchase dwellings. Loan approvals are dated when housing ownership changes and hence show the amount of borrowed funds that go directly to purchase a dwelling in a given quarter.[7] The advantage of new loan approvals data is that it abstracts from changes in the repayment behavior of a bank's existing borrowers and the reclassification of existing loans. When issuing new loans following the first policy, banks used credit reports matched with a borrower's mailing address to verify whether borrowers were owner occupiers or investors. Increased scrutiny by APRA provided banks with an incentive to correctly classify new borrowers. The easiest way for a bank to reduce investor credit growth below the cap was through changing the amount of new investor loans that it wrote.

[6]The tax benefits of an interest-only loan relative to a principal and interest loan are modest because the typical interest-only loan reverts to principal and interest payments after 5 years (Kent, 2018).

[7]Note, although the first macroprudential policy placed restrictions on bank level investor credit growth, credit statistics were affected by a reclassification of existing investor loans to owner-occupier loans after the first policy (Figure 1a). Banks raised interest rates on investor loans relative to owner-occupier loans following the introduction of the first policy, providing borrowers with an incentive to reclassify existing investor loans as owner-occupier loans (Garvin, Kearney and Rose, 2021). This occurred for example, where a borrower was now living in a property they had previously rented. Banks did not require existing borrowers to make a new loan application to switch their loan type (Garvin, Kearney and Rose, 2021). APRA abstracted from the reclassification of loan type when it applied the 10 per cent cap on investor credit growth (APRA, 2019).

Prior to the introduction of the cap on investor credit growth in December 2014, aggregate investor credit growth was a little above 10 percent on a six month annualized basis (Figure 1a). Figure 2 shows the value of new loan approvals to both owner-occupiers and investors, broken down by principal and interest and interest-only loans. Growth in new lending to investors initially slowed only slightly after the announcement of the investor cap. APRA allowed for a "soft" introduction of the cap, as many lenders found it difficult initially to reduce investor credit growth (APRA, 2019). Banks reported needing time to improve their systems to implement the policy (Garvin, Kearney and Rose, 2021). In mid 2015 lenders tightened lending standards and increased interest rates on investor loans.[8] Interest rates on investor loans were increased by around 25 basis points relative to owner-occupier principal and interest home loans (Figure 1b). Prior to this, lenders charged the same interest rates on owner-occupier and investor loans and for interest-only and principal and interest loans.[9] Following this, there was a sharp fall in new investor lending: the value of new lending to investors fell by close to 50 percent on a six-month annualized basis in the December quarter 2015. Reduced interest-only lending explains almost all of the decline in investor lending. During the same period, lending to owner occupiers continued to increase. Though, the steep falls in new lending to investors was temporary; there was a partial rebound in investor lending in 2016, but it still remained 9 percent below its previous peak at the end of 2016.

Figure 3 shows the share of interest-only loans in *new* lending. Prior to the introduction of the cap on interest-only lending in March 2017, the aggregate share of interest-only loans in new loan approvals was around 35 percent. By mid 2017, its share had fallen to 15 percent of new lending and it remained around that level. This was a result of banks reducing the supply of interest-only loans and raising interest rates on interest-only loans relative to principal and interest loans (Figure 1b). While interest rates rose on both owner-occupier and investor interest-only loans, interest rates rose by more for investor loans. Following the second policy, there was a sharp fall in new interest-only lending to both owner-occupiers and investors (Figure 2). For owner occupiers, the fall in new

[8]By mid 2015, banks were treating the 10 per cent investor cap as a hard limit on lending (Garvin, Kearney and Rose, 2021).

[9]Lenders did differentiate their interest rates based on other factors, such as loan size.

interest-only lending was offset by increases in principal and interest lending, leading to an overall initial increase in the value of new loan approvals to owner occupiers. For investors, the increase in principal and interest lending was not enough to offset the fall in interest-only lending. There was an extended fall in lending to investors; interest-only lending to investors continued to fall two years after the policy came into effect. This indicates that a large fraction of prospective investor borrowers were unable to substitute from interest-only to principal and interest loans. Required repayments are 30 to 40 per cent higher on a representative principal and interest loan than on an equivalent interest-only loan (Kent, 2018). The net effect of the second policy was a large decline in new lending to investors relative to new lending to owner occupiers.

A surprising feature of the decline in investor lending following the first policy is that it fell well below the 10 percent cap set by APRA, despite a number of banks initially being constrained by this cap. This is because banks could not easily fine tune credit growth to be within a narrow band under the cap (RBA, 2018). Accordingly, banks reduced credit growth to be well below the cap to ensure that they did not breach the cap and trigger more intense supervisory action by APRA. Similarly, following the second policy, the share of interest-only loans in new lending fell below the 30 percent cap. This also reflects banks facing difficulty targeting interest-only loan volume close to the cap. Furthermore, around the same time as the interest-only lending cap was introduced, APRA announced future increases in capital requirements for new and existing investor and interest-only loans, which may have influenced banks to further reduce supply of this type of lending (RBA, 2018).

3 Effect of macroprudential policies on lending

This section uses bank-level data to formally analyze the effect of the macroprudential policies on housing investor lending relative to owner-occupier lending. Data for the period from the March quarter 2009 to the December quarter 2018 are sourced from APRA.

3.1 Regression analysis

We use the following regression to estimate the effect of the macroprudential policies on investor lending relative to owner-occupier lending at the bank level:

$$\Delta log(lending_{i,j,t}) = \alpha_{i,t} + \Sigma_t \beta_t (\mathbb{1}(j = investor) \times d_t) + \varepsilon_{i,j,t} \quad (1)$$

where $\Delta log(lending_{i,j,t})$ is the quarterly log difference of the value of new lending for bank i of loan type $j \in \{investor, owner\ occupier\}$ at time t, $\alpha_{i,t}$ is a bank $\times$ time fixed effect, d_t is a time dummy and $\mathbb{1}(j = investor)$ is an indicator function that is equal to one if $j = investor$. The $\alpha_{i,t}$ fixed effects capture all variation in lending growth that is common within a bank in a given time period, such as changes in a bank's funding arrangements, market share or seasonality. The coefficients of interest are β_t, which indicate the increase in investor lending relative to owner-occupier lending. The omitted category in the regression is the December quarter 2014, when the first macroprudential policy was introduced, so all estimated β_t-coefficients are relative to that period. We use weighted least-squares, with weights equal to total housing loans of bank i in 2014. Standard errors are clustered at the bank level. Figure 4 presents the estimated β_t-coefficients, with the dashed lines showing two standard error confidence bands. Growth in new investor lending relative to owner-occupier lending fell sharply two quarters after the introduction of the investor credit growth cap. Within a year of the introduction of the first policy, growth in the value of new lending to investors relative to owner occupiers halved. This was followed by a pick-up in investor lending growth relative to owner-occupier lending growth until the imposition of the second macroprudential policy in March 2017. The second policy, restricting interest-only lending, caused an approximately 20 percentage point decline in the growth of new lending to investors relative to owner occupiers in its first year. Investor lending growth declined relative to owner-occupier lending growth because in the year prior to the policy interest-only loans comprised 63 percent of investor lending but only 24 percent of owner-occupier lending, with there being incomplete substitution from interest-only to principal and interest loans for investors. Results are similar when restricting the sample to the largest four banks.

Overall, both macroprudential policies led to falls in the value of new lending to investors relative to owner occupiers. The first policy led to a sharp drop in new lending to investors relative to owner occupiers within a year. However, the sharp fall in investor credit growth was temporary. New lending growth to investors relative to owner occupiers picked up during 2016, though it was still 25 percentage points lower at the end of 2016 compared to the period prior to the first macroprudential policy coming into effect. Although the second macroprudential policy caused a smaller immediate fall in lending to investors relative to owners occupiers, its effects were longer lasting. Lending to investors relative to owner occupiers continued to decline two years after the second policy came into effect. This suggests that the inability of investors to substitute from interest-only to principal and interest loans had persistent effects on the ability of investors to obtain financing.

3.2 Credit reallocation

The first macroprudential policy did not place any restrictions on owner-occupier lending. One concern to our identification approach would be that the first policy caused banks to reallocate lending from investors to owner-occupiers, implying that a reduction in prices of investor housing *relative* to owner-occupier housing could result in part from a relaxation in credit supply to owner-occupiers which increased the price of owner-occupied housing. However, we find little evidence that banks sought to reallocate lending from investors to owner occupiers. Banks did not lower interest rates or reduce lending standards for owner occupiers relative to investors. Interest rates on owner-occupier principal and interest loans moved in line with changes in the central bank policy rate (Figure A1a). There was no change in the share of new owner-occupier home loans given to risky borrowers, classified as those with a loan to valuation ratio above 80 percent (Figure A1b).

We find further evidence that banks did not seek to reallocate lending from investors to owner occupiers by comparing the lending behavior of banks constrained by the cap on investor credit growth relative to banks there were unconstrained (see Appendix A). Here we focus on total credit as this allows us to identify the banks constrained by the investor credit growth cap.[10] Any reclassification of existing loans from investor to owner occupier will not affect the overall level of credit for a given bank. Total credit growth for banks constrained by the investor credit growth cap fell relative to those banks who were not constrained by the cap (Figure A2). In the second half of 2015 — the period with the steepest declines in investor credit growth — total credit growth for constrained banks was around 4 percentage points lower than that of unconstrained banks (compared with total credit growth that was on average 1 percentage point lower for the constrained banks in the four years prior to the policy being introduced). Overall, the lower credit growth for banks constrained by the investor lending cap, relative to those banks that were unconstrained, indicates that constrained banks did seek to not reallocate credit from investors to owner occupiers.

The second policy provided no manipulation opportunity because the restriction on interest-only lending applied to investor and owner-occupier loans.

4 The effect on investor participation

We now study how the sharp decline in lending to investors relative to owner occupiers influenced investor participation in the housing market.

4.1 Data

We use unit record data on property sales and listings, supplied by the Rozetta Institute on behalf of CoreLogic. The *sales* database is an administrative record of all capital city residential property transfers. There are eight capital cities in Australia, comprising around 70 percent of the total population (Australian Bureau of Statistics, 2020). The sales database includes information on the property location, land area, sale price, contract date and settlement date. The median time from signing of a contract of sale to settlement is two months.[11]

The *listings* database comprises capital city sale and rental advertisements. It is compiled by

[10] Our data on new lending does not allow us to identify individual banks, so we cannot match banks who were constrained in terms of the investor credit growth cap in the credit data to that in the new lending data.

[11] Either the contract or settlement date is missing for some records for Adelaide, Darwin, Hobart and Perth. We impute the missing dates using the median time of two months between contract and settlement.

CoreLogic from property listing websites and real estate agents. The listings database records the date a listing was first advertised (campaign start date) and characteristics of the advertised property. The property characteristics we use are property type (house/apartment), land area, number of bedrooms and number of bathrooms.

We match advertisements for sale in the listings database that resulted in a sale to properties in the sales database by a unique identifier. The share of all sold properties that were advertised for sale in the listings database has trended up over time and been more than 60 percent since 2008 (Figure A3). It has exceeded 50 percent in each capital city since 2009. The subset of sold properties in the listings database is broadly representative of all sold properties in terms of price and land area, with the dataset becoming more representative over time as coverage of the listings database has increased (Table A2). We restrict our analysis to properties advertised in the listings database in order to make use of detailed property characteristics that are only available in the listings database. Our dataset contains around 2.5 million property sales over the period from 2007 to 2020.

We do not have information on private and corporate ownership of residential property. However, we infer from household survey data that the vast majority of residential investment property is privately owned. In the 2015-16 financial year, at least 2.548 million residential properties were owned by households out of a stock of 2.678m rented dwellings reported in the 2016 Census (Australian Bureau of Statistics, 2017).[12] This indicates that 95 percent of rented dwellings are privately owned, which is likely to be a lower bound because the survey data top code ownership of investor property at four dwellings.[13]

[12]On Census night 11.2 percent of dwellings were unoccupied. We have assumed 11.3 percent of unoccupied dwellings are available for rent, and therefore investor owned, equal to the proportion from the 1986 Census, the most recent to record the reason dwellings are unoccupied.

[13]Tax data indicate that for the 2015-16 financial year 3.050 million individuals directly owned an investment property, which more than accounts for the stock of the privately rented dwellings (Australian Taxation Office, 2019). However, tax data include commercial property owned by households and double count joint ownership.

4.2 Identifying investors

We construct a measure of investor participation in the housing market over time. For each sold property, we classify it as being purchased by an investor if a rental listing appears in the listings database within 6 months of the property settlement date. This is a useful measure of investor purchases because it shows the clear intention of a buyer to rent out, rather than occupy, a recently purchased property. Other measures of investor purchases, discussed below, need to infer whether the buyer is an investor or owner occupier.

Our measure, however, does have two potential limitations. First, not all rental listings will appear in the listings database. Unlike sold properties, there is no administrative dataset of all new rental listings that can be matched to property sales, and therefore would enable us to measure the rental coverage of the listings database. Second, we may miss investor-to-investor property sales for which there is a continuing tenant, and therefore no rental listing post sale. However, investor-to-investor property sales with a continuing tenant are likely to be small. Data from the largest state indicates that the median time a property is rented for is 1.3 years, with two-thirds of properties being rented for less than 2 years. In later sensitivity analysis we show that our results are robust to using a longer window for rental listings to appear. Further, restricting the sample of sold properties to those not listed for rent in the previous 4 years, and therefore less likely to be investor owned, results in a very similar profile of investor participation to our baseline measure. Both of these limitations cause our measure to understate of the share of investor property purchases. This does not matter for our purposes provided the degree of understatement does not vary systematically with lending supply. As we show below, the similarity of our measure of investor participation with the loan approvals data indicates this is not the case.

Our measure of investor participation is novel.[14] The literature has measured investor presence in the housing market using: (i) mortgage data (Bhutta, 2015; Gao, Sockin and Xiong, 2020; Mian and Sufi, 2022), or (ii) by comparing a buyer's mailing address to the address of the purchased property (Chinco and Mayer, 2016).

[14] We know of only one paper that uses this measure; Bracke (2021) whose work is contemporaneous to ours.

Identifying investors based on mortgage data omits a likely non-trivial share of investors who do not take out a mortgage. In Australia, household balance sheet data indicates that investors are less financially constrained than owner occupiers; investors have higher incomes, assets and net worth (including and excluding property) across nearly all percentiles of the income and wealth distribution (Table A3). For the United States, DeFusco, Nathanson and Zwick (2017) find that 38 per cent of non-occupant buyers do not require a mortgage to purchase a property. This compares with 20 per cent of all property purchases not requiring a mortgage. This figure is similar for Australia, though no breakdown is available separately for owner occupiers and investors (Australian Bureau of Statistics, 2017). However, given that investors are wealthier than owner-occupiers we would expect the share to be higher for investors. For the United Kingdom, Bracke (2021) finds that 47 per cent of investor property purchases do not require a mortgage. Including these financially unconstrained buyers is important here to assess the effects of restrictions on investor credit supply on investor activity. Mortgage based measures would overstate the effects of restrictions on credit on investor activity as it ignores investors who are unaffected by changes in the supply of credit. Our classification allows us to capture investor property purchases with and without a mortgage.

In addition, quantitative macroeconomic models, discussed in more detail in Section 6.2, differ in their predictions about the importance of the credit channel for the housing market. Models in which changes in credit have a limited effect on prices have a marginal buyer who is an unconstrained investor who is unaffected by changes in the supply of credit. Hence our measure of investor activity - which includes both financially constrained and unconstrained investors - can empirically test whether changes in the supply of credit matter for investor activity and house price growth if a non-trivial segment of the market is financially unconstrained.

We view the second approach of classifying a buyer as an investor if the buyer's mailing address is different from that of the purchased property, as being complementary to ours. This approach will, however, misclassify investors as being owner occupiers if they use the purchased property's address for tax collection purposes. Similarly, owner-occupiers would be misclassified as investors if owner-occupier buyers used the mailing address of their lawyer or accountant. A difficulty of implementing this approach is that it requires researchers to be able to access buyer's mailing addresses. For most locations, this data is not publicly available.[15] Our use of sale and rental listings data does not require the use of any personal information about the buyer.

4.3 Investor participation

We have shown in Section 3 that the macroprudential policies caused a sharp relative contraction in lending supply to investors. If housing investors are borrowing constrained then we expect the macroprudential policies to have reduced the share of properties purchased by investors.

Figure 5 shows the share of sold properties purchased by investors in each quarter together with the investor share of the value of new lending.[16] There is a close correspondence between changes in the two series: the correlation coefficient is 0.75. Following the introduction of both macroprudential policies, falls in the investor share of new lending were matched by a decline in the share of properties purchased by investors. Despite a non-trivial fraction of investors not requiring a mortgage, the fact that investor participation declined following each policy tell us that the marginal housing investor is constrained by credit supply. If investors were unconstrained, the macroprudential polices would not have affected the investor share of property purchases.

Note following the first policy, the decline in the investor share of new lending was large relative to the decline in participation in the housing market. This could reflect the fact that while investor lending fell sharply following the first policy, there was a pick-up in investor lending a year after the policy was introduced. For the second policy we see declines in investor participation consistent with the continued falls in the investor share of new lending. This provides evidence that the inability of investors to substitute from interest-only to principal and interest loans reduced investor participation in the housing market.

Our measure of investor participation is robust to classifying a property as being purchased by an investor if a rental listing appears within shorter (3 month) or longer (12 or 18 month)

[15] An exception is the United States.

[16] We do not have data on the number of new loans by investor and owner occupier prior to 2019. However, since 2019 the investor share of lending finance by value and number of loans is almost the same.

periods than the 6-month window for our baseline definition (Figure A4). In all cases there is close correspondence between the investor share of property purchases and the investor share of new lending finance.

5 The effect on property prices

We have shown that a decline in lending supply to investors negatively affected investor participation in the housing market. Here we look at what effect this had on prices.

5.1 Identification

Our identification of the effect of the lending restrictions on housing prices relies on there being partial segmentation between investor and owner-occupier owned properties. This assumption is supported by the literature: there is limited evidence of arbitrage between rental and owner-occupied dwellings (Glaeser and Gyourko, 2007), distinct property characteristics (Halket, Nesheim and Oswald, 2020), and limited tenure status flows between renting and owning (Bachmann and Cooper, 2014).

We compare properties with characteristics associated with a high investor share (higher treatment intensity) relative to properties with characteristics associated with a high owner-occupier share (lower treatment intensity). If investors are constrained by the availability of credit then we expect a relative reduction in the supply of credit to investors to cause a relative reduction in prices for properties more likely to be purchased by investors. Partial segmentation implies owner-occupier demand will not fully adjust to eliminate price differences.

There are the distinct differences in both property characteristics and the geographic location of the property purchases of owner occupiers versus investors. Investors are more likely to purchase apartments than houses and to purchase dwellings with fewer bedrooms and bathrooms (Table A4). By geography, the mean investor purchase share is 24 percent in the top 10 Local Government Areas (LGAs), compared with 5 percent for the bottom 10 LGAs (Table A5). These differences support our assumption of partial segmentation of investor activity in the housing market.

More formally, we identify the set of property characteristics most closely associated with investor ownership by estimating the linear probability model

$$inv_i = \alpha_j + \sum_k \gamma_{j,k} X_{i,k} + \varepsilon_i \tag{2}$$

on sold properties over the period 2013Q1-2014Q4, prior to the introduction of the first policy, where inv_i is a binary variable taking the value one if property i was purchased by an investor (using the measure constructed in Section 4.2), α_j is a fixed effect for capital city j in which property i is located, $X_{i,k}$ is characteristic k for property i and ε_i is an error term. The included property characteristics are location (local government area), type (house or apartment), number of bedrooms (categorical), number of bathrooms (categorical), land area and land area squared.

Property characteristics have significant explanatory power for investor purchase propensity. The mean investor purchase propensity for the top quartile of $\widehat{inv_i}$ is 24 percent, compared with 5 percent for the bottom quartile of $\widehat{inv_i}$.

5.2 Prices

This section looks at the effect of a decline in investor participation on housing prices. We do this using variation in housing prices across percentiles of the investor purchase propensity $(\widehat{inv_i})$. Specifically, we estimate the equation

$$p_{i,j,t} = \alpha_j + \sum_{j,k} \gamma_{j,k} X_{i,k} + \sum_{j,t} \delta_{j,t} d_t + \phi_0 \cdot \widehat{inv_i} + \phi_1 \cdot t \cdot \widehat{inv_i} + \sum_{t=20010Q1, t \neq t_0}^{2020Q4} \beta_t \left(d_t \times \widehat{inv_i} \right) + \varepsilon_{i,j,t} \tag{3}$$

where $p_{i,j,t}$ is the log sale price of property i in capital city j at time t, α_j is a fixed effect for capital city j in which property i is located, $X_{i,k}$ is characteristic k for property i (zip code, dwelling type, categorical number of bedrooms, categorical number of bathrooms, land area and land area squared), d_t is a dummy variable taking the value one in period t, $\widehat{inv_i}$ is the investor purchase propensity for property i estimated in Equation (2), and $\varepsilon_{i,j,t}$ is an error term. The terms $\alpha_j + \sum_k \gamma_{j,k} X_{i,k}$ absorb the city-specific time-invariant effect of property characteristics on prices and $\sum_{j,t} \delta_{j,t} d_t$ is a set of time fixed effects for each capital city. The terms $\phi_0 \cdot \widehat{inv_i}$ and $\phi_1 \cdot t \cdot \widehat{inv_i}$ absorb variation in the level and mean growth rate of prices across percentiles of $\widehat{inv_i}$ and capture different price trends across percentiles of $\widehat{inv}_i$. The coefficients of interest are β_t, indicating the relationship in period t between percentiles of investor purchase propensity and housing prices. The omitted category is 2014Q4, when the first macroprudential policy was announced, so all estimated β_t-coefficients are relative to that period. Equation (3) is estimated at a quarterly frequency over the period 2007-2020. Standard errors are clustered at the LGA level and computed using 400 bootstrap repetitions to account for the use of the generated regressor $\widehat{inv}_i$.[17]

Figure 6a plots the β_t coefficients relative to the announcement of the first policy ($t_0 = 2014Q4$). The magnitude of the β_t coefficients can be interpreted as follows. Moving from the bottom to the top quartile of $\widehat{inv}_i$ increases the mean probability an investor purchases a property by about 0.2. Thus, a β_t coefficient of -0.5 indicates that moving from the bottom to the top quartile of $\widehat{inv}_i$ was associated with approximately 10 percent lower price growth (-0.5×0.2) relative to 2014Q4.

The β_t coefficients are close to zero over the 5 years prior to the first macroprudential policy, providing evidence of no pre-trend. The coefficients start trending down from the second half of 2015, consistent with the weakening in investor credit growth and participation. There was a statistically significant fall in the β_t coefficients in 2015Q4. This is two quarters after the implementation of the first macroprudential policy in 2015Q2 and one quarter after the effect of the first macroprudential policy on lending (Figure 4). The absence of a pre-trend and the statistically significant decline in the β_t coefficients occurring immediately after the fall in credit provides evidence that the first policy restricting investor credit supply reduced property prices. Our point estimates indicate that within two years of the first policy coming into effect that moving from the bottom to the top quartile of $\widehat{inv}_i$ was associated with 3 per cent lower price growth relative to 2014Q4.

Following the second policy, there was a further and larger decline in the β_t coefficients.[18] Our point estimates indicate that two years after the second policy came into effect, that moving from the bottom to the top quartile of $\widehat{inv}_i$ was associated with 10 percent lower price growth compared to 2017Q1. The larger effect on prices from the second policy is consistent with investor

[17] Bootstrap resampling is done with replacement at the LGA level.

[18] Figure A5 shows β_t coefficients from Equation (3) relative to the introduction of the second policy in 2017Q1.

participation in the property market declining by more following the second policy (Figure 5). Cumulatively by the end of 2018 – 4 years after the implementation of the first policy and 2 years after the second – our point estimates indicate that both policies led to price growth being 13 per cent lower in the top quartile of $\widehat{inv_i}$ compared to the bottom quartile relative to the period before the first macroprudential policy was implemented. Given that new lending growth to investors relative to owner occupiers halved during this period, a back of the envelope calculation indicates that a one percentage percentage point fall in the value of new lending to investors is associated with an approximately 0.25 percentage point fall in the price of housing more likely to be owned by investors.

To more clearly see variation in the β_t coefficients, Figure 6b shows quarter-to-quarter changes in β_t. To reduce noise, a three-quarter moving average is overlaid on the quarter-to-quarter changes $\Delta\beta_t$. Standard errors are computed for the three-quarter moving average of $\Delta\beta_t$ using the simulated data from 400 bootstrap repetitions of Equations (2) and (3). Consistent with the discussion of Figure 6a, there is statistically significant evidence of a decline in relative price growth for high investor propensity property types in the second half of 2015, coinciding with the trough in new investor lending following the first policy (Figure 4). Relative prices for high investor propensity property types began to decline after the introduction of the second policy, and one quarter after the peak in investor participation (Figures 5 and 6b).

Robustness.—The baseline results use a linear probability model to estimate investor purchase propensity based on dwelling characteristics (Equation 2). The results are robust to using a Probit rather than linear probability model (Figure A6). To check sensitivity of the model to in-sample over-fitting of property characteristics, we re-estimate Equation (2) using Ridge and LASSO estimators with 10-fold cross-validation for the tuning parameter. Results using the Ridge and LASSO estimators are almost identical to the baseline results (Figure A6).

5.3 Non-price indicators of market strength

We provide validation for our results by examining non-price housing market indicators. These show weakness in those segments of the market where investors were most active following each macroprudential policy.

Periods of weak property price growth are typically associated with longer mean time-to-sale and a lower clearance rate which measures the share of listings that result in a sale (Genesove and Hansen, 2020). We compare the mean time to sale and the share of listings selling within 6 months of the campaign start date (first listing date) for the top and bottom quartiles of investor purchase propensity. Since 2010, the mean time from first listing to signing of a contract of sale is $2\frac{1}{2}$ months. Following the first policy, there was an immediate rise in mean time-to-sale for properties with a high relative to low investor purchase propensity (Figure 7a). There was also a sharp drop in the share of sale listings sold within 6 months of first listing (Figure 7b). Similarly, following the second policy, there was an increase in mean time-to-sale and a decrease in the share of properties sold within 6 months for the top relative to the bottom quartile of investor purchase propensity (Figures 7a and 7b). Note that the effects appear to break about one quarter prior to the implementation of the policies. This is because time is measured relative to the campaign start date. With a mean time-to-sale of $2\frac{1}{2}$ months, we expect the policies to affect listings appearing from around one quarter prior to implementation, as is evident in Figures 7a and 7b. The sharp movement of these non-price indicators in response to both policies provides clear evidence that the reductions in credit supply to investors weakened demand in those segments of the market where investors were the most active.

We can also examine the supply of the properties offered for sale in those segments of the market where investors are more active. We find a modest decline in relative listing volume in high investor propensity segments of the market, indicating that some owners may have decided not to attempt a sale in the face of lower prices (Figure A7).[19] The fact that we find a relative fall in

[19]The decline in relative listing volume could also reflect a shift to off market sales (i.e. those sales that are not listed on real estate websites). This is also consistent with a weaker market because listing volume is pro-cyclical.

prices in those segments of the market dominated by investors suggests that the relative decline in the supply of investor properties was not enough to offset the fall in demand for investor properties induced by reduced lending to investors.

5.4 State level analysis

Our baseline analysis uses variation in investor purchase propensity across property characteristics within cities to estimate the effect of lending restrictions on housing prices. This section provides supplementary evidence using state-level variation in housing lending and prices.

Data.— We measure state level lending as the dollar value of new residential loans (excluding refinancing) to owner-occupiers and investors, by state, from the Australian Bureau of Statistics (ABS) publication *Lending Indicators* (Australian Bureau of Statistics, 2022*a*). We measure housing prices using index values for capital cities in Australia, from the ABS publication *Residential Property Price Indexes: Eight Capital Cities* (Australian Bureau of Statistics, 2022*b*). While the lending data are for states and the housing price data cover only capital cities, around 70 per cent of the population lives in the capital cities.

Effect on prices.—Prior to each macroprudential policy being introduced, there was substantial variation across states in the investor share of housing lending: there was around a 25 percentage point difference in the investor share between the state with the highest and lowest investor share (Table 1). The macroprudential policies caused a relatively large reduction in lending to investors in states in which the investor-lending share was initially high. The correlation between the investor share of new lending prior to these macroprudential policies coming into effect and the change in the investor share of new lending after these policies came into effect are -0.69 and -0.71 for the first and second policy respectively (Table 1). Assuming segmentation of housing markets across states, we look for evidence of a relative decline in housing prices in states where the investor-share of lending was high prior to each macroprudential policy.

We estimate the regression:

$$\Delta^4 log\left(p_{j,t}\right) = \alpha_j + \delta_t + \sum_{t=2010Q1, t\neq t_0}^{2019Q4} \beta_t \left(d_t \times investor_{j,t_0}\right) + \varepsilon_{j,t}, \quad (4)$$

where $p_{j,t}$ is the price index for housing in state j at time t, α_j is a state fixed effect, δ_t is a time fixed effect, d_t is a dummy equal to one at time t, $investor_{j,t_0}$ is the investor-share of housing lending in state j at time t_0 and $\varepsilon_{j,t}$ is an error term. The coefficients of interest are β_t, indicating the relationship between prices at time t and the investor share at time t_0. We estimate the equation separately using the investor share of lending prior to each macroprudential policy ($t_0 = 2014Q4$ for the first policy and $t_0 = 2017Q1$ for the second policy). We look at growth rather than the level of housing prices to remove trends in the data and use annual growth, $\Delta^4 log\left(p_{j,t}\right)$, to smooth out variation in the quarterly data. The total value of investor lending by state is used as regression weights and standard errors are clustered at the state level.

Figure 8a shows the β_t coefficients relative to the announcement of the first policy and Figure 8b relative to the introduction of the second policy. Following the implementation of both policies, there was a substantial and statistically significant relative decline in the price of housing in states with an initially high investor share of lending. For the first policy, we find that moving from the state with the lowest share to the highest share of investor lending would have reduced annual housing price growth by around 12 per cent a year after the fall in lending started. For the second policy, annual housing price growth was 26 percent lower, two years after the policy came into effect. These results support the findings from the baseline analysis. However, unlike the baseline analysis, the state-level analysis shows evidence of a partial rebound in prices in states with a higher investor share of lending prior to the second policy. This is consistent with the loan approvals data.

Expectations.—Some papers in the literature argue that expectations rather than credit supply are central to housing price cycles (Kaplan, Mitman and Violante 2020). To rule out that movements in housing price expectations prior to the macroprudential policies confound our analysis, we examine survey data on housing prices expectations from the Melbourne Institute Consumer Attitudes, Sentiments and Expectations Survey. The survey is a nationally representative sample of approximately 1,200 households per month. The question we use asks respondents "With respect to house prices in your state, over the next 12 months do you expect prices to: rise by over 10 percent, rise by 0-10 percent, stay the same, fall by 0-10 percent or fall by over 10 percent." We aggregate the individual response data to the state-by-quarter level.

Analogous to Equation (4) above for prices, we estimate the regression

$$rise_{j,t} = \alpha_j + \delta_t + \sum_{t=2010Q1, t \neq t_0}^{2019Q4} \beta_t \left(d_t \times investor_{j,t_0} \right) + \sum_{k=1}^{12} \gamma_k \Delta log \left(p_{t-k} \right) + \varepsilon_{j,t}, \tag{5}$$

where $rise_{j,t}$ is the share of survey respondents in state j at time t expecting house prices to rise, and the other terms are as defined for Equation (4). For simplicity, we re-coded the categorical survey variable to the share of people expecting prices to rise. This has little effect on the results because more than 70 percent of reported expectations are either unchanged prices or a rise in prices of 0-10 percent.[20] The number of survey responses by state-quarter is used as regression weights and standard errors are clustered at the state level.

We first estimate Equation (5) without lagged growth in housing prices as a control variable. The estimated β_t coefficients, relative to the first policy, are shown in Figure 9a. Prior to the first policy, there was no significant difference in housing price expectations across states. Thus, the movement in prices we estimate were not caused by shifts in housing price expectations prior to the first policy. This is important because in the literature it has been difficult to identify movements in credit supply independent of shifts in expectations. Following the first policy, housing price expectations moved together with prices (Figures 8a and 9a). This is consistent with people having backward-looking (adaptive) housing price expectations.

Estimating Equation (5) including lagged housing price growth allows us to see whether expectations moved more or less than would be expected based on the historical relationship between expectations and *past* price growth.[21] Figure 8b shows the β_t coefficients relative to the first policy. Conditional on past price growth, housing price expectations were broadly unchanged, except for the second half of 2015 and toward the end of the sample. This indicates that, other than these periods, housing price expectations did not move by significantly more than would be expected based on past housing price growth. This provides further evidence that expectations did not move in a confounding manner prior or following either policy.

[20] We have experimented with alternative coding of the categorical survey data and the results are similar.

[21] The coefficients on lagged housing price growth, γ_k, in Equation (5) are estimated to be large and highly statistically significant.

5.5 Discussion

Our results demonstrate a causal chain of transmission from investor credit supply to investor participation and housing prices. Both macroprudential policies substantially reduced credit supply to investors. The value of new lending to investors relative to owner-occupiers fell by 50 percent within a year of the first policy being introduced and by 20 percent within a year of the second policy being introduced. These effects are sharp and large relative to the literature. The first policy affected only investor lending, providing clear evidence on the effect of investor credit supply on the housing market. The second policy restricted interest-only lending. Incomplete substitution from interest-only to principal and interest loans indicates that higher required repayments on principal and interest loans deterred many prospective borrowers. New investor lending fell relative to new owner-occupier lending because the share of interest-only lending was much larger for investors than owner-occupiers (Figure 2).

We use unit record data to identify investor participation in the housing market. We classify a property as being bought by an investor if it is listed for rent within 6 months of being sold. We find that falls in investor credit supply reduced investor participation in the housing market within 3 months of each policy being introduced. This shows that the marginal housing investor is constrained by the supply of credit. The ability to show the effect of changes in credit supply on investor participation is a key contribution of this paper. The existing literature has largely relied on credit data to measure investor activity (e.g. Bhutta, 2015), which ignores unleveraged investors. This distinction is important because some researcher argue that debt-free investors are quantitatively important (see Section 6.2).

The fall in investor participation following each policy caused an immediate rise in the mean time to sale for properties in the top quartile of investor purchase propensity relative to those in the bottom quartile of investor purchase propensity; there was an accompanying fall in the clearance rate (the share of listings selling within 6 months) following each policy. The weakening of these indicators coincident with the policies provides evidence that the reduction in investor participation weakened demand for properties in segments of the market in which investors had been most active.

We have used two distinct identification strategies to estimate the effect of the contractions in investor lending supply and participation on housing prices. The first strategy exploits variation in investor purchase propensity across property types within cities while the second strategy exploits cross-city variation in prices and investor activity. Both identification strategies find significant evidence of price declines following each policy. The magnitude and timing of the movement in prices closely follows that of investor participation. The only exception is following the first policy for the state-level analysis, which shows a more pronounced fall in prices. We found no evidence of confounding movements in housing price growth expectations, giving us confidence that the relative falls in prices we observe are being driven by a relative fall in the supply of credit to investors.

6 Relationship with the literature

6.1 Empirical literature

A growing literature finds that investors played an important role in driving the housing market boom and bust in the United States in the early 2000s (see for example, Albanesi, Giorgi and Nosal, 2017; Bhutta, 2015 and Haughwout et al., 2011). Areas where a greater fraction of dwellings were purchased by investors experienced more amplified housing cycles (Chinco and Mayer, 2016; DeFusco, Nathanson and Zwick, 2017; Gao, Sockin and Xiong, 2020; Mian and Sufi, 2022). However, work on understanding the mechanisms through which investor activity affects the housing market has been more limited, given the difficulty in identifying exogenous variation in investor activity. The benefit of our setting is that we are able to observe a change in policy that directly affected investors and hence we do not need to rely on instruments to identify exogenous changes in investor activity. Gao, Sockin and Xiong (2020) and Nathanson and Zwick (2018) find a role for supply side speculation and overhangs. Bayer et al. (2011), Gao, Sockin and Xiong (2020) and Mian and Sufi (2022) find evidence of optimistic price expectations by investors. Our contribution is to provide casual evidence on how the supply of credit to investors affects the housing market.

It is challenging to identify exogenous changes in credit supply. Our paper contributes to a small literature using quasi-experimental variation to identify the causal effect of credit supply on housing prices. This literature uses variation in credit supply induced by changes in banking regulations (Favara and Imbs, 2015; Di Maggio and Kermani, 2017), by changes in the conforming loan limit (Loutskina and Strahan, 2015; Adelino, Schoar and Severino, 2012) and by exposure to the private label securitization market (Mian and Sufi, 2022). These papers exploit falls in credit that are smaller compared to that used in this paper or changes in the conforming loan limit which affect only a small number of borrowers. The exception is Mian and Sufi (2022), which we discuss in detail below. These papers find a positive relationship between credit supply and house price growth. However, the size of these effects vary. A one percentage point increase in the value of originations is estimated to lead to between a 0.2 to 0.3 percentage point increase in prices (in the case of Favara and Imbs, 2015 and Di Maggio and Kermani, 2017) to around 0.5 percentage point increase in house prices (in the case of Mian and Sufi, 2022). Our estimates of the effects of a reduction in new lending to investors on the price of housing more likely to purchased by investors lies within this range.

Our paper is related to, but distinct from Mian and Sufi (2022), who find for the United States that areas that experienced increases in the supply of credit through the private label secularization market had amplified housing price cycles with increased speculator activity. They argue that differences in beliefs between speculators and the general population are important in explaining their results. Mian and Sufi (2022) analyze a subset of all investors; speculators (e.g. flippers) who comprise no more than 1.3 percent of the stock of loans. In contrast, we study all investors, who account for on average around 36 per cent of total residential lending over our sample period.

Our paper has several strengths relative to Mian and Sufi (2022). We exploit policy-induced variation in the supply of credit to housing investors that was unexpected and implemented soon after announcement. In contrast, Mian and Sufi (2022) rely on the assumption that exposure to private label securitization was exogenous to other factors affecting the housing market. The policy changes we exploit were introduced during a period of relative macroeconomic stability, mitigating the role of adverse shocks affecting our results (see the discussion in Albanesi, Giorgi and Nosal (2017)). Secondly our measure of investor activity includes investors who purchased a property without a mortgage. This is important as a significant fraction of investors do not use debt. Mian and Sufi (2022) use mortgage data to measure investor activity, which likely overstates the effects of changes in credit on investor activity. Thirdly, Mian and Sufi (2022) observe increases in the supply of credit at the same time as speculators reported more optimistic beliefs about prices, making it more challenging to disentangle the effect of beliefs from changes in the supply of credit. In our setting we find no evidence of confounding movements in housing price expectations. Disentangling these effects is important as the quantitative models disagree about the relative importance of credit and beliefs in driving the housing cycle (see the discussion in Section 6.2). Nonetheless, our findings are complementary to Mian and Sufi (2022). In our setting, we are able to show, that despite a significant fraction of investors being debt free, that the marginal investor is credit constrained. Falls in the supply of credit to investors reduce investor participation and price growth for properties more likely to be purchased by an investor.

A related literature looks at the effect of macroprudential policies on housing prices. This literature has focused on the effects of loan-to-income (LTI) and loan-to-value (LTV) restrictions and found that a tightening of these restrictions leads to slower price growth, falls in housing transaction volumes and a decline in expected house price appreciation (see Acharya et al., 2020; Igan and Kang, 2011 ; Johnson, 2020; Armstrong, Skilling and Yao, 2019).

Our contribution relative to the literature is to provide evidence on the effects of a relative tightening in credit supply to *investors*. In contrast, the existing literature studied variation in credit supply that affects both owner occupiers and investors (or a subset of investors) or macroprudential policies that are likely to be relatively more binding for owner-occupiers than investors. Interestingly, our estimates of the effect of changes in the supply of credit on house price growth is similar to that found by the literature that has considered both owner occupiers and investors. The effect of investor credit supply on investor behavior matters because the existence of rental markets is a critical element in quantitative models of the housing market, which we discuss next.

6.2 Quantitative models

Quantitative models of the housing market differ in their predictions about the the importance of credit supply in determining house price growth. Authors such as Justiniano, Primiceri and Tambalotti (2019) and Favilukis, Ludvigson and Van Nieuwerburgh (2017) find that changes in credit availability can have large effects on house prices.[22] In contrast, Kaplan, Mitman and Violante (2020) and Kiyotaki, Michaelides and Nikolov (2011) find that changes in credit have little effect on house prices, with the former arguing that shifts in beliefs play a more important role.

Quantitative models in which house prices are sensitive to changes in the availability of credit typically assume either the absence of a rental market for housing and/or the absence of long-term debt contracts (see Kaplan, Mitman and Violante (2020) for a discussion). In models with a rental market for housing, such as Kaplan, Mitman and Violante (2020) and Kiyotaki, Michaelides and Nikolov (2011), the existence of rental markets means few households are constrained in the amount of housing services they consume. Here the marginal buyer is an unconstrained investor whose housing valuation is equal to the discounted sum of rents, so the price they offer for housing is unaffected by changes in credit supply. Greenwald and Guren (2020) show the sensitivity of house prices to changes in credit depends on the degree of segmentation between the rental and owner-occupier housing.

Papers arguing that housing investors are unconstrained typically do so on the basis of household balance sheet data. For example, Kaplan, Mitman and Violante (2020) calibrate their model using the distribution of net-worth from the U.S. Survey of Consumer Finances. Household survey data in Australia show similar patterns to the U.S. data: investors have higher incomes, assets and net worth than owner occupiers (Table A3). Our results suggest that inferring the sensitivity of the marginal investor to credit supply from household balance sheet data can be misleading. Our finding that investor credit supply has a large and significant effect on investor purchases and housing prices provides evidence that the marginal housing investor is constrained by credit supply.

[22] See also Garriga, Manuelli and Peralta-Alva (2019), Guren, Krishnamurthy and Mcquade (2021), Landvoigt, Piazzesi and Schneider (2015) and Liu, Wang and Zha (2019).

7 Conclusion

In this paper we have analyzed the effects on the housing market of two macroprudential policies implemented in Australia. The first policy placed a binding bank-level cap on investor credit growth and the second policy placed a binding bank-level cap on interest-only housing lending, which is disproportionately used by investors. We found clear evidence that both policies caused a sharp and large reduction in lending to investors relative to owner occupiers. Using unit-record data on property sales and listings, we trace effects of the fall in lending supply on the housing market. Using a novel measure of investor participation in the housing market, we show that there is a close correspondence between the investor share of lending finance and property purchases. Investor participation declined following both macroprudential policies. The decline in investor participation caused an economically and statistically significant relative price fall in segments of the market in which investors are most active. Consistent with weaker prices, the mean time-to-sale increased and the listing clearance rate declined, in relative terms, in investor segments of the market.

This paper adds to a growing literature looking at the effect of investor activity on the housing market. Our finding that investor credit supply has a substantial effect on investor participation in the housing market and on housing prices is consistent with the marginal housing investor being constrained by credit availability. This finding is important because the degree to which lending constraints bind for housing investors is a key source of disagreement in quantitative models about the relative importance of credit availability in explaining housing boom and busts. Our findings indicate that macroprudential policies affecting investor lending are a powerful tool to affect housing prices.

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Table 1: Investor Share of New Housing Lending: By State

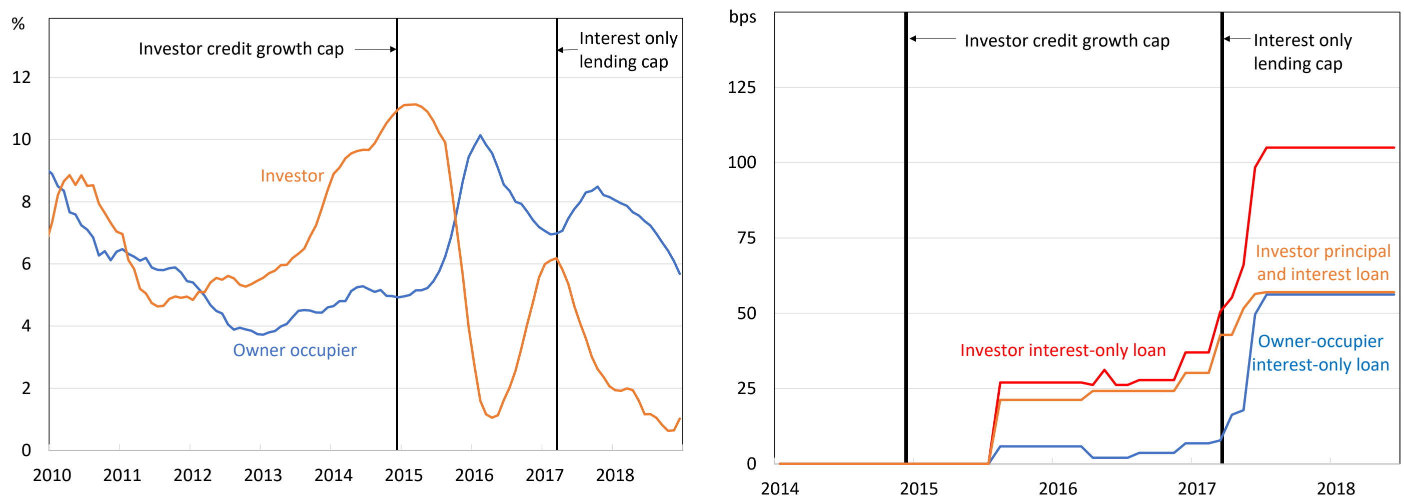
	Prior to first policy: 2014Q4	Change in year after first policy	Prior to second policy: 2017Q1	Change in 2 years after second policy
NSW	0.55	-0.15	0.49	-0.12
VIC	0.43	-0.11	0.38	-0.09
NT	0.39	-0.14	0.23	-0.09
QLD	0.39	-0.05	0.35	-0.10
SA	0.37	-0.07	0.31	-0.07
WA	0.36	-0.11	0.25	-0.08
ACT	0.36	-0.10	0.33	-0.07
TAS	0.29	-0.04	0.27	-0.06
Correlation		-0.69		-0.71

Notes: The table shows the share of total new housing lending (excluding refinancing) to investors, by state, prior to each macroprudential policy and the change following each macroprudential policy. The correlation is between the level and the change in the investor lending share for each policy.

Summary: The share of new lending to investors differed substantially across states prior to the implementation of the macroprudential policies. States with higher investor lending shares saw larger declines following both policies.

Figure 1: Housing Credit Growth and Lending Rates

(a) Six-month Annualized Credit Growth | (b) Lending Rates: Relative to Owner-Occupier P&I Loan

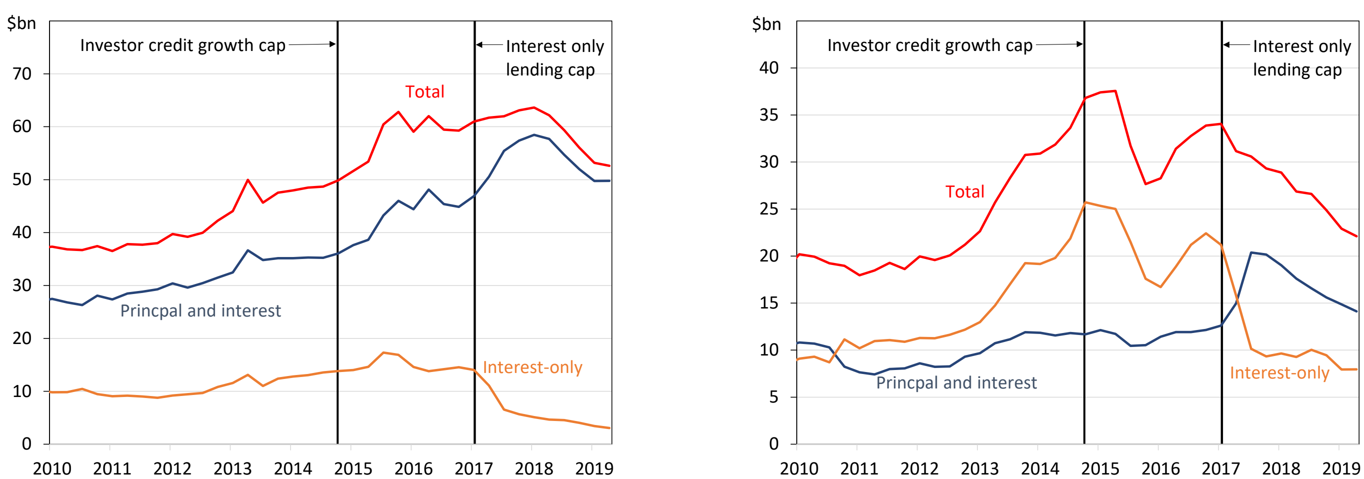


Notes: Panel (a) shows credit growth for owner-occupier and investor housing at a six-month annualized rate. The first policy, introduced in December 2014, required each bank to have investor credit growth of no more than 10 percent. The second policy, introduced in March 2017, restricted interest-only lending to be no more than 30 percent of new housing lending. Panel (b) shows the difference in housing lending rates between each series shown and the lending rate for owner-occupier principal and interest (P&I) lending. Data are at a monthly frequency. Source: RBA (2018).

Summary: Both policies caused a decrease in investor lending relative to owner-occupier lending. Banks increased lending rates for investors following the first policy and increased lending rates for interest-only loans following the second policy.

Figure 2: Value of New Housing Loan Approvals: Quarterly

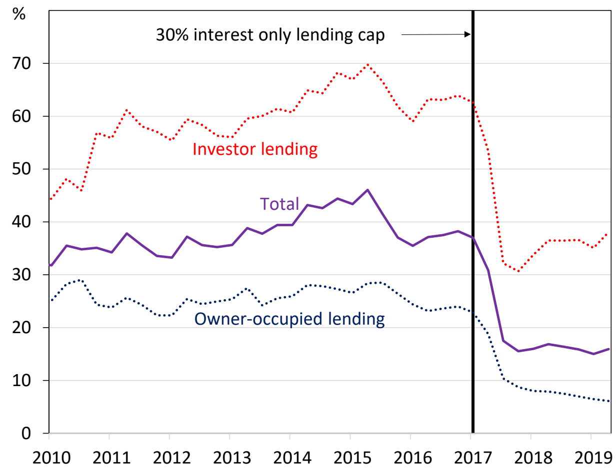
(a) Owner-Occupier | (b) Investor



Notes: Panel (a) shows the quarterly value of new housing lending to owner-occupiers by repayment type. Panel (b) shows the same for new housing investor lending. Data are at a quarterly frequency.

Summary: The first policy caused a sharp reduction in investor lending relative to owner-occupier lending. The second policy caused a reduction in investor lending relative to owner-occupier lending and a sharp change in repayment type.

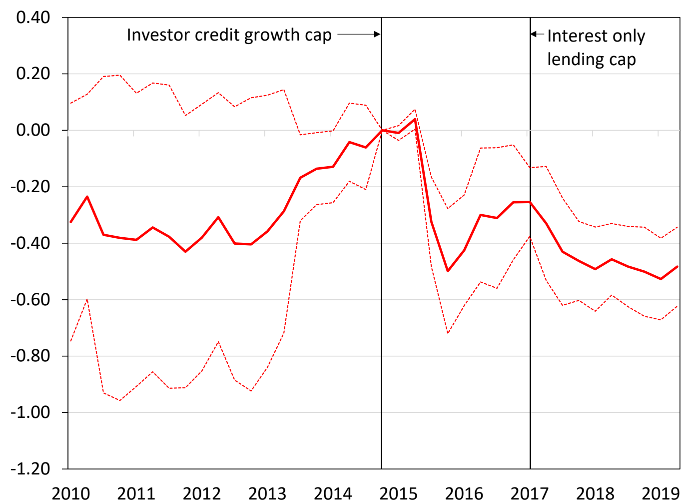
Figure 3: Interest-only Share of New Lending



Notes: New interest-only lending was capped at 30 percent of a bank's total lending from March 2017.

Summary: The second policy caused a sharp and large fall in the interest-only lending share.

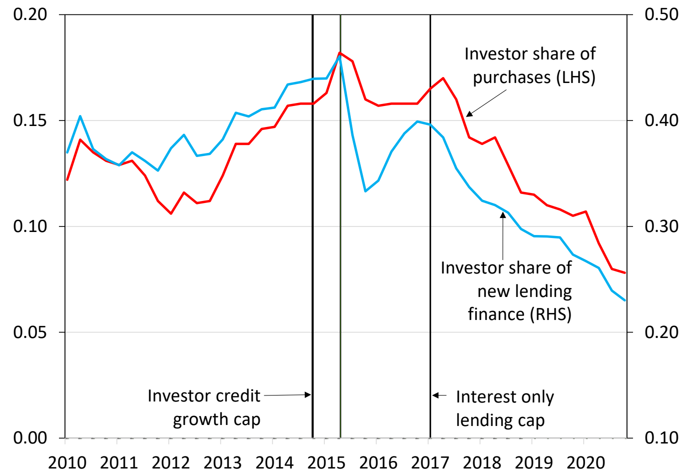
Figure 4: Investor Lending Relative to Owner-Occupier Lending: Quarterly Value of New Housing Loans



Notes: The figure shows coefficient estimates β_t for Equation (1). The omitted category is the December quarter 2014, when the first policy restricting investor credit growth was introduced. Dashed lines show two standard error confidence bands and standard errors are clustered at the bank level. Data are at a quarterly frequency.

Summary: Both policies caused a sharp reduction in lending to investors relative to owner-occupiers.

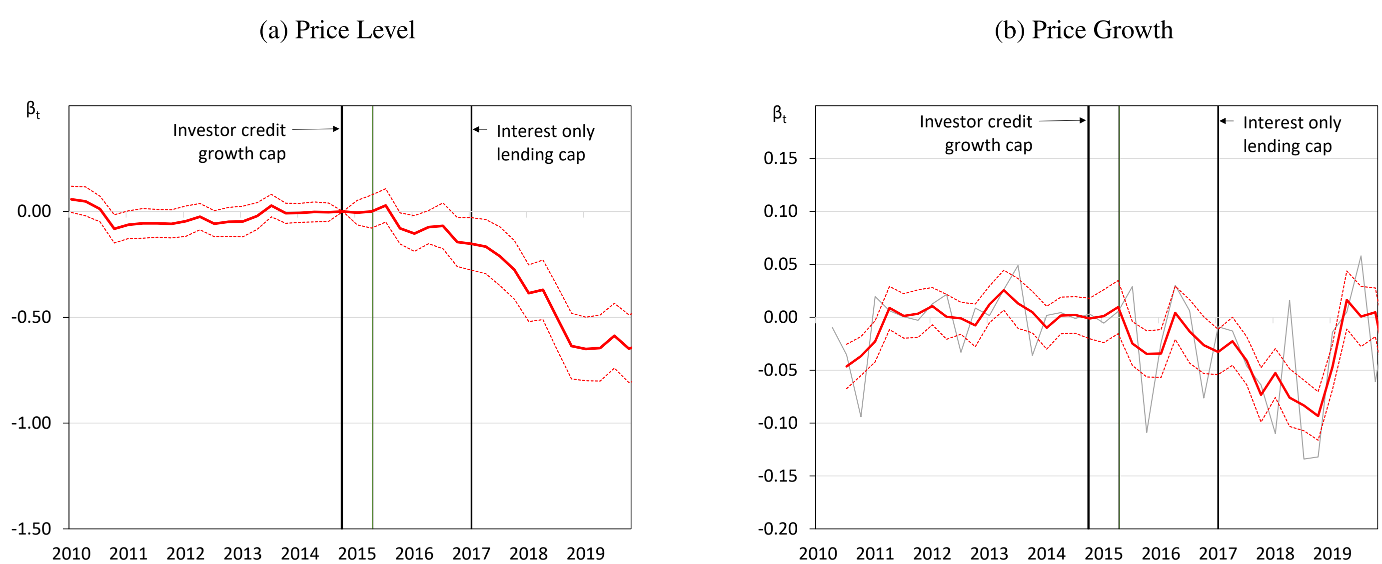
Figure 5: Investor Share of Purchases and Lending Finance



Notes: The figure shows the share of sold properties that were purchased by investors and the investor share of total new property lending, on a quarterly basis. A property listed for rent within 6 months of the settlement date is classified as being purchased by an investor. The sample is restricted to sold properties that were publicly advertised for sale. The vertical line at 2015Q2 denotes the implementation of the first macroprudential policy.

Summary: There is a close correspondence between changes in the investor share of property purchases and the investor share of lending finance.

Figure 6: Effect of Investor Lending Restrictions on Housing Prices

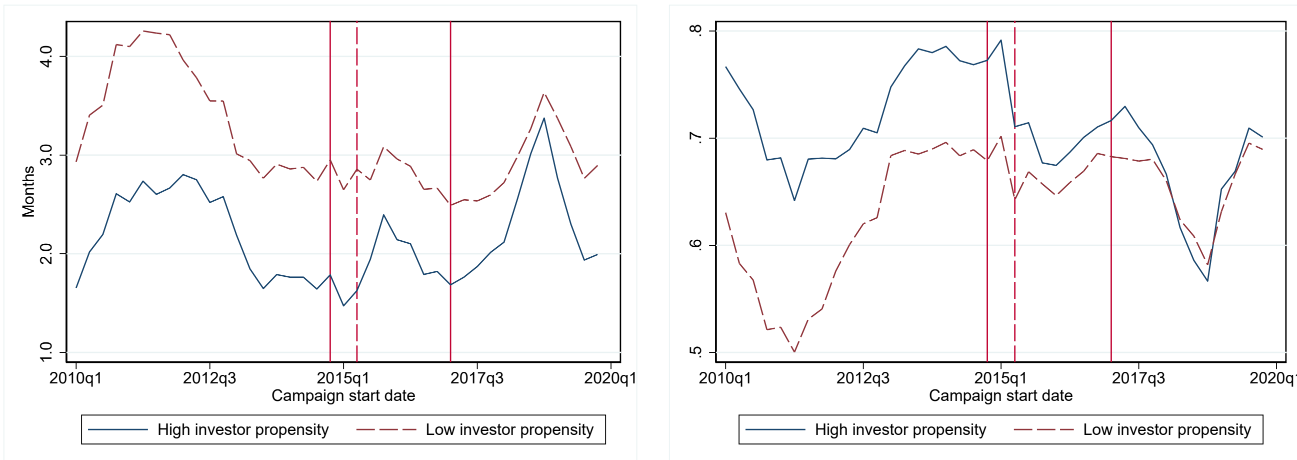


Notes: Panel (a) shows coefficient estimates β_t for Equation (3). The omitted category is the December quarter 2014, when the first policy restricting investor credit growth was introduced. Panel (b) shows the 3-quarter moving average of the quarter-to-quarter change $\Delta\beta_t$ overlaid on top of $\Delta\beta_t$. Dashed lines show two standard error confidence bands with standard errors computed from 400 bootstrap repetitions. Data are at a quarterly frequency. The vertical line at 2015Q2 denotes the implementation of the first macroprudential policy.

Summary: The restrictions on investor lending caused a large relative decline in the property prices for segments of the market in which investors are most active.

Figure 7: Non-Price Indicators: by Investor Purchase Propensity

(a) Mean Months to Sale (b) Share Sold in 6 Months

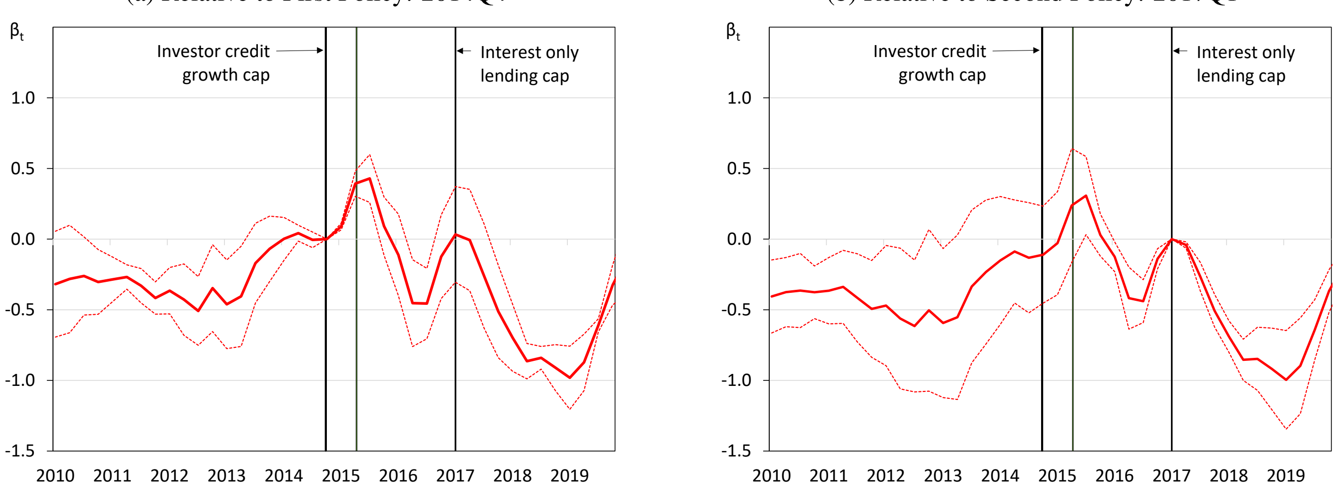


Notes: Panel (a) shows the mean number of months a sold property was listed for sale. Panel (b) shows the share of properties listed for sale that were sold within 6 months of first being listed. High (low) investor propensity is the top (bottom) quartile of investor purchase propensity. Investor purchase propensity is identified by the property characteristics that best predict an investor purchase over the period 2013-2014 (the two years prior to the first macroprudential policy). Vertical lines are at 2014Q4 when the first macroprudential policy was announced, 2015Q2 when the first policy was implemented by Banks and 2017Q1 when the second macroprudential policy took effect.

Summary: Following both policies, there was a rise in the mean time to sale and a fall in the share of listings sold within 6 months for segments of the market in which investors are most active.

Figure 8: Effect of Investor Lending Restrictions on Housing Prices: State Level Analysis

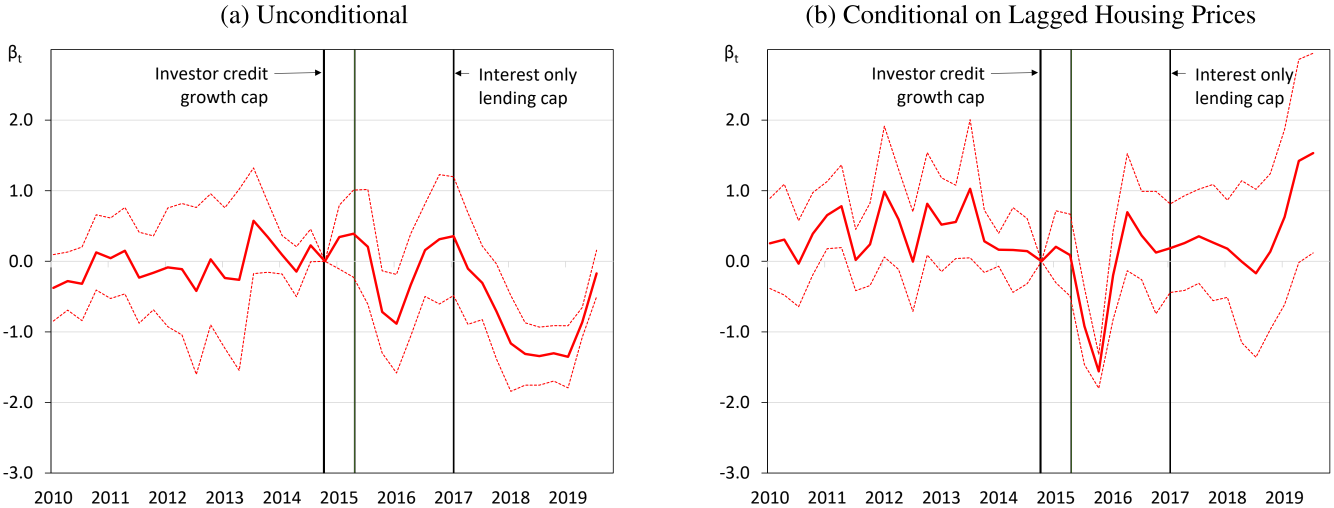
(a) Relative to First Policy: 2014Q4 (b) Relative to Second Policy: 2017Q1



Notes: The figure shows coefficient estimates β_t for Equation (4). Panel (a) shows estimates where the omitted category is 2014Q4. Panel (b) shows estimates where the omitted category is 2017Q1. Dashed lines show two standard error confidence bands with standard errors clustered at the state level level. Data are at a quarterly frequency. The vertical line at 2015Q2 denotes the implementation of the first macroprudential policy.

Summary: The restrictions on investor lending caused a relative decline in the property prices for states in which investors comprised a larger share of lending finance prior to introduction of the macroprudential policies.

Figure 9: Effect of Investor Lending Restrictions on Housing Price Expectations



Notes: The figure shows coefficient estimates β_t for Equation (5) where the omitted category is 2014Q4, when the first macroprudential policy was introduced. Panel (a) shows estimates excluding lagged housing prices as a control variable. Panel (b) shows estimates including lagged housing prices as a control variable. Dashed lines show two standard error confidence bands with standard errors clustered at the state level level. Data are at a quarterly frequency. The vertical line at 2015Q2 denotes the implementation of the first macroprudential policy.

Summary: Housing price expectations were similar across states prior to the first macroprudential policy. Following the introduction of the first policy, price growth expectations moved in line with the causal effect of the policies on prices. Conditional on past price growth, there was little change in housing price expectations, except in the second half of 2015 and the end of our sample.

Online Appendix

A Investor credit growth: constrained vs. unconstrained banks

We compare credit growth for constrained relative to unconstrained banks, following the first policy, by estimating the regression

$$\Delta log(credit_{i,t}) = \alpha_i + \Sigma_t \beta_t (\mathbb{1}(i = binding) \times d_t) + \Sigma_t \delta_t \times d_t + \varepsilon_{i,t}, \tag{A.1}$$

where $\Delta log(credit_{i,t})$ is the quarterly log difference of total credit (owner occupier plus investor) for bank i at time t, α_i is a bank fixed effect, d_t is a time dummy and $\mathbb{1}(i = binding)$ is an indicator function that is equal to one if the cap on investor credit growth was binding for bank i. We define the cap as binding if six-month annualized investor credit growth for bank i was greater than 8 percent in the December quarter 2014 when the policy was imposed. We choose 8 percent as our measure given the volatility of monthly credit growth. However, our findings are qualitatively unchanged if we use 10 percent or 5 percent as the cap or if replace our dummy variable with a continuous variable that measures the difference between six month annualized credit growth for bank i and the 10 percent cap. The omitted category in the regression is the December quarter 2014. We use weighted least-squares, with weights equal to total housing loans of bank i in 2014. Standard errors are clustered at the bank level. Figure A2 presents the estimated β_t-coefficients, which show the increase in total credit growth for a bank constrained by the cap relative to bank that was unconstrained.

Table A1: Housing Credit Shares: 2014

	Total	Owner-occupier	Investor
ANZ	0.16	0.16	0.16
Commonwealth	0.28	0.30	0.25
NAB	0.16	0.16	0.18
Westpac	0.26	0.23	0.30
Other: total	0.18	0.15	0.11

Notes: This table shows the shares of total, owner-occupier and housing credit by Bank for 2014.

Table A2: Summary Statistics of Sold Properties in Sales and Listings Database

		2010		2015		2020	
		Mean	Median	Mean	Median	Mean	Median
Price, ($ '000)	All	526	430	652	517	810	636
	Listed	582	470	703	551	818	647
Land area (sq. meters)	All	2,326	600	2,208	565	2,239	560
	Listed	2,073	632	2,197	608	2,312	598

Notes: This table reports mean and median summary statistics for sold properties. Listed properties are those that were advertised for sale in the listings database.

Table A3: Household Balance Sheet Summary Statistics

	Mean	Std. Dev.	P10	P25	P50	P75	P90
Owner occupiers							
Disposable income	95,931	81,228	26,847	46,540	81,374	120,979	172,425
Assets	841,510	893,001	306,500	417,000	606,500	947,770	1,500,148
Assets excluding property	216,754	601,203	12,000	29,500	67,000	176,246	462,000
Net worth	678,531	863,084	117,400	257,000	464,599	796,136	1,325,000
Net worth excluding property	192,388	583,505	1,566	18,621	52,538	159,702	429,000
Investors							
Disposable income	137,046	100,690	51,382	83,806	120,209	163,962	228,739
Assets	1,774,872	1,686,176	528,700	873,00	1,313,500	2,096,250	3,126,701
Assets excluding property	400,979	884,907	24,000	47,500	107,800	305,690	950,000
Net worth	1,208,080	1,429,040	140,500	360,000	825,500	1,578,000	2,441,363
Net worth excluding property	316,290	845,360	-22,600	23,253	82,570	270,122	870,100

Notes: Statistics are by ownership type and are population weighted. Data are from the 2014 Household, Income and Labour Dynamics in Australia (HILDA) survey. HILDA is a nationally representative household survey of 17,000 individuals. We define investor households as those who own and earn rental income from a dwelling that is not their primary residence. Owner-occupier households are defined as those who own their residence and do not own investment properties.

Summary: On average, investors have higher incomes, assets and net worth than owner occupiers.

Table A4: Investor Share of Purchases by Selected Dwelling Characteristics

Characteristic	Share
Dwelling type:	
House	0.13
Apartment	0.21
Num. bedrooms:	
1	0.25
2	0.21
3	0.16
4	0.10
5	0.08
Num. bathrooms:	
1	0.20
2	0.12
3	0.08

Notes: This table shows the mean shares of investor purchases by selected dwelling characteristic averaged over the period 2013-2014.

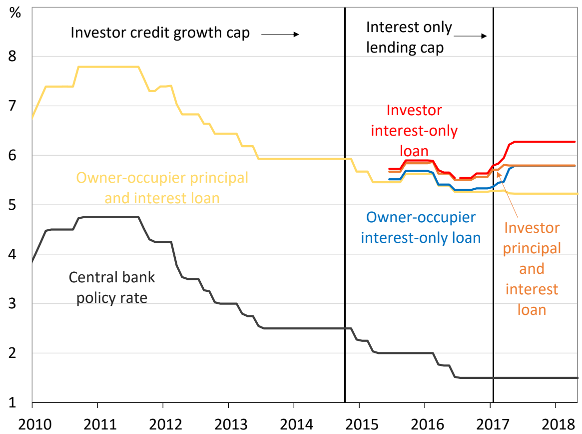
Table A5: Investor Share of Purchases by Geography: Top and Bottom 10 LGAs

Top 10 LGAs		Bottom 10 LGAs	
Adelaide (SA)	0.25	Tuggeranong (ACT)	0.06
Blacktown (NSW)	0.25	Kingborough (TAS)	0.06
Cumberland (NSW)	0.25	Gungahlin (ACT)	0.06
Penrith (NSW)	0.25	Yarra Ranges (VIC)	0.06
Perth (WA)	0.25	Nillumbik (VIC)	0.06
Burwood (NSW)	0.24	Mundaring (WA)	0.05
Campbelltown (NSW)	0.24	Serpentine-Jarrahdale (WA)	0.05
Canterbury-Banks (NSW)	0.24	Somerset Regional (QLD)	0.05
North Sydney (NSW)	0.23	Murray (NSW)	0.05
Ryde (NSW)	0.23	Scenic Rim Region (QLD)	0.03
Memo: Mean all LGAs	0.15		

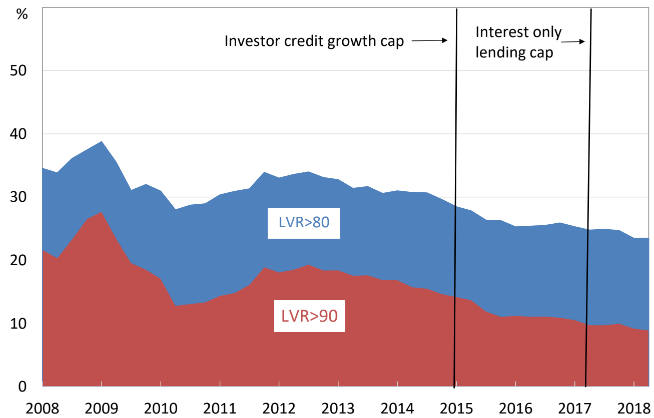
Notes: This table shows the mean shares of investor purchases by LGA averaged over the period 2013-2014, for LGAs with at least 500 properties sold in 2013-2014. The abbreviated state for each LGA is shown in parentheses.

Figure A1: Lending Standards for Owner Occupiers

(a) Interest Rates by Loan Type



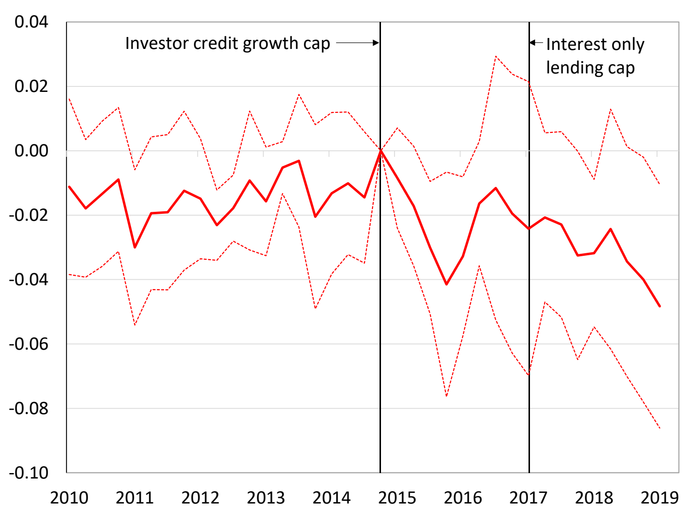
(b) Share of High Risk Owner-Occupier Lending



Notes: Panel (a) shows interest rates by loan type. Panel (b) shows the share of new lending given to high risk owner-occupier borrowers, defined as those with a loan to valuation ratio above 80 percent.

Summary: Banks did not lower interest rates or lending standards for owner-occupier borrowers following the introduction of the first macroprudential policy. This indicates Banks did not seek to reallocate credit from investor lending to owner occupier lending

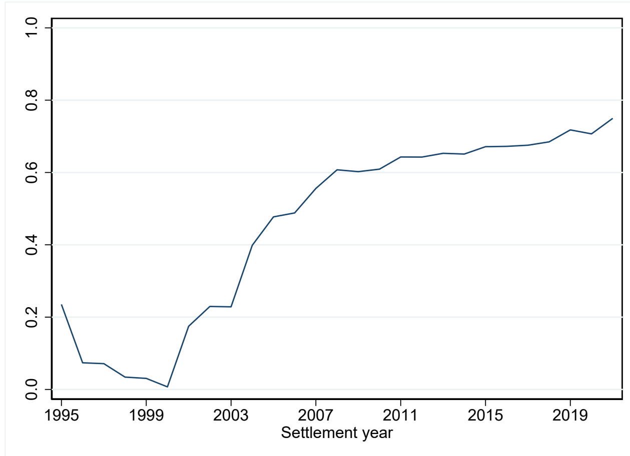
Figure A2: Credit Growth of Constrained Banks Relative to Unconstrained Banks
Quarterly Credit Growth



Notes: This shows coefficient estimates β_j for Equation (A.1) where the dependent variable is the log difference of total housing credit. The omitted category is the December quarter 2014, when the first policy restricting investor credit growth was introduced. Dashed lines show two standard error confidence bands and standard errors are clustered at the bank level.

Summary: Following the introduction of the first macroprudential policy, banks that were constrained by the cap on investor credit growth experienced slower credit growth compared with banks unconstrained by the cap. This indicates that banks constrained by the cap on investor credit growth did not reallocate lending from investors to owner occupiers.

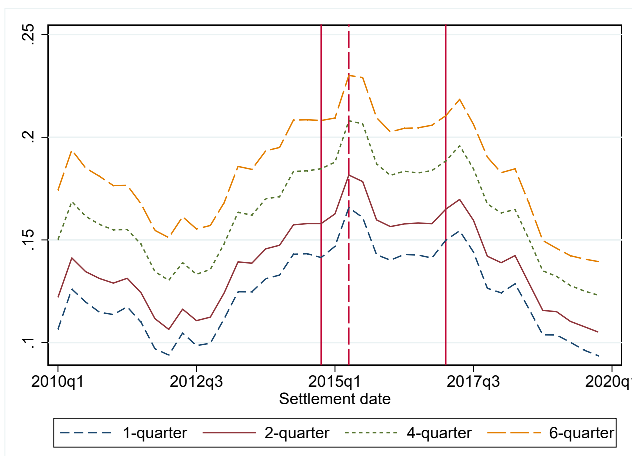
Figure A3: Share of Sold Properties Advertised



Notes: The figure shows the share of properties that were advertised for sale in the listings database. Data on sales is from the land titles office and comprises all sales.

Summary: From the mid 2000s, at least half of all sales were advertised in the listings database.

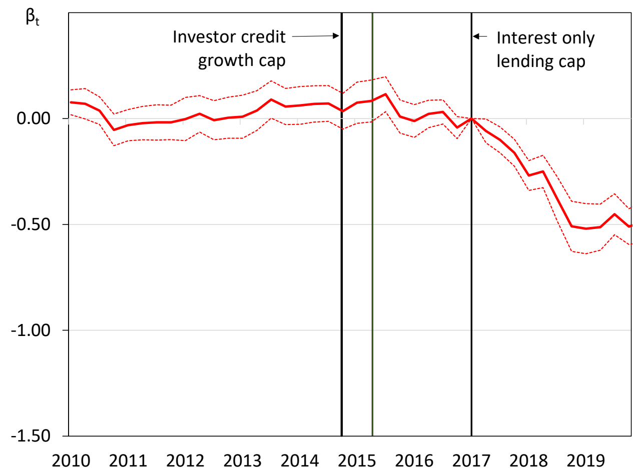
Figure A4: Investor Share of Purchases: By Time to Rental



Notes: This figure shows the share of sold properties that were listed for rent within 1, 2, 4 and 6 quarters of the settlement date. The sample comprises sold properties that were advertised for sale in the listings database. Vertical lines are at 2014Q4 when the first macroprudential policy was announced, 2015Q2 when the first policy was implemented by Banks and 2017Q1 when the second macroprudential policy took effect.

Summary: Variation over time in the share of investor purchases is similar when an investor purchase is identified by a rental listing occurring within 1 to 6 quarters of the settlement date.

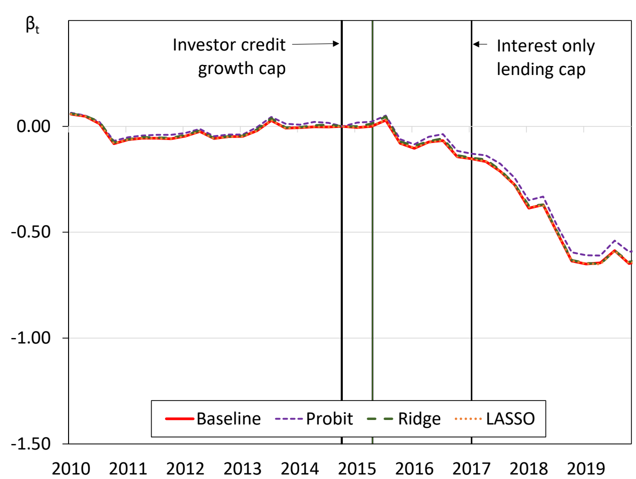
Figure A5: Effect of Investor Lending Restrictions on Housing Prices: Relative to Second Policy



Notes: The figure shows coefficient estimates β_t for Equation (3). The omitted category is the March quarter 2017, when the second policy restricting interest-only lending was introduced. Dashed lines show two standard error confidence bands with standard errors computed from 400 bootstrap repetitions. Data are at a quarterly frequency. The vertical line at 2015Q2 denotes the implementation of the first macroprudential policy.

Summary: The restrictions on investor lending caused a large relative decline in the property prices for segments of the market in which investors are most active.

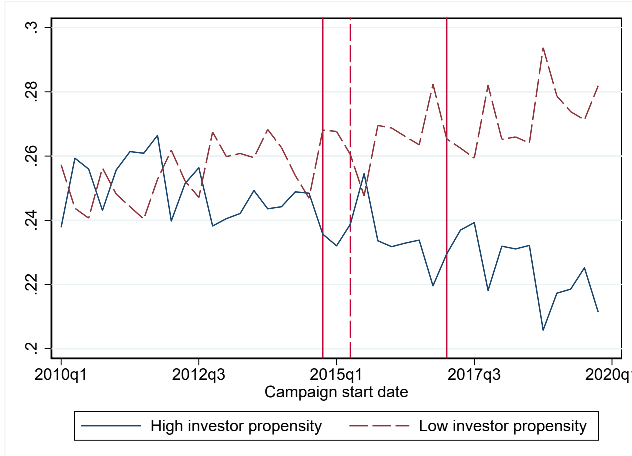
Figure A6: Effect of Investor Lending Restrictions on Housing Prices: Robustness



Notes: The figure shows coefficient estimates β_t for Equation (3) using different estimators for Equation (2). The omitted category is the December quarter 2014, when the first policy restricting investor credit growth was introduced. Data are at a quarterly frequency. The vertical line at 2015Q2 denotes the implementation of the first macroprudential policy.

Summary: The baseline findings are robust to using different estimators for investor propensity.

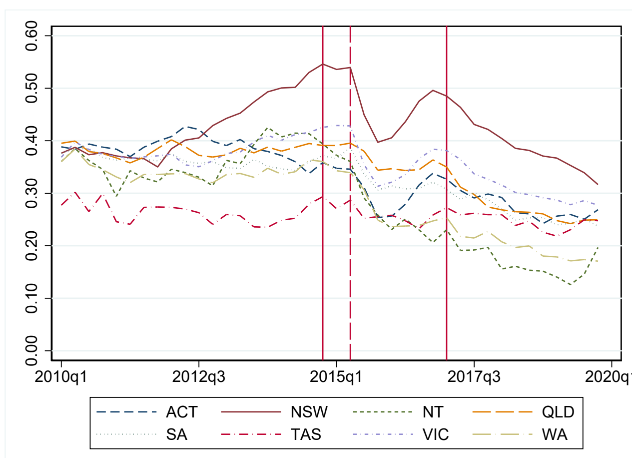
Figure A7: Share of Sale Listings: By Investor Purchase Propensity



Notes: The figure shows the share of properties that were listed for sale by investor purchase propensity. Investor purchase propensity is identified by the property characteristics that best predict an investor purchase over the period 2013-2014 (the two years prior to the first macroprudential policy). Vertical lines are at 2014Q4 when the first macroprudential policy was announced, 2015Q2 when the first policy was implemented by Banks and 2017Q1 when the second macroprudential policy took effect.

Summary: There was a relative decline in sale listings for high investor purchase propensity properties.

Figure A8: Investor Share of New Housing Lending: By State



Notes: The figure shows the share of total new housing lending (excluding refinancing) to investors, by state.

Summary: The share of new lending to investors differed substantially across states prior to the implementation of the macroprudential policies.