HOUSING PRICES AND SPECULATION DYNAMICS: A STUDY OF AUCKLAND HOUSING MARKET

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ABSTRACT

Housing markets across the globe have experienced a considerable increase in property prices and speculative activities. The interplay between these two variables has been analysed by previous studies but they considered market-wide speculation using aggregate measures. This research, however, dissects speculation in Auckland, a metropolis facing a severe housing problem, at the transactional level and focuses on a single group: property investors. In addition, to test the relationship between speculation and prices, this paper adopts a legitimate and novel proxy for housing speculation: rental yields. This study also distinguishes leveraged sales from unleveraged ones to examine the impact of bank financing on the dynamics between the two variables. A vector error correction model is established as a framework to conduct Granger causality tests and impulse response analyses. The findings demonstrate a vicious cycle: leveraged investors' speculative behaviour lifted Auckland house prices which in turn spurred property speculation.

Keywords: House prices, Speculation, Time series, Granger causality

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INTRODUCTION

Against a backdrop of financial liberalisation and the commercialisation of residential real estate, housing markets worldwide have witnessed a considerable increase in both speculative activities and property prices. This phenomenon is of great interest for academics and policymakers because understanding if and to what extent speculation and house prices affect each other is crucial to solving housing crises that sweep many metropolises. Although previous research has documented the relationship between the above two variables (e.g. Levin and Wright, 1997; Ho and Kwong, 2002; Hui and Yue, 2006; Cadil, 2009; Shi, Young and Hargreaves, 2010; Li and Chiang, 2012; Towbin and Weber, 2015; Al-Masum and Lee, 2019), there are three reasons why this area should be further explored.

First, the vast majority of past research tends to use aggregated housing price data and considers market-wide speculation contributed by all market participants (e.g. Kim and Suh, 1993; Levin and Wright, 1997; Riddel, 1999; Roche, 2001; Chung and Kim, 2004; Goodman and Thibodeau, 2008; Li and Chiang, 2012; Lan, 2014; Towbin and Weber, 2015; Al-Masum and Lee, 2019). However, speculation occurs at the property sale level where property owners conduct every transaction. Furthermore, governments' counter-speculation measures are usually designed at this level. For example, the tax authority of New Zealand may levy a quasi- capital gain tax after a profit has been generated from a property disposition. In addition, by using aggregated housing price data, previous studies mix property investment with homeowners' purchases but the main motivation behind these two types of transactions varies. This paper dissects speculation on a transaction-by-transaction basis and focuses on only one cohort of all market participants: property investors.

Second, existing literature commonly adopts housing price bubbles (e.g. Riddel, 1999; Roche, 2001; Chung and Kim, 2004; Goodman and Thibodeau, 2008; Lan, 2014; Al-Masum and Lee, 2019) or future price expectations (e.g. Kim and Suh, 1993; Levin and Wright, 1997; Ho and Kwong, 2002; Malpezzi and Wachter, 2005; Mallick and Mahalik, 2012; Towbin and Weber, 2015) as an indicator of speculation. Nevertheless, the conventional definition of bubbles as the difference between asset prices and market fundamentals is problematic because the concept of fundamentals is vague (Roche, 2001; Cadil, 2009; Lind, 2009). With regard to future price expectations, it is commonplace to assume aggregated price changes in the past as investors' future expectations. This practice might be flawed because previous price fluctuations are not necessarily equivalent to buyers' real vision of future price movements. Meanwhile, to the best of the authors' knowledge, rental yields have not been used as a metric of speculation to test the interplay between speculation and property prices. If rental yields are not satisfactory, it is reasonable to infer that capital gain-focused speculation is the most possible justification for a purchase. Therefore, this study employs this legitimate but unused barometer of housing speculation.

Three, past research (e.g. Levin and Wright, 1997; Ho and Kwong, 2002; Hui and Yue, 2006; Cadil, 2009; Shi, Young and Hargreaves, 2010; Li and Chiang, 2012; Towbin and Weber, 2015; Al-Masum and Lee, 2019) fails to consider the influence of leverage on the relationship between speculation and property prices. Property purchases with bank financing usually demonstrate a higher degree of speculation than unleveraged sales. However, previous studies often use aggregated housing price data and do not draw a difference between leveraged sales and unleveraged ones. This study, however, not only distinguishes these two categories of transactions, but also differentiates them at the transactional level using property data that include only investor-purchase records.

In summary, although previous research has shed much light on the interplay between real estate speculation and prices, the vast majority of current studies does not delve into the property transactional level. By analysing sales conducted by investors on a transaction-by-transaction basis with rental yields as a proxy for speculation, the present research aims to reveal the relationship between the two variables in Auckland, a housing market that has experienced rampant speculation and a strong upward trend in residential house prices from 2003 to 2016, at a nuanced level.

This paper will be structured as follows. Section 2 will be a summary and review of the current literature on the relationship between speculation and housing prices. The data and the model for this study will be elaborated in Section 3. Section 4 will present a table and graphs to demonstrate the findings of the research. The final section will conclude the article.

LITERATURE REVIEW

Using various methods, academics have analysed the interplay between speculation and housing prices. Table 1 summarises some of previous research with a focus on this topic.

Table 1. A summary of previous studies about speculation and housing prices.

Author	Method	Finding	Market	Level of analysis	Speculation indicator
Kim and Suh (1993)	Rational expectations model	S → HP	Korea and Japan	Aggregated	Expectation
Levin and Wright (1997)	Pooled cross-sectional regression	S → HP	London and UK	Aggregated	Expectation
Riddel (1999)	Autoregressive model	S → HP	California	Aggregated	Bubble
Phillips and Goodstein (2000)	Regression	S → HP	Portland	Aggregated	Bubble
Roche (2001)	Regime-switching model	S → HP	Dublin	Aggregated	Bubble
Ho and Kwong (2002)	Vector error correction model	HP → S	Hong Kong	Transactional	Expectation
Zhou and Sornette (2003)	Log-periodic function	S → HP	US an UK	Aggregated	Bubble
Chung and Kim (2004)	Mixed methods	S → HP	Korea	Aggregated	Bubble
Malpezzi and Wachter (2005)	Lagged supply model	S → HP	N/A	Aggregated	Expectation
Goodman and Thibodeau (2008)	Long-run equilibrium model	S → HP	US	Aggregated	Bubble
Hatzvi and Otto (2008)	Fundamental value model	S → HP	Sydney	Aggregated	Bubble
Shi, Young and Hargreaves (2010)	Vector autoregression	S → HP	New Zealand	Transactional	Sale volume
Šliupas and Simanavičienė (2010)	Regression	S → HP	Lithuania	Aggregated	Bubble
Li and Chiang (2012)	Vector error correction model	S ≠ HP	China	Aggregated	GDP
Mallick and Mahalik (2012)	Vector autoregression	S → HP	China	Aggregated	Expectation
Lan (2014)	Vector autoregression	S ≠ HP	China	Aggregated	Bubble
Towbin and Weber (2015)	Vector autoregression	S → HP	US	Aggregated	Expectation
Arestis, Gonzalez-Martinez and Jia (2017)	Fundamental value model	S → HP	Hong Kong	Aggregated	Bubble
Al-Masum and Lee (2019)	Vector error correction model	S ≠ HP	Sydney	Aggregated	Bubble
Wong, Lee and Koong (2019)	Pooled regression	S ≠ HP	Malaysia	Aggregated	Bubble

Note: S → HP indicates speculation is a determinant of housing prices and S ≠ HP indicates speculation is not a determinant of housing prices.

As shown by Table 1, the interplay between speculation and property prices has been examined in different housing markets and a positive relationship—either speculation is a determinant of housing prices or the opposite—is reported by the vast majority of the above studies. However, the bulk of them deals with market-level speculation and focuses on both homeowners and investors. Ho and Kwong (2002) tested the direction of causal relationship between speculation and property prices using transactional level data but the study is built on a small sample of 25 sales. Shi, Young and Hargreaves (2010) revealed the price-volume dynamics based on transactional level datasets but the research does not distinguish property investment from owner-occupiers' purchases.

As for what is used as a proxy for housing speculation to test the relationship with property prices, the studies shown in Table 1 can be categorised into two major camps: capital gain expectations or housing price bubbles. It is commonplace to assume previous price fluctuations as investors' future price expectations but this practice might be flawed. This is because past price changes are not necessarily equivalent to buyers' real vision of price movements in the future. Instead of simply using price changes in the past as expectations, Towbin and Weber (2015) modelled expectations directly by establishing what they called as "price expectation shocks". They defined the term as "a shift in expectations about future house prices by households and housing investors (Towbin and Weber, 2015, p.8)". They adopted a novel way to quantify expectations but did not set investors' expectations from those of other market participants. We argue that the real investors' expectations should be obtained by asking investors, not all market players, about how housing prices are likely to change in the future.

The issue associated with the use of price bubbles as a barometer of speculation is that “the traditional definition [of bubbles] in terms of prices not determined by fundamentals is problematic primarily because the concept ‘fundamentals’ is vague (Lind, 2009, p.78)”. Other researchers such as Roche (2001) and Cadil (2009) stated similar opinions. Against the conventional wisdom, Lei, Noussair and Plott (2001) studied the role of speculation in bubble formation under an experimental setting and the results show that bubbles are observed when speculation is impossible. Their findings suggest that bubbles may not be a suitable proxy for speculation.

Rent and capital gains consist of total returns generated from an investment property. If rental income cannot justify a sale as a cash-flow purchase, the transaction is most likely to be capital gain-oriented speculation. In a nutshell, the lower rental returns are, the greater the amount of speculative pressure a given investor applies to a housing market through his or her behaviour. Rehm and Yang (in press) measured housing speculation in Auckland on the basis of the rental yields derived from an investment property purchase. Based on Rehm and Yang (in press), the present paper extends this earlier work and uses the yields produced by them as the metric of speculation to test the relationship between house prices and speculation in Auckland. Some studies (e.g. Hatzvi and Otto, 2008; Arestis, Gonzalez-Martinez and Jia, 2017) included rent as a component of market fundaments but this study, to the best of the authors’ knowledge, marks the first attempt to employ rental yields as an indicator of housing speculation. Additionally, the studies listed in Table 1 did not distinguish leveraged sales from unleveraged ones. The present research sets them apart at a transactional level.

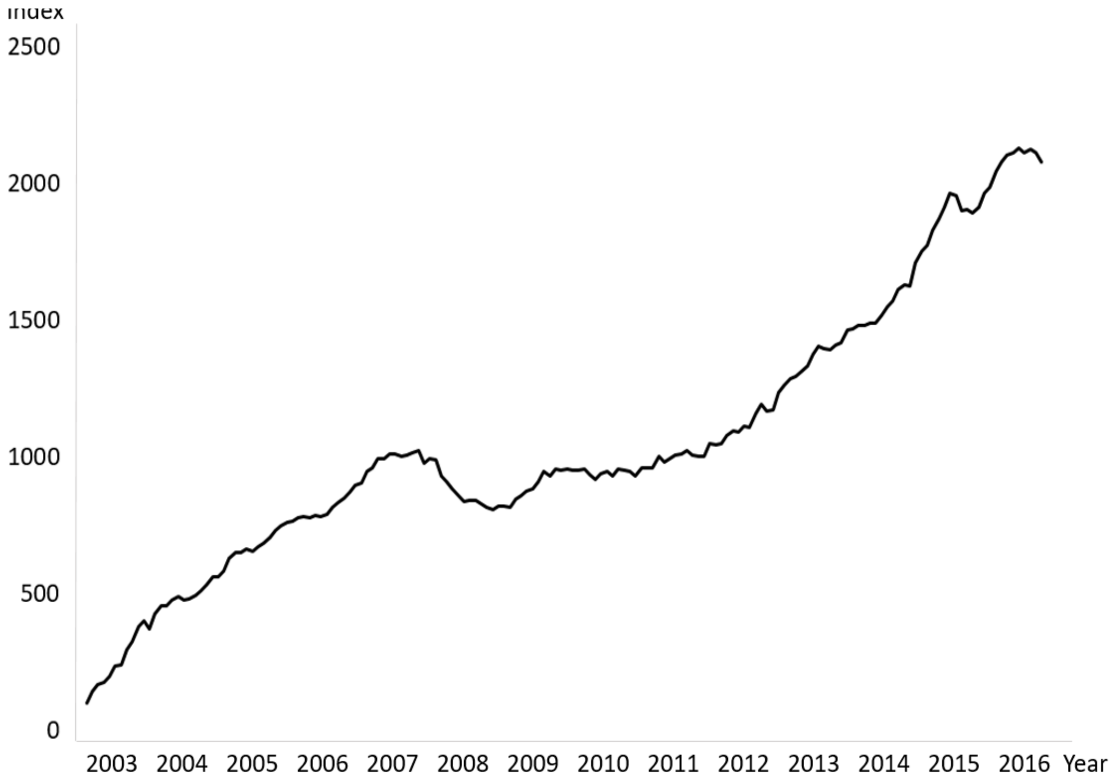
In summary, compared with existing literature, this article delves into the relationship between speculation and property prices at a more nuanced level by using sale-level data, focusing on only investors, adopting rental yields as a metric of speculation and differentiating leveraged sales from unleveraged ones.

DATA AND METHOD

This study uses monthly data covering a period from January 2003 to December 2016. There are six series included in our Vector Error Correction Model (VECM): Auckland house price index, metric of leveraged speculation, metric of unleveraged speculation, effective mortgage interest rate, the number of building consent issued in Auckland and net permanent and long-term immigrants entered into New Zealand.

Auckland Council provided the authors with property sale data including all residential transactions from 2002 to 2016 in Auckland. Auckland house price index was constructed using a hedonic regression on the basis of the gross sale prices of stand-alone house transactions, which account for 77% of total Auckland residential sales. The coefficients of the hedonic regression were indexed to a starting point of 100 in January 2003, as shown in Figure 1. The price index was developed on a monthly basis with 2002 being the base year. There are two advantages associated with the index. First, it was constructed upon the transactional level records. Englund, Quigley, and Redfearn (1999) and Geltner and Ling (2006) claimed that a housing price index should be established based on the finest possible disaggregated data. Second, the frequency of data is monthly. Shi, Young and Hargreaves (2010) argued that the use of high frequency data increases the degree of freedom in a vector autoregression (VAR) model and is more likely to unearth the interplay between variables. As indicated by Figure 1, Auckland freestanding house prices, on average, increase substantially over this timeframe except for the period from 2008 to 2012 as the market reacted to the Global Financial Crisis.

Figure 1. Auckland house price index (2003-2016)



Note: The coefficients of the hedonic regression are indexed to a starting point of 100 in January 2003.

Source: authors' own calculations.

The housing tenure of each property transaction was identified using the same approach as Rehm and Yang (in press). Leveraged and unleveraged status of each sale were determined by analysing the title memorial data publically available from Land Information New Zealand, a government department managing geographical and property information within New Zealand. The present authors coded the data and joined them to the property sale data provided by Auckland Council. According to the method employed by Rehm and Yang (in press), metric of leveraged speculation and metric of unleveraged speculation were calculated as the average of net rental yields of leveraged and unleveraged sales consisting of freestanding houses and units. As discussed previously, rental yields are used as a proxy for property speculation. A decrease in rental yields signals an increase in the degree of speculation that is likely to drive up house prices. To allow a more intuitive interpretation, the signs of metric of leveraged speculation and metric of unleveraged speculation were switched. After the change, an increase in metric of leveraged speculation or metric of unleveraged speculation means the extent of property speculation is elevated so there is upward pressure applied to house prices.

Effective interest rates are directly sourced from the Reserve Bank of New Zealand (RBNZ). The number of building consents issued in Auckland and net permanent and long-term immigrants entered into New Zealand are seasonally adjusted series downloaded from the Statistics New Zealand, a department of the New Zealand government. A one-year lag is applied to the number of building consents because, for typical freestanding houses in New Zealand, most construction work is completed within 12 months of the issuance of a building consent (Statistics New Zealand, 2017). The descriptive statistics of the data are reported in Table 2.

Table 2. Descriptive statistics of the variables

Variable	Average	Std.dev.	Minimum	Maximum
Auckland housing price index (HP)	1053	481	100	2129
Metric of leveraged speculation (MS_LEV)	0.0179	0.0165	-0.0084	0.0496
Metric of unleveraged speculation (MS_CASH)	-0.0343	0.0048	-0.0450	-0.0227
Effective interest rate (IR)	0.0678	0.0107	0.0486	0.0882
Building consents (BC)	592	266	213	1359
Permanent and long-term immigrants (IM)	1894	1985	-910	6460

Unit Root Test

There is a set of procedures to follow in order to build a VECM and test the Granger causality between speculation and house prices. The very first step is to check whether data are stationary. If they are nonstationary, a problem known as spurious regression may happen and this further leads to misleading and meaningless statistical evidence. To prevent the issue derived from non-stationarity, Augmented Dickey-Fuller (ADF) tests were applied to examine whether variables contain unit roots.

Table 3 reports the results of a series of ADF tests with the model specification being set as intercept and trend. It can be seen that all data are non-stationary at level but stationary at a significance level of 1% after taking the first difference, a situation defined as being integrated of order one I (1). Although other two model specifications, intercept and none, are not reported here, the data have been tested under these two circumstances and the results demonstrate that all variables contain no unit root at 1% significance level.

Table 3. The results of unit root tests

Variable	Level		First difference	
	ADF test statistic (5%, 1% CV)	P value	ADF test statistic (5%, 1% CV)	P value
HP	-1.53 (-3.44, -4.01)	0.8169	-9.82 (-3.44, -4.01)	0.0000
MS_LEV	-1.69 (-3.44, -4.01)	0.7513	-15.07 (-3.44, -4.01)	0.0000
MS_CASH	-1.29 (-3.44, -4.01)	0.8865	-12.46 (-3.44, -4.01)	0.0000
IR	-2.37 (-3.44, -4.01)	0.3957	-18.11 (-3.44, -4.01)	0.0000
BC	-0.41 (-3.44, -4.02)	0.9864	-7.64 (-3.44, -4.02)	0.0000
IM	-2.37 (-3.44, -4.01)	0.3957	-18.11 (-3.44, -4.01)	0.0000

Lag Length Selection

It is necessary to include a lag in our VECM because past fluctuations in a variable are likely to affect another variable in the future. In our case, previous housing price growth exerts influence on investors' prospective decisions about whether or not to buy. Optimal lag selection is important as an inappropriate lag length falsely reflects the impact of the past on the future. In addition, an incorrect selection of a lag makes a model over-parameterised or over-simplified (Chen and Patel, 1998). To prevent these issues, a maximum possible lag length, p_{max}, that is neither too large nor too small should be tested by several information criteria. p_{max} serves as the upper limit of selected lag length. In the literature, there is no consensus about what is the most appropriate value of p_{max} but it is a common practice to let it equal to the frequency of data. Therefore, with monthly data being used in this study, p_{max} was set as 12.

Information criteria applied to select the optimal lag length include sequential modified LR test statistic (LR), final prediction error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQC). The output of the lag selection process is largely consistent as all criteria suggest that the optimal lag length should be 2 except for LR. Liew (2004, p. 6) provided a guideline regarding the choice of the above information criteria and concluded that "with relatively large sample (120 or more observations), HQC is found to outdo the rest in correctly identifying the true lag length". As our data contain 156 observations, we decided to use HQC and hence the lag length selected is 2. Although it is not shown here, we tested p_{max} up to 20 and found that, based on HQC, the recommended lag length is still 2.

Cointegration and Granger Causality Test

According to the results of our ADF tests, all series are difference stationary and this signals the presence of at least one equilibrium among variables. A Johansen cointegration test was conducted to detect the long run relationship. The number of cointegrating equations is 1 according to the output of the test. As cointegration is present, equilibrium relationship exists so we can establish a VECM and run Granger causality tests to examine the interplay between speculation and house prices.

If a series X contains exclusive information in the past that helps in the forecast of another series Y, then X is said to Granger cause Y (Granger, 1969). When two variables Granger cause each other, a bidirectional Granger causality forms. Granger causality is not real causation but indicates that the past value of a variable has statistical explanatory power of the future value of another variable. In general, if variables are stationary, unrestricted vector autoregressive models (VAR) can be applied to conduct Granger causality tests. However, if cointegration exists, a VAR with differenced variables is incompatible with cointegrated systems because it omits an error correction term (Engle and Granger, 1987). In this case, a VECM should be used as a framework to carry out Granger causality tests. The result of our Johansen cointegration test demonstrates the existence of cointegration. Therefore, we established a VECM (see Appendix) and tested Granger causality.

Granger causality tests reveal little about to what extent a variable affects another so an impulse response analysis was conducted as a supplement. An impulse response function examines the response of the present and future values of an endogenous variable to one standard deviation shock (Hui and Yue, 2006). The technique unveils whether the impact of a variable on another variable is positive or negative and how long its effect persists. An impulse response analysis with shocks being orthogonalised using the Cholesky decomposition method is variant to the ordering of the variables in a VECM (Pesaran and Shin, 1998). To overcome this shortcoming, we conducted a generalised impulse response analysis that does not require the orthogonalisation of shocks. The output of a generalised impulse response analysis is not subject to a change of sequence of the variables included in the analysis.

RESULTS

Granger causality

Table 4 reports the results of Granger causality tests. It can be noted that the metric of leveraged speculation Granger causes Auckland house prices at 1% level of significance and the metric of unleveraged speculation Granger causes Auckland house prices at 10% level of significance. This result indicates that the collective speculative force applied by residential investors has driven house prices up during the study period. The impact on house prices is especially prominent in the case of leveraged purchases. On the other hand, house prices Granger cause the metric of leveraged speculation at 1% significance level, showing that an increase in Auckland property prices formed an incentive for leveraged investors to speculate more on future capital gains. A bidirectional Granger causality has been discovered between the metric of leveraged speculation and house prices at 1% significance level, showing a vicious feedback cycle: leveraged investors' speculative behaviour lifted Auckland house prices which in turn spurred housing speculation. In addition, a one-way Granger causal relationship has been identified from mortgage rates to the metric of leveraged speculation, suggesting that interest rates are another important determinant of speculative activities with the use of financing.

As for the metric of unleveraged speculation, the number of building consents Granger causes speculation without financing at 5% significance level, indicating that housing supply has a positive impact on cash-buyers' investment decisions. Additionally, the metric of leveraged speculation Granger causes its unleveraged counterpart at 10% level of significance. This result is not surprising as the only difference between these two series is leverage.

Table 4. The results of Granger causality tests

H_0	X^2	P value	H_0	X^2	P value	H_0	X^2	P value
BC→HP	1.021	0.600	BC→MS_LEV	1.143	0.565	BC→MS_CASH	7.187	0.028
IM→HP	1.299	0.522	IM→MS_LEV	0.772	0.680	IM→MS_CASH	0.300	0.861
IR→HP	0.438	0.803	IR→MS_LEV	58.747	0.000	IR→MS_CASH	0.959	0.619
MS_LEV→HP	12.683	0.002	HP→MS_LEV	24.643	0.000	HP→MS_CASH	0.492	0.782
MS_CASH→HP	5.880	0.053	MS_CASH→MS_LEV	3.432	0.180	MS_LEV→MS_CASH	5.558	0.062

Note: x→y indicates the null hypothesis that x does not Granger cause y.

Generalised Impulse Response Analysis

Figure 2 presents the response of Auckland house prices to exogenous shocks. The shock of Auckland house prices itself positively affects future house prices after 12 months, suggesting that an increase in house prices at present elevates investors' capital gain expectations in the short run. The reaction of house prices to a shock of the metric of leveraged speculation is positive, indicating that speculation with bank financing leads to Auckland house price growth. The number of building consents positively influences house prices, showing that boosting housing supply pours fuel on the fire. The impact of unleveraged speculation and immigrants on house prices is nearly negligible. Lastly, an increase in mortgage rates has a significant negative effect on house prices, meaning that a rise in interest rates curbs house price escalation.

Figure 2. Response of HP to shocks

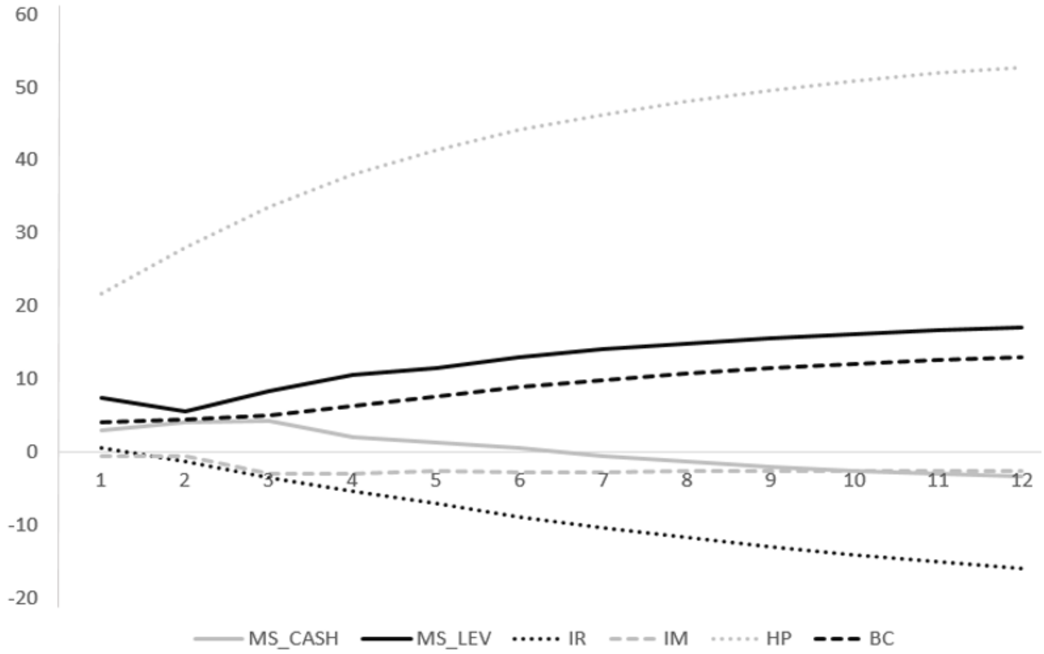


Figure 3 demonstrates the response of the metric of leveraged speculation to exogenous shocks. The reaction of leveraged speculation to a shock of house prices and mortgage rate is noticeably positive after 12 months, indicating that rising prices and increasing interest rate hearten leveraged speculation. An increase in mortgage rate tends to dampen property speculation but in our case a rise in the rate encourages speculation because we have already switched the sign of the metric of leveraged speculation. Consistent with the results of our Granger causality tests, impulse response analyses (Figure 2 and Figure 3) reveal the same vicious cycle: leveraged investors' speculative behaviour lifts Auckland house prices which in turn spurs housing speculation. Immigrants and the number of building consents have a positive effect on leveraged speculation after 12 months but the extent is low.

Figure 3. Response of MS_LEV to shocks

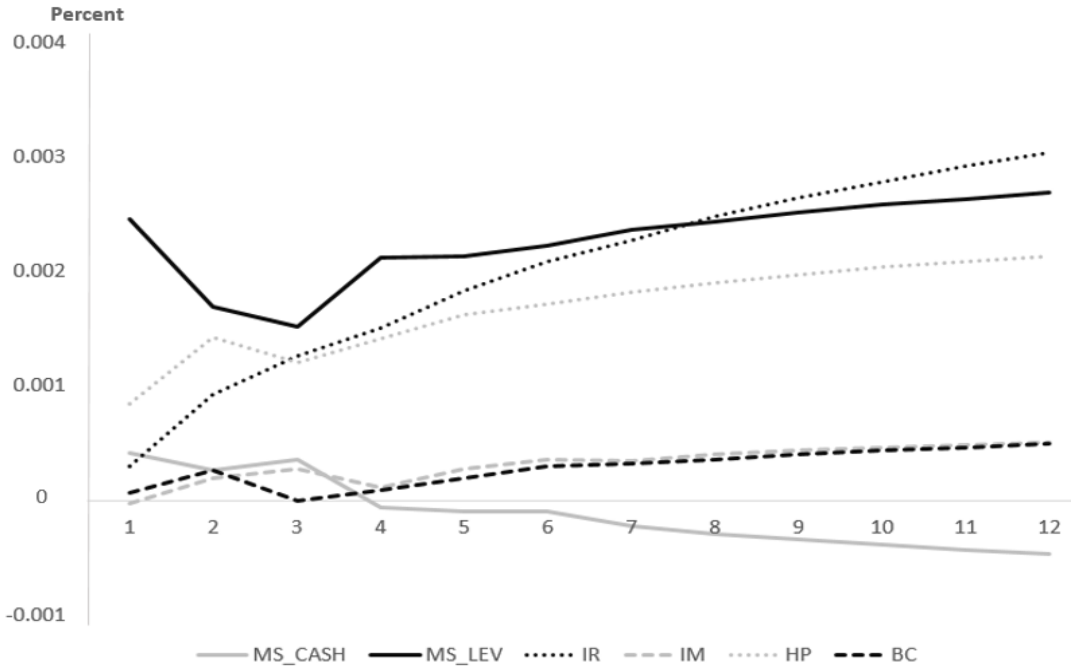
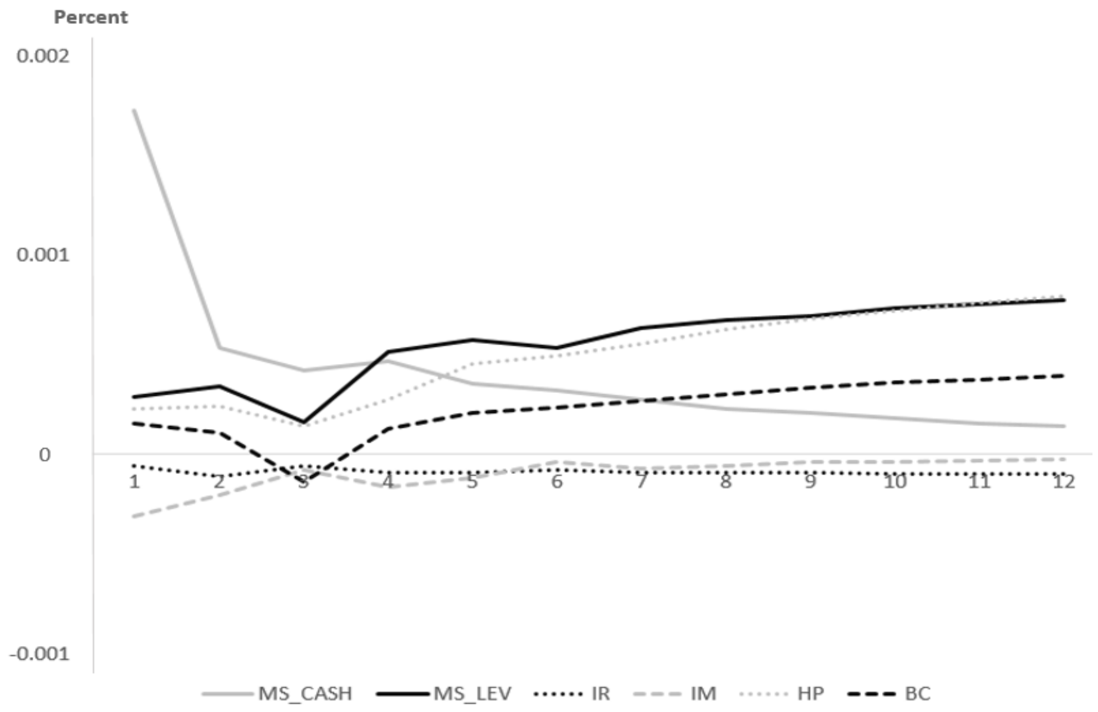


Figure 4 illustrates the response of unleveraged speculation to exogenous shocks. The reaction of unleveraged speculation to a shock of leveraged speculation is prominent after 12 months. This result is not surprising as the only difference between these two series is the use of mortgages. House prices are another influential determinant that positively affects the metric of unleveraged speculation. Compared with leveraged investors, Auckland cash buyers are less motived by price growth but capital gain appreciation is still important driving force. The response of unleveraged speculation to the number of building consents is moderately noticeable after 12 months, suggesting that housing supply plays a role in unleveraged speculation. With regard to immigrants and mortgage rate, their effect on the metric of unleveraged speculation is almost negligible.

Figure 4. Response of MS_CASH to shocks



CONCLUSION

Housing markets worldwide have witnessed a strongly growing trend in real estate prices during the past two decades. Meanwhile, housing speculation has become a serious issue that concerns not only policymakers but also the general public. The interplay between property prices and speculation is of great interest for academics and politicians because understanding if and to what extent these two variables affect each other is crucial to solving housing crises that sweep many metropolises. Auckland is a suitable housing market to examine the relationship because the city has experienced rampant speculation and a strong upward trend in residential house prices from 2003 to 2016.

Although previous research has shed much light on the interplay between real estate speculation and prices, there are three reasons why this area should be further explored. First, the bulk of past research used aggregated housing price data and considered market-wide speculation contributed by all market participants. However, speculation occurs at the property sale level and governments' anti-speculation measures tend to target only investors at this level. Second, existing literature commonly adopts housing price bubbles or future price expectations as an indicator of speculation. Nevertheless, there are disadvantages associated with the use of the above two as a proxy for housing speculation. We employed a legitimate and novel barometer of speculation, the rental yield of investment property, to test its relationship with property prices. Third, the vast majority of previous studies used aggregate price data and did not draw a difference between leveraged sales and unleveraged ones. However, purchases with bank financing usually demonstrate a higher degree of speculation than unleveraged sales so it is worthwhile to set these two categories of transactions apart. By doing so, the interplay between leveraged speculation and prices can be distinguished from the relationship between unleveraged speculation and prices.

This study focuses on only investors, divides property sales into leveraged and unleveraged transactions, uses rental yields as a metric of speculation, builds a VECM and tests the relationship between real estate speculation and house prices at the transactional level. Both Granger causality tests and impulse response analyses have revealed a vicious cycle: leveraged investors' speculative behaviour lifted Auckland house prices which in turn spurred housing speculation. Additionally, unleveraged speculation added moderate upward pressure on house prices according to the results of our Granger causality tests and the reaction of unleveraged speculation to house prices is mildly positive. Therefore, it can be inferred that unleveraged speculation and house prices are, to a certain degree, intertwined. Although we focused on the Auckland housing market, we suspect that other markets experiencing widespread housing speculation are subject to similar behaviour feedback loops. Further studies can test whether the vicious cycle exists in other housing markets.

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Appendix

Table 5. VECM model

Cointegrating Eq	Coefficient	T stat	Coefficient	T stat	Coefficient	T stat	Coefficient	T stat	Coefficient	T stat	Coefficient	T stat
MS_CASH(-1)	1.00											
MS_LEV(-1)	-0.42	-6.09*										
IR(-1)	0.67	4.50										
IM(-1)	0.00	1.38***										
HP(-1)	0.00	0.16***										
BC(-1)	0.00	-3.69***										
C	0.00	-0.21**										
Error Correction	D(MS_CASH)		D(MS_LEV)		D(IR)		D(IM)		D(HP)		D(BC)	
CointEq1	-0.47	-5.40*	-0.11	-0.84	-0.01	-0.74**	-75103.23	-3.79	-2075.18	-1.87	7093.37	1.95
D(MS_CASH(-1))	-0.26	-2.93*	0.08	0.62	0.00	-0.22**	35611.99	1.74	2689.36	2.36	-15.83	-0.00
D(MS_CASH(-2))	-0.11	-1.45*	0.20	1.81	-0.01	-0.56**	27792.10	1.60	1634.16	1.69	-2545.25	-0.79
D(MS_LEV(-1))	-0.10	-1.55*	-0.53	-5.86*	0.00	-0.08**	-24873.62	-1.74	-2736.43	-3.43	3510.17	1.33
D(MS_LEV(-2))	-0.14	-2.27*	-0.28	-3.23*	0.01	0.87**	-12054.02	-0.87	-534.38	-0.69	-41.19	-0.01
D(IR(-1))	-0.03	-0.06	2.30	3.75	0.83	10.1*	-55730.82	-0.57	-3081.62	-0.56	-19465.98	-1.08
D(IR(-2))	0.29	0.63	0.63	0.96	0.02	0.23*	2270.00	0.02	3794.42	0.65	16548.85	0.87
D(IM(-1))	0.00	-0.38***	0.00	0.60***	0.00	-0.21***	-0.36	-4.61*	0.00	0.47***	0.03	1.82**
D(IM(-2))	0.00	0.23***	0.00	0.80***	0.00	-0.67***	-0.16	-2.09*	0.00	-0.81***	0.02	1.41**
D(HP(-1))	0.00	0.63***	0.00	4.72***	0.00	-0.69***	-1.25	-0.83	0.36	4.32*	0.33	1.19
D(HP(-2))	0.00	-0.46***	0.00	0.12***	0.00	0.05***	-0.52	-0.32	0.20	2.27*	-0.12	-0.40
D(BC(-1))	0.00	-0.66***	0.00	0.11***	0.00	-0.00***	-0.71	-1.63	-0.02	-0.97**	0.03	0.40*
D(BC(-2))	0.00	-2.55***	0.00	-1.06***	0.00	-0.14***	-0.56	-1.29	0.00	-0.20**	0.03	0.33*
R-squared	0.40		0.37		0.75		0.20		0.11		0.09	
Adj. R-squared	0.35		0.32		0.73		0.13		0.04		0.02	

Note: numbers rounded to the second decimal place. *** denotes significance at the 1% level. ** denotes significance at the 5% level. * denotes significance at the 10% level.