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Asset Price Booms, Busts and Financial Crises

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Abstract

While historical market busts and financial crises are usually preceded by asset price booms, booms may not necessarily be predictive of busts or crises, given the rarity of these adverse events in history. This paper therefore aims to study the ability of asset price booms in the stock and the housing market to predict asset market busts as well as financial crises. This paper replicates Goetzmann's 2015 study of global stock market bubbles, showing that the probability of a bust conditional on a boom is only slightly higher than the unconditional probability. Based on empirical evidence drawn from global market data, this paper also extends the conclusion from the stock market to the housing market, as well as from asset price busts to macroeconomic financial crises. In other words, stock and housing price booms are not strong indicators of impending busts or financial crises.

Keywords

asset prices, booms and busts, financial crises, asset bubbles

Disciplines

Business

ASSET PRICE BOOMS, BUSTS AND FINANCIAL CRISES

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ABSTRACT

While historical market busts and financial crises are usually preceded by asset price booms, booms may not necessarily be predictive of busts or crises, given the rarity of these adverse events in history. This paper therefore aims to study the ability of asset price booms in the stock and the housing market to predict asset market busts as well as financial crises. This paper replicates Goetzmann's 2015 study of global stock market bubbles, showing that the probability of a bust conditional on a boom is only slightly higher than the unconditional probability. Based on empirical evidence drawn from global market data, this paper also extends the conclusion from the stock market to the housing market, as well as from asset price busts to macroeconomic financial crises. In other words, stock and housing price booms are not strong indicators of impending busts or financial crises.

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INTRODUCTION

Asset bubbles and financial crises are nothing new in history, as they have been around for as long as financial markets have existed. In fact, the first asset bubbles happened even before the development of organized stock exchanges, as seen from evidence of a speculative bubble in German silver mining shares towards the end of the 15th century (Goetzmann 2015). However, even though asset bubbles and financial crises have had a long history, they are relatively rare events. For this reason, history plays an even more important role in the study of these rare events. The recent global financial crisis in 2008, for instance, was often compared to past crises, such as the Great Depression of the 1930s.

Whenever a financial crisis happens, we have a tendency to believe that "this time is different", claiming that we have learned from past mistakes but the old rules of valuations no longer apply, due to reasons such as technological or regulatory innovations (Reinhart and Rogoff 2009). Through the studying of the history of financial crises, however, it has been shown that past financial crises share certain common precursory features, hence leading some to believe that these signs can be used as warning indicators to predict a looming crisis.

On the other hand, it has also been argued that, history may be misleading due to the small sample size of past salient market crashes and financial crises. As economics Nobel laureate Paul Samuelson famously claimed, "Wall Street indexes predicted nine out of the last five recessions." Even though crashes or crises usually take place following similar patterns such as market booms, those patterns on their own merits may not necessarily lead to crashes.

This paper therefore aims to study the ability of asset price booms, including booms in the stock market and the housing market, to predict asset market busts as well as financial crises.

Through an empirical analysis of global stock and housing market data from more than a century, this paper finds that the condition of a prior market boom only slightly increases the probabilities of market busts and financial crises, compared to the unconditional probabilities of such events. In most cases, post-boom markets are found to be much more likely to thrive again than to give back its previous gains. In other words, the appearance of market booms does not significantly increase the chance of markets crashing or going into crises. Asset price booms are not strong indicators of impending busts or financial crises.

This paper successfully replicates Goetzmann's finding in the stock market that, while bubbles are booms that went bad, not all booms are bad (2015). This paper also extends this conclusion from the stock market to the housing market, as well as from market crashes to the more macroeconomic financial crises.

BACKGROUND

Definition of Financial Crises

This paper follows the financial crisis definitions proposed by Reinhart and Rogoff (2009), who use a combination of quantitative thresholds and event-based criteria to define four different types of financial crises, which are banking crises, currency crises, inflation crises and sovereign debt crises.

In banking crises, a significant part of a country's banking sector becomes insolvent due to heavy investment losses or banking panics. Currency crises usually occur with the steep devaluation of a currency, despite government guarantees to maintain the exchange rate. Inflation crises involve high and sudden increases in inflation rates, which would effectively lead to outright defaults, since high inflation allows debtors to repay their debts with currency that has a much lower purchasing power. Sovereign debt crises occur when a government is unable to repay or refinance its external or domestic debt obligations.

The detailed definitions, thresholds and criteria for each of the crisis types, as well as any additional comments or limitations as specified by Reinhart and Rogoff (2009), are listed in Table A1 in Appendix A.

Common Features of Financial Crises

Even though the different types of financial crises have distinct characteristics, it is important to note that they often occur in clusters and are interrelated. Financial crises are also closely related to booms and busts in the financial markets. For instance, banking crises and stock market crashes are often closely intertwined (Allen and Gale 2007).

In addition, most financial crises in history have been found to share the same precursors or symptoms. These symptoms include markedly rising asset prices in the stock and housing markets, slowing real economic activity as measured by real per capital GDP, large current account deficits and sustained central government debt buildups (Reinhart and Rogoff 2009). For instance, there is usually a massive run-up in equity and housing prices preceding a financial crisis, which usually plummet a year after the onset of the crisis. In terms of the trajectory of current account balance, current account deficits brought about by accelerating capital inflow are generally observed in the years prior to a crisis. Real GDP growth on a PPP basis also consistently show an inverted V shape, in which growth momentum falls going into the crisis and remains low for two years before going back up again. Increasing public debt has also been found to be an almost universal precursor of postwar financial crises. (Reinhart and Rogoff 2008, 2009)

It has been argued that these signs can be used as warning signals to predict looming financial crises. Specifically, it is claimed that many of these red lights were in fact flashing before 2007, which should have enabled us to foresee that the US was facing a high risk of a deep financial crisis, even though these signals may not be able to predict when exactly an asset bubble will burst, or the severity of a looming crisis (Reinhart and Rogoff 2009).

Not All Booms Lead to Busts

However, it has also been argued that precursors are not necessarily good predictors. While most past financial crises share the same precursory signals, these signals may not always lead to crises. In other words, these signals may deliver too many false alarms to somewhat accurately predict or serve as effective warning signs of future crises.

A study of the booms and busts in worldwide real equity prices over the past century argued that history may be misleading because the rarity of past asset bubbles or financial crises only allows for a small sample size for inference. We also tend to place a disproportionately large amount of attention on a small number crashes (Goetzmann 2015). More specifically, even though asset bubbles are conditional upon a market boom, not all market booms lead to bubbles or crashes. The probability of a crash conditional on a boom is only slightly higher than the unconditional probability of bubbles. Moreover, following a 100 percent price boom, market prices were found to be twice as likely to double again, while crashes that gave back previous gains happened only about ten percent of the time (Goetzmann 2015).

In another study of booms and busts in asset prices in post-war OECD, only four out of 24 boom episodes in stock prices were followed by busts, hence giving a 16.7 percent sample probability of a boom ending up in a bust. In property prices, however, 11 out of 20 booms were followed by busts, giving a higher probability of a boom ending up in a bust at 55 percent. In other words, more than one in two property booms end up in a bust, while only one in six stock market booms end up crashing. (Bordo and Jeanne 2002)

Implications

Research has shown that the probability of rare booms and disasters has significant implications on the equity risk premium, as both types of events represent extreme one-sided risks that are realized only rarely (Tsai and Wachter 2016). Even a small probability of a substantial drop in consumption would cause a significant impact on risk premium and asset prices. The equity premium increases with the risk of a disaster, due to the extra compensation required for the risk

in assets that fall when there is a high probability of a disaster (Tsai and Wachter 2015). On the other hand, a higher possibility of a boom also leads to an increase in the risk premium due to higher returns when the boom is realized, which is compensated by lower returns when booms do not occur (Tsai and Wachter 2016).

It is therefore important for long-term investors to understand the probability of a market crash or a financial crisis following a boom, which would impact the equity risk premium. By focusing too much on avoiding booms that are unlikely to lead to busts, investors forgo the equity risk premium and give up higher returns that they can earn on the market during those booms.

The ex-ante assessment of the likelihood that an economic boom will end up in a market crash or financial crisis is also extremely important for regulators, as it has significant implications on monetary and fiscal policy. For instance, if asset price booms are found to be robust predictors of looming crashes and crises, it will be beneficial to society to proactively restrict monetary policy during such booms in order to deflate the bubble and prevent the crisis from happening (Bordo and Jeanne 2002). Hence, policymakers face a trade-off between preventing financial crises and stimulating economic growth. Having warning signals with high predicting power can thus allow them to pursue more proactive monetary and fiscal policy, as well as strike a better balance between costs and benefits in the formulation of such policies.

ANALYSIS

Stock Market Analysis

Data

For the empirical analysis of booms and busts in the global stock market, this paper mainly utilizes of a database of dollar-denominated stock price appreciation indexes constructed by Jorion and Goetzmann (1999) (JG). The database contains indexes for 39 countries dating from 1919 to 1996. The JG indexes are derived mostly from documentary data from the League of Nations and the United Nations throughout the 20th century, and include markets that failed or disappeared due to reasons such as wars and revolutions (Goetzmann 2015).

In addition, this paper also makes use of dollar-denominated total return indexes for the Saint-Petersburg Stock Exchange and the Shanghai Stock Exchange constructed by the International Center for Finance (ICF) at the Yale School of Management. These indexes provide stock market return data on the two exchanges in the early 20th century.

Both the JG and ICF series are augmented with the FTSE dollar-denominated price appreciation series available on FactSet, so as to incorporate more recent stock market data from the past two decades. In addition, the Russian index from ICF is augmented by recent data from S&P Global Equity Indices provided by IFC of the World Bank Group.

Beyond stock market data, this paper also draws upon a database containing various time series of different types of financial crises in 70 countries constructed by Reinhart and Rogoff (2010) (RR). The RR time series are yearly tallies of each type of crisis, i.e. banking, currency, inflation and sovereign debt (external and domestic) crises, in each country. The definitions of each type of crisis as measured by RR are detailed in Table A1 of Appendix A.

Table B1 in Appendix B lists the stock markets analyzed in this study, along with the data sources, periods, as well as the summary statistics for each market. It should be noted that the stock market return series are discontinuous for some of the countries because of the disappearance of some markets in the 20th century due to political turmoil, as well as because of the general availability of data. In particular, the JG indexes are only available until 1996, while the FTSE series for many emerging markets, e.g. countries in South America, Eastern Europe and Asia, only begin in 2000, hence leading to a gap between 1996 and 2000 in these markets. For markets known to have been expropriated, a negative 100 percent return is included. Another point to note is that the financial crisis data for Pakistan, Czech and Israel are unavailable, thus these three countries are not included in the financial crisis section of the analysis.

Replication of Goetzmann's Study (Market Price Analysis)

This paper first attempts to replicate Goetzmann's findings on stock market bubbles (2015). This analysis computes the probabilities of market booms and busts, in order to examine how the condition of a prior market boom changes the probabilities of such market events.

Definition of booms and busts. Consistent with Goetzmann's methodology (2015), a bubble is defined as a boom followed by a bust.

A boom is defined in two ways: (1) a single year in which a market increased by at least 100 percent; (2) a three-year period over which the market increased by at least 100 percent.

A bust is similarly defined with two time horizons: (1) a decline in market value of at least 50 percent in the following year; (2) a decline in market value of at least 50 percent over the

following five years. Hence, a bust following a boom would require market prices to return to the pre-boom level.

Methodology. To compute the relevant probabilities of market booms and busts, the market years under different conditions have to be first counted. Table 1 shows the counts and the results for the replication analysis under the one-year 100 percent price boom definition. As illustrated in the first horizontal panel of the table, the total unconditional market-years at T=0 are first counted in column one, i.e. there is a total of 2,835 market-years in the dataset. In the next column under T+1, it is shown that the number of market-year counts drops to 2,766, due to the requirement of a prior year return. Among these unconditional T+1 market-years, 57 show a 100 percent price increase and 71 show a 50 percent price decline. The same process is repeated for the five-year horizon in the right-most columns – 2,495 market-years fulfill the requirement of having both a five-year return and a single-year return five years prior at T=0. In 495 of these market-years the market doubled again, while 179 of them showed a five-year bust in which the market value halved.

The next horizontal panel in Table 1 is only concerned with the market-years that showed a 100 percent one-year price increase. Repeating the above process, the analysis counts the market-years with no conditions, a 100 percent price increase and a 50 percent price decline for both the one-year (T+1) and five-year (T+5) horizons.

With all the market-year counts, the unconditional probabilities of the markets showing a 100 percent price increase and a 50 percent price decline, as well as the probabilities conditional on a prior boom are then computed and presented in the same table. The most relevant probabilities are highlighted in blue and will be examined in greater detail in the next section.

Table 1 Market-year counts and probabilities of market booms (one-year) and busts in the stock market

	100% One-Year Price Increase (Dollar-Denominated)						
	T=0	T+1			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Market-year counts	2835	2766	-	100.00%	2495	-	100.00%
100% price increase		57	-	2.06%	495	-	19.84%
50% price decline		71	-	2.57%	179	-	7.17%
Years with a 100% price increase	59	58		2.10%	56		2.24%
100% price increase		8	13.79%	0.29%	15	26.79%	0.60%
50% price decline		2	3.45%	0.07%	9	16.07%	0.36%

The same methodology is applied to the three-year boom definition, with the only difference being market-years at T=0 being replaced by three-year periods. Complete results for both boom definitions with the period counts and probabilities are presented in Tables C1 and C2 in Appendix C.

Findings. A summary of the probabilities of booms and busts computed in the stock market price analysis is reported in Table 2. Focusing on the top left quadrant of the table, in the one-year horizon under the one-year boom definition, the unconditional probabilities of the market doubling and halving in value are 2.06% and 2.57% respectively. With the added condition of a one-year 100 percent price boom in the previous year, the probability of a market boom jumps from 2.06% to 13.79%, while the probability of a market bust only increases slightly from 2.57% to 3.45%. This means that having a one-year market boom does not significantly increase the chance of a bust happening in the following year; in fact, the market is about four times as likely to boom again than to crash.

As the deflation of asset bubbles may take some time, in the five-year horizon, the condition of a prior one-year boom increases the probability of the market doubling in value in the next five years from 19.84% to 26.79%, while the probability of the market declining 50 percent

over the next five years to return to its pre-boom level increases more significantly from 7.17% to 16.07%. Still, after a 100 percent boom in a year, the market value is more likely to double again than to halve over the next five years.

For the broader three-year definition of a boom, markets halved in value 4.97% of the time in the year following a three-year run-up in prices, which is higher than the unconditional probability of 2.36%, but a bust is still very rare. In the five-year horizon, the three-year boom increases the probability of a subsequent 50 percent decline from 6.98% to 10.33%, while the market is still more likely to double in value again over the same period of time with a probability of 16.24%.

Consistent with Goetzmann's findings in 2015, this analysis shows that a market boom is not a strong indicator of a forthcoming bust. While the condition of a prior one-year or three-year 100 percent price boom increases the chance of a bust in both the one-year and five-year horizons, the increase is not very significant and the probability of the bubble bursting and resulting in a bust remains fairly low. Moreover, in most cases, a post-boom market is more likely to boom again than to bust. In Goetzmann's words, bubbles are booms that went bad, but not all booms are bad (2015).

Table 2 Probabilities of market booms and busts following one-year and three-year 100% dollar-denominated price increases in the stock market

	1-year horizon (T+1)		5-year horizon (T+5)	
	Unconditional	Conditional on boom	Unconditional	Conditional on boom
1-year 100% dollar-denominated price increase (T=0)				
100% increase in price	2.06%	13.79%	19.84%	26.79%
50% decline in price	2.57%	3.45%	7.17%	16.07%
3-year 100% dollar-denominated price increase (T=0)				
100% increase in price	1.79%	3.97%	19.25%	16.24%
50% decline in price	2.36%	4.97%	6.98%	10.33%

Extension to Financial Crises (Financial Crisis Analysis)

Beyond analyzing market price dynamics and asset bubbles, this paper also extends the analysis to macroeconomic conditions. Specifically, this analysis examines the effects of the condition of a market boom on the occurrence of financial crises.

Definition of booms and busts. For booms, this analysis follows the same definition from the above market price analysis, i.e. a 100 percent price increase in one year or three years. However, instead of market price declines, this analysis examines the occurrence of different types of financial crises, i.e. banking, currency, inflation and sovereign debt crises as defined in Table A1 of Appendix A, following an asset price boom. Note that the four different types of financial crisis can occur concurrently.

Methodology. The methodology of this analysis is very similar to that of the market price analysis. However, instead of counting the market-years in which the market declined in value to a certain extent, this analysis counts the market-years in which the country is in any type of financial crisis. Similarly, when examining post-market boom events, the analysis looks at whether the country is in a financial crisis one year and five years after the boom. The complete market year counts are presented in Tables C3 and C4 in Appendix C.

Findings. The relevant probabilities of different types of financial crises are presented in Table 3. It is interesting to note that, based on the specified definitions, the RR time series include a relatively large number of crisis years, such that over 30 percent of all market-years in the data are in fact in crisis. The summary statistics in Table B1 in Appendix B show that this is mostly due to the fact that many South American countries, such as Chile, Argentina and Brazil, are very

frequently in currency, inflation and debt crises. Banking crises, on the other hand, display a less skewed distribution among the countries.

In most cases, a prior market boom increases the chance of a financial crisis, as compared to the unconditional probability of the crisis, but the increase is not highly significant. For both inflation crises and sovereign debt crises, the condition of a prior one-year boom causes the probability of a crisis to approximately double in both the one-year and five-year horizons; however, the observation is not found following a broader three-year boom. Combining all types of crises, a one-year 100 percent price boom increases the total crisis probability from 31.06% to 41.07% over the next year and from 32.61% to 46.15% over the next five years. A three-year 100 percent price boom increases the crisis probability from 30.15% to 34.53% over the next year and from 32.26% to 43.11% over the next five years.

Table 3 Probabilities of financial crises following one-year and three-year 100% dollar-denominated price increases in the stock market

	1-year horizon (T+1)		5-year horizon (T+5)	
	Unconditional	Conditional on boom	Unconditional	Conditional on boom
1-year 100% dollar-denominated price increase (T=0)				
Crisis (all types)	31.06%	41.07%	32.61%	46.15%
Banking crisis	10.33%	8.93%	10.67%	17.31%
Currency crisis	15.04%	25.00%	16.10%	15.38%
Inflation crisis	9.46%	25.00%	10.07%	19.23%
Sovereign debt crisis	10.66%	19.64%	11.64%	21.15%
3-year 100% dollar-denominated price increase (T=0)				
Crisis (all types)	30.15%	34.53%	32.26%	43.11%
Banking crisis	10.28%	13.67%	10.95%	18.67%
Currency crisis	14.47%	15.47%	16.20%	20.44%
Inflation crisis	8.93%	11.51%	9.78%	12.00%
Sovereign debt crisis	10.07%	12.59%	11.34%	14.22%

Note: The definitions of the various types of crises are listed in Appendix A

However, in some instances, such as for banking crises in the one-year horizon following a one-year boom, the condition of a boom actually decreases the probability of a banking crisis from 10.33% to 8.93%. In other words, if the market experienced a 100 percent price increase this year, it is actually less likely for a banking crisis to occur next year than when there is no boom. The same observation stands for currency crises in the five-year horizon following a one-year boom.

Based on the results of this analysis, while the condition of a stock market boom increases the probabilities of most financial crises, it is still not a particularly strong indicator of an upcoming financial crisis. Therefore, Goetzmann's finding that not all booms lead to busts (2015) can be extended beyond stock market prices to macroeconomic conditions. Not all booms lead to financial crises.

Housing Market Analysis

Data

In addition to studying stock markets, this paper also examines booms and busts in the housing market, as markedly rising housing price is also one of the precursors of financial crises (Reinhart and Rogoff 2009). This analysis utilizes a dataset of long-run real residential property prices in 23 countries, which include 18 advanced economies and five emerging economies, beginning as early as 1947 but for most countries from 1970 onwards. This dataset is constructed from nominal residential property prices compiled by the Bank for International Settlements (BIS) from various national sources, deflated by consumer price indexes also provided by the BIS. In the dataset, 1995 prices are set to be 100 units.

Similar to the stock market analysis, this analysis also draws upon the RR financial crises time series for the countries present in the housing price database. Table B2 in Appendix B lists the housing markets analyzed in this study, along with the data source, periods, as well as the summary statistics for each market. Note that the financial crisis data for Hong Kong are unavailable in the RR time series, thus Hong Kong is not included in the financial crisis analysis section.

Market Price Analysis

Definition of booms and busts. For the market price analysis of housing prices, a boom is defined in three ways: (1) a single year in which a market increased by at least 40 percent; (2) a three-year period over which the market increased by at least 40 percent; (3) a five-year period over which the market increased by at least 40 percent.

The threshold for a boom in the housing market is lower than that of the stock market because the housing market is less volatile than the stock market. In addition, the housing price data are in real terms, while the stock price data are in US dollar terms. Therefore, the threshold for a boom is set at 40 percent in this housing market analysis, as opposed to 100 percent in the stock market analysis. In addition, there is an extra time horizon of five years when compared to the stock market analysis, as housing prices are less volatile and take longer to boom.

A bust is similarly defined with three time horizons: (1) a decline in market value of at least 29 percent in the following year; (2) a decline in market value of at least 29 percent over the following three years; (3) a decline in market value of at least 29 percent over the following five years.

The 29 percent decline is determined based on the requirement for post-boom market prices to return to their pre-boom level in the deflation of a bubble. Similar to booms, when compared to the stock market price analysis, there is an extra time horizon of three years. This is because, as mentioned above, housing markets are less volatile and bubbles would take longer to deflate.

Methodology. The methodology of this analysis follows the same framework as that of the stock market price analysis, i.e. the Goetzmann replication, with only changes in the definitions of booms and busts. The market-year and period counts used in the computations of the probabilities are presented in Tables D1, D2 and D3 in Appendix D.

Findings. The unconditional and conditional probabilities of booms and busts in the housing market are presented in Table 4. The table shows that not much can be inferred from the one-year boom and the one-year horizon conditions, as there are extremely few or no counts of booms or busts under those conditions.

Table 4 Probabilities of market booms and busts following one-year, three-year and five-year 40% real price increases in the housing market

	1-year horizon (T+1)		3-year horizon (T+3)		5-year horizon (T+5)	
	Unconditional	Conditional on boom	Unconditional	Conditional on boom	Unconditional	Conditional on boom
1-year 40% real price increase (T=0)						
40% increase in price	0.11%	0.00%	5.83%	0.00%	14.84%	0.00%
29% decline in price	0.11%	0.00%	2.14%	0.00%	4.15%	0.00%
3-year 40% real price increase (T=0)						
40% increase in price	0.12%	0.00%	5.66%	15.69%	14.95%	16.33%
29% decline in price	0.12%	0.00%	2.01%	5.88%	4.14%	10.20%
5-year 40% real price increase (T=0)						
40% increase in price	0.13%	0.83%	5.47%	9.40%	15.08%	19.59%
29% decline in price	0.13%	0.00%	2.14%	6.84%	4.13%	8.25%

However, the three-year and five-year conditions display similar findings as the earlier stock market price analysis in this paper. In the three-year period following a three-year 40 percent real price increase, the probability of a bust in which market prices return to the pre-boom value increases from 2.01% unconditionally to 5.88%, which is still a rare occurrence. However, the market is around three times as likely to undergo a 40 percent price boom again, with a conditional probability of 15.69%. In the five years following a three-year boom, the probability of a bust increases from 4.14% unconditionally to 10.20%, while another boom is still more likely at 16.33%.

The broader five-year boom definition also leads to comparable results. In the three-year horizon, a boom increases the chance of a bust from 2.14% to 6.84%, while the market is more likely to undergo a three-year 40 percent price boom with a 9.40% probability. Over the five-year horizon, a boom raises the probability of a bust from 4.13% to 8.25%, still much lower compared to the 19.59% chance that the market would experience another five-year boom.

This analysis demonstrates that Goetzmann's findings apply not only to the stock market, but also to the housing market. While a boom in housing prices increases the probability of a bust, the probability of a bust occurring remains low at between 5.88% and 10.20% under different conditions. On the other hand, the post-boom market is much more likely to experience another boom. Therefore, booms in housing prices are not good indicators of busts in housing prices. In most instances, the housing market does not give back its previous gain from a boom.

Financial Crisis Analysis

Definition of booms and busts. This paper also extends the financial crisis analysis on the stock market to the housing market. This analysis uses the definition for market booms as the above housing market price analysis, i.e. 40 percent real price increase in one, three or five years.

Similar to the financial crisis analysis on the stock market, this analysis examines the occurrence of the four different types of financial crises measured in the RR time series instead of market price declines.

Methodology. The methodology of this analysis follows the same framework as that of the stock market analysis, with the definition of market booms and the time horizons being the only changed factors, in addition to the underlying data. The market-years or periods in which the country is in any type of financial crisis are counted under the different conditions. For instance, the market-years or periods in a financial crisis one, three and five years after a market boom are counted. The complete market-year and period counts used in the computations of the probabilities are provided in Tables D4, D5 and D6 in Appendix D.

Findings. Table 5 shows the relevant unconditional and conditional probabilities of the different types of financial crises. As there is no instance of a one-year 40 percent real price boom in any market-year, not much can be inferred from the one-year boom panel and this paper will focus on the three-year and five-year price booms.

A particularly interesting finding from the table is that the probabilities of banking crises decrease significantly in the year following a boom (T+1), from 16.24% to 2.17% after a three-year boom and from 17.04% to 9.17% after a five-year boom. This means that the occurrence of a housing price boom makes it a few times less likely for a banking crisis to take place in the following year.

Table 5 Probabilities of financial crises following one-year, three-year and five-year 40% real price increases in the housing market

	1-year horizon (T+1)		3-year horizon (T+3)		5-year horizon (T+5)	
	Unconditional	Conditional on boom	Unconditional	Conditional on boom	Unconditional	Conditional on boom
1-year 40% real price increase (T=0)						
Crisis (all types)	23.57%	NA	24.85%	NA	25.49%	NA
Banking crisis	15.40%	NA	16.24%	NA	17.04%	NA
Currency crisis	8.52%	NA	8.98%	NA	9.10%	NA
Inflation crisis	1.17%	NA	1.23%	NA	0.91%	NA
Sovereign debt crisis	0.58%	NA	0.62%	NA	0.65%	NA
3-year 40% real price increase (T=0)						
Crisis (all types)	24.85%	13.04%	25.49%	30.43%	24.97%	40.91%
Banking crisis	16.24%	2.17%	17.04%	21.74%	17.10%	25.00%
Currency crisis	8.98%	8.70%	9.10%	10.87%	8.28%	13.64%
Inflation crisis	1.23%	2.17%	0.91%	2.17%	0.55%	4.55%
Sovereign debt crisis	0.62%	0.00%	0.65%	0.00%	0.69%	0.00%
5-year 40% real price increase (T=0)						
Crisis (all types)	25.49%	20.18%	24.97%	34.26%	25.26%	33.71%
Banking crisis	17.04%	9.17%	17.10%	23.15%	16.89%	22.47%
Currency crisis	9.10%	11.01%	8.28%	12.96%	8.37%	11.24%
Inflation crisis	0.91%	0.92%	0.55%	1.85%	0.59%	2.25%
Sovereign debt crisis	0.65%	0.00%	0.69%	0.93%	0.73%	0.00%

Note: The definitions of the various types of crises are listed in Appendix A

However, such an observation cannot be made in the three-year and five-year horizons post-boom. In these two timeframes, the analysis finds the usual observation: while the condition of a prior market boom increases the probability of a crisis taking place in the following three or five years, the increase is not very significant. Aggregating all types of crises, a three-year 40 percent price boom increases the total crisis probability from 25.49% to 30.43% over the next three years and from 24.97% to 40.91% over the next five years. A five-year 40 percent price boom increases the crisis probability from 24.97% to 34.26% over the next three years and from 25.26% to 33.71% over the next five years.

Therefore, this analysis presents a similar conclusion as the other analyses on the stock and housing markets in this paper – housing market price booms are not particularly robust indicators of financial crises.

CONCLUSION

While most analyses done on asset bubbles and financial crises focus on a small number of well-known events in history, this paper presents empirical evidence from long-run global stock and housing markets to argue that asset price booms are weak indicators of impending busts or financial crises. This paper successfully replicates Goetzmann's finding from his 2015 study of global stock market bubbles that the probability of a bust conditional on a boom is only slightly higher than the unconditional probability (2015), and extends this conclusion from the stock market to the housing market, as well as from asset price busts to macroeconomic financial crises. While busts and financial crises tend to be preceded by booms, not all booms will lead to busts or crises.

This finding has significant implications for investors and regulators. For investors, while booms do slightly increase the chance of an upcoming bust or financial crisis, it may be even more notable that after a boom the market is more likely to boom again than to bust. For regulators who face a trade-off between fending off a financial crisis and stimulating economic growth, the findings of this paper may caution against overly proactive monetary policies that preemptively deflate asset price bubbles. Such policies, which aim at preventing market crashes or financial crises, would more likely cause the market to forgo another boom rather than a bust.

This paper analyzes the ability of asset price booms to anticipate market busts and financial crises. Aside from asset price booms, there are also other factors identified as common patterns in the run-up to historical financial crises, such as large current account deficits, slowing real GDP growth and buildup of real central government debt (Reinhart and Rogoff 2009). For future research, it would be interesting to conduct empirical analyses on the ability of these macroeconomic factors to predict financial crises, using a methodology similar to that employed

in this paper, which takes into account extensive global historical data, as opposed to only focusing on a relatively small number of financial crises throughout history.

APPENDIX A

Table A1: Definitions of different types of financial crisis by Reinhart and Rogoff (2009)

Type of Crisis	Definition (Threshold/ Criteria)	Comments
Inflation crisis	An annual inflation rate of **20 percent** or higher. We also examine separately the incidence of more extreme cases where inflation exceeds 40 percent per annum.	
Currency crisis	An annual depreciation versus the US dollar (or the relevant anchor currency – historically the UK pround, the French franc, or the German DM and presently the euro) of **15 percent** or more.	
Banking crisis	We mark a banking crisis by two types of events: (1) bank runs that lead to the closure, merging, or takeover by the public sector of one of more financial institutions; and (2) if there are no runs, the closure, merging, takeover, or large-scale government assistance of an important financial institution (or group of institutions), that marks the start of a string of similar outcomes for other financial institutions.	This approach to dating the beginning of a banking crisis is not without drawbacks. It could date a crisis too late, because the financial problems usually begin well before a bank is finally closed or merged; it could also date a crisis too early, because the worst part of a crisis may come later. Unlike the external debt crises (see below), which have well-defined closure dates, it is often difficult or impossible to accurately pinpoint the year in which a crisis ended.
Debt crisis: External	A sovereign default is defined as the failure to meet a principal or interest payment on the due date (or within the specified grace period). The episodes also include instances where rescheduled debt is ultimately extinguished in terms less favorable than the original obligation.	While the time of default is accurately classified as a crisis year, there are a large number of cases where the final resolution with the creditors (if it ever did take place) seems interminable. For this reason we also work with a crisis dummy that only picks up the first year.
Debt crisis: Domestic	The defintion given above for external debt applies. In addition, domestic debt crises have invilved the freezing of bank deposits and/ or forcible conversions of such deposits from dollars to local currency.	There is at best some partial documentation of recent defaults on domestic debt provided by Standard and Poors. Historically, it is very difficult to date these episodes and in many cases (like banking crises) it is impossible to ascertain the date of the final resolution.

Source: Reinhart and Rogoff (2009)

APPENDIX B

Table B1: Summary statistics for global stock markets

				1 Year Return				Market	1Y 100%	Crisis Years				
Country	**Source**		**Period**	**Mean**	**Std.**	**Max**	**Min**	**Years**	**Booms**	**All**	**Banking**	**Currency**	**Inflation**	**Debt**
Chile	JG	FTSE	1927-1996, 2000-2016	0.12	0.39	1.18	-0.53	76	3	57	5	35	33	30
Argentina	JG	FTSE	1947-1996, 2000-2016	0.22	0.99	4.55	-0.86	55	5	51	10	32	33	30
Colombia	JG	FTSE	1936-1996, 2000-2016	0.08	0.38	1.88	-0.55	70	3	41	6	21	23	8
Germany	JG	FTSE	1919-2016	0.14	0.55	4.41	-0.75	91	3	40	9	12	4	22
Brazil	JG	FTSE	1961-2016	0.19	0.60	2.32	-0.70	49	4	37	7	33	31	14
Mexico	JG	FTSE	1934-2016	0.13	0.36	1.15	-0.79	76	1	35	9	17	19	17
Spain	JG	FTSE	1919-2016	0.05	0.37	1.43	-1.78	84	2	32	19	16	1	4
US	JG	FTSE	1919-2016	0.08	0.20	0.76	-0.47	91	0	31	17	18	0	1
Japan	JG	FTSE	1919-2016	0.07	0.34	1.67	-0.93	91	2	30	13	9	6	11
France	JG	FTSE	1919-2016	0.07	0.30	0.88	-0.61	89	0	27	9	15	10	0
UK	JG	FTSE	1919-2016	0.07	0.25	1.07	-0.53	91	1	27	9	13	2	8
China	ICF	FTSE	1900-1941, 2000-2016	0.08	0.33	1.20	-1.00	51	1	27	11	13	7	19
Peru	JG	FTSE	1941-1952, 1957-1977, 1988-1996, 2000-2016	0.13	0.47	2.23	-0.71	49	3	24	2	10	11	20
India	JG	FTSE	1939-1996, 2000-2016	0.06	0.27	0.94	-0.63	67	0	21	6	7	4	7
Philippines	JG	FTSE	1954-2016	0.12	0.84	6.21	-0.61	56	1	21	12	7	4	12
Venezuela	JG		1937-1996	0.08	0.56	3.90	-0.76	59	1	20	11	11	11	9
Italy	JG	FTSE	1928-2016	0.08	0.37	1.51	-0.84	76	4	17	9	5	5	2
South Africa	JG	FTSE	1947-2016	0.06	0.27	0.83	-0.43	63	0	17	3	11	0	5
Australia	JG	FTSE	1931-2016	0.09	0.23	0.99	-0.53	79	0	16	5	10	3	0
Austria	JG	FTSE	1925-2016	0.10	0.37	1.94	-0.69	76	2	14	5	6	4	8
Finland	JG	FTSE	1931-2016	0.12	0.38	1.46	-0.62	79	3	14	5	8	5	0
Denmark	JG	FTSE	1926-2016	0.08	0.23	1.02	-0.49	84	1	13	10	3	1	0
Ireland	JG	FTSE	1934-2016	0.08	0.27	0.99	-0.72	76	0	13	4	7	2	0
Sweden	JG	FTSE	1919-2016	0.09	0.26	0.74	-0.58	91	0	13	8	6	0	0
Greece	JG	FTSE	1929-1930, 1932-1939, 1999-2016	0.05	0.67	2.74	-0.67	19	1	13	3	4	0	7
Poland	JG	FTSE	1921-1938, 2000-2016	0.07	0.45	1.12	-1.00	28	1	13	3	4	3	8
Belgium	JG	FTSE	1920-2016	0.07	0.27	1.27	-0.62	88	1	12	8	4	2	0
Norway	JG	FTSE	1928-2016	0.09	0.30	1.00	-0.64	78	1	12	8	4	0	0
New Zealand	JG	FTSE	1931-2016	0.07	0.26	1.24	-0.53	79	1	11	4	6	0	1
Portugal	JG	FTSE	1930-1973, 1977-2016	0.12	0.47	1.98	-0.52	74	6	10	5	5	3	0
Hungary	JG	FTSE	1925-1930, 1932-1940, 2000-2016	0.10	0.41	0.92	-1.00	24	0	10	3	2	0	6
Netherlands	JG	FTSE	1919-2016	0.06	0.22	0.66	-0.54	91	0	9	5	4	0	0
Russia	ICF	IFC	1900-1914, 1997-2015	0.16	0.66	2.84	-1.00	27	2	8	3	4	5	3
Canada	JG	FTSE	1919-2016	0.08	0.24	1.34	-0.49	91	1	7	4	2	0	1

Table B1 (continued): Summary statistics for global stock markets

				1 Year Return				Market	1Y 100%	Crisis Years				
Country	**Source**		**Period**	**Mean**	**Std.**	**Max**	**Min**	**Years**	**Booms**	**All**	**Banking**	**Currency**	**Inflation**	**Debt**
Switzerland	JG	FTSE	1926-2016	0.09	0.22	1.06	-0.34	84	1	6	3	3	0	0
Romania	JG		1937-1940	-0.40	0.48	0.02	-1.00	4	0	4	0	1	0	4
Uruguay	JG		1936-1943	0.10	0.21	0.32	-0.26	7	0	3	0	2	0	2
Egypt	JG	FTSE	1950-1961, 2000-2016	0.12	0.44	1.26	-0.62	21	2	2	0	2	0	0
Pakistan	JG	FTSE	1960-1996, 2000-2016	0.08	0.33	1.18	-0.72	46	1	NA	NA	NA	NA	NA
Czech	JG	FTSE	1920-1944, 2000-2016	0.10	0.37	1.13	-1.00	35	1	NA	NA	NA	NA	NA
Israel	JG	FTSE	1957-1996, 2000-2016	0.12	0.35	0.86	-0.70	49	0	NA	NA	NA	NA	NA
			Average	0.08	0.39	1.61	-0.70	63.76	1.44	19.95	6.66	9.79	6.11	6.82
			Median	0.08	0.36	1.18	-0.64	76	1	15	6	7	3	4
			Standard Deviation	0.09	0.17	1.22	0.25	25.69	1.48	13.23	4.33	8.60	9.33	8.35
			Min	-0.40	0.20	0.02	-1.78	4	0	2	0	1	0	0
			Max	0.22	0.99	6.21	-0.26	91	6	57	19	35	33	30

Return data sources: (1) JG: Dollar-denominated stock price appreciation indexes constructed by Jorion and Goetzmann (1999)

(2) ICF: Dollar-denominated total return indexes for the Saint-Petersburg Stock Exchange and the Shanghai Stock Exchange constructed by the International Center for Finance at the Yale School of Management

(3) FTSE: FTSE dollar-denominated price appreciation series available on FactSet

(4) IFC: S&P Global Equity Indices provided by IFC of the World Bank Group

Crisis year data source: Reinhart and Rogoff (2010)

Table B2: Summary statistics for global housing markets

			1 Year Return				Market	Crisis Years				
Country	**Source**	**Period**	**Mean**	**Std.**	**Max**	**Min**	**Years**	**All**	**Banking**	**Currency**	**Inflation**	**Debt**
United States	BIS	1971-2010	0.01	0.06	0.12	-0.18	40	16	12	4	0	0
South Africa	BIS	1967-2010	0.02	0.10	0.30	-0.21	44	16	3	10	0	5
Korea	BIS	1976-2010	0.01	0.09	0.29	-0.16	35	15	11	4	2	0
Spain	BIS	1972-2010	0.04	0.09	0.29	-0.13	39	14	12	4	1	0
UK	BIS	1969-2010	0.04	0.10	0.33	-0.16	42	13	9	7	1	0
Japan	BIS	1956-2010	0.04	0.09	0.27	-0.15	55	13	10	2	1	0
Australia	BIS	1971-2010	0.03	0.07	0.24	-0.10	40	11	4	6	1	0
Ireland	BIS	1971-2010	0.03	0.09	0.20	-0.15	40	11	4	5	2	0
Germany	BIS	1971-2010	-0.01	0.02	0.05	-0.05	40	10	6	4	0	0
Italy	BIS	1948-2010	0.02	0.06	0.21	-0.07	63	10	6	3	2	0
Norway	BIS	1971-2010	0.03	0.08	0.22	-0.17	40	10	7	3	0	0
Denmark	BIS	1971-2010	0.02	0.09	0.23	-0.17	40	9	9	1	0	0
New Zealand	BIS	1971-2010	0.03	0.08	0.22	-0.12	40	9	4	5	0	0
Sweden	BIS	1971-2010	0.02	0.07	0.12	-0.17	40	8	4	5	0	0
France	BIS	1971-2010	0.03	0.05	0.14	-0.05	40	7	5	2	0	0
Thailand	BIS	1992-2010	-0.01	0.04	0.05	-0.08	19	6	6	2	0	0
Belgium	BIS	1971-2010	0.03	0.06	0.13	-0.11	40	5	3	2	0	0
Malaysia	BIS	1989-2010	0.03	0.06	0.17	-0.12	22	5	5	1	0	0
Canada	BIS	1971-2010	0.03	0.07	0.19	-0.16	40	4	3	1	0	0
Switzerland	BIS	1971-2010	0.01	0.05	0.14	-0.09	40	4	2	2	0	0
Finland	BIS	1971-2010	0.02	0.10	0.33	-0.21	40	4	4	1	0	0
Netherlands	BIS	1971-2010	0.03	0.09	0.24	-0.20	40	4	3	1	0	0
Hong Kong	BIS	1980-2010	0.04	0.17	0.41	-0.37	31	NA	NA	NA	NA	NA
	Average		0.02	0.08	0.21	-0.15	39.57	9.27	6.00	3.41	0.45	0.23
	Median		0.03	0.08	0.22	-0.15	40	10	5	3	0	0
	Standard Deviation		0.01	0.03	0.09	0.07	8.64	4.06	3.13	2.30	0.74	1.07
	Min		-0.01	0.02	0.05	-0.37	19	4	2	1	0	0
	Max		0.04	0.17	0.41	-0.05	63	16	12	10	2	5

Return data sources: National sources, BIS Residential Property Price database, www.bis.org/statistics/pp.htm

Crisis year data source: Reinhart and Rogoff (2010)

APPENDIX C

Table C1: Market year counts and probabilities of market booms (one-year) and busts in the stock market

	100% One-Year Price Increase (Dollar-Denominated)						
	T=0	T+1			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Market-year counts	2835	2766	-	100.00%	2495	-	100.00%
100% price increase		57	-	2.06%	495	-	19.84%
50% price decline		71	-	2.57%	179	-	7.17%
Years with a 100% price increase	59	58		2.10%	56		2.24%
100% price increase		8	13.79%	0.29%	15	26.79%	0.60%
50% price decline		2	3.45%	0.07%	9	16.07%	0.36%
Years with a 50% price decline	72	66		2.39%	57		2.28%
100% price increase		10	15.15%	0.36%	19	33.33%	0.76%
50% price decline		4	6.06%	0.14%	5	8.77%	0.20%

Table C2: Market year counts and probabilities of market booms (three-year) and busts in the stock market

	100% Three-Year Price Increase (Dollar-Denominated)						
	T=0	T+1			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Three-year period counts	2695	2628	-	100.00%	2364	-	100.00%
100% price increase		47	-	1.79%	455	-	19.25%
50% price decline		62	-	2.36%	165	-	6.98%
Three-year periods with a 100% price increase	303	302		11.49%	271		11.46%
100% price increase		12	3.97%	0.46%	44	16.24%	1.86%
50% price decline		15	4.97%	0.57%	28	10.33%	1.18%
Three-year periods with a 50% price decline	154	144		5.48%	129		5.46%
100% price increase		9	6.25%	0.34%	64	49.61%	2.71%
50% price decline		3	2.08%	0.11%	9	6.98%	0.38%

Table C3: Market year counts and probabilities of market booms (one-year) and financial crises in the stock market

	100% One-Year Price Increase (Dollar-Denominated)						
	T=0	T+1			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Market-year counts	2484	2421	-	100.00%	2174	-	100.00%
100% price increase		55	-	2.27%	455	-	20.93%
Crisis (all types)		752	-	31.06%	709	-	32.61%
Banking crisis		250	-	10.33%	232		10.67%
Currency crisis		364	-	15.04%	350		16.10%
Inflation crisis		229	-	9.46%	219		10.07%
Sovereign debt crisis		258	-	10.66%	253		11.64%
Years with a 100% price increase	57	56		2.31%	52		2.39%
100% price increase		8	14.29%	0.33%	14	26.92%	0.64%
Crisis (all types)		23	41.07%	0.95%	24	46.15%	1.10%
Banking crisis		5	8.93%	0.21%	9	17.31%	0.41%
Currency crisis		14	25.00%	0.58%	8	15.38%	0.37%
Inflation crisis		14	25.00%	0.58%	10	19.23%	0.46%
Sovereign debt crisis		11	19.64%	0.45%	11	21.15%	0.51%

Table C4: Market year counts and probabilities of market booms (three-year) and financial crises in the stock market

	100% Three-Year Price Increase (Dollar-Denominated)						
	T=0	T+1			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Three-year period counts	2356	2295	-	100.00%	2055	-	100.00%
100% price increase		47	-	2.05%	422	-	20.54%
Crisis (all types)		692	-	30.15%	663	-	32.26%
Banking crisis		236	-	10.28%	225	-	10.95%
Currency crisis		332	-	14.47%	333	-	16.20%
Inflation crisis		205	-	8.93%	201	-	9.78%
Sovereign debt crisis		231	-	10.07%	233	-	11.34%
Three-year periods with a 100% price increase	279	278		12.11%	225		10.95%
100% price increase		12	4.32%	0.52%	42	18.67%	2.04%
Crisis (all types)		96	34.53%	4.18%	97	43.11%	4.72%
Banking crisis		38	13.67%	1.66%	42	18.67%	2.04%
Currency crisis		43	15.47%	1.87%	46	20.44%	2.24%
Inflation crisis		32	11.51%	1.39%	27	12.00%	1.31%
Sovereign debt crisis		35	12.59%	1.53%	32	14.22%	1.56%

APPENDIX D

Table D1: Market year counts and probabilities of market booms (one-year) and busts in the housing market

	40% One-Year Price Increase (Real)								
	T=0	T+1			T+3			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Market-year counts	910	887	-	100.00%	841	-	100.00%	795	-	100.00%
40% price increase		1	-	0.11%	49	-	5.83%	118	-	14.84%
29% price decline		1	-	0.11%	18	-	2.14%	33	-	4.15%
Years with a 40% price increase	1	1		0.11%	1		0.12%	1		0.13%
40% price increase		0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
29% price decline		0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
Years with a 29% price decline	1	1		0.11%	1		0.12%	1		0.13%
40% price increase		0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%
29% price decline		0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%

Table D2: Market year counts and probabilities of market booms (three-year) and busts in the housing market

	40% Three-Year Price Increase (Real)								
	T=0	T+1			T+3			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Three-year period counts	864	841	-	100.00%	795	-	100.00%	749	-	100.00%
40% price increase		1	-	0.12%	45	-	5.66%	112	-	14.95%
29% price decline		1	-	0.12%	16	-	2.01%	31	-	4.14%
Three-year periods with a 40% price increase	51	51		6.06%	51		6.42%	49		6.54%
40% price increase		0	0.00%	0.00%	8	15.69%	1.01%	8	16.33%	1.07%
29% price decline		0	0.00%	0.00%	3	5.88%	0.38%	5	10.20%	0.67%
Three-year periods with a 29% price decline	18	17		2.02%	14		1.76%	14		1.87%
40% price increase		0	0.00%	0.00%	1	7.14%	0.13%	2	14.29%	0.27%
29% price decline		0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%

Table D3: Market year counts and probabilities of market booms (five-year) and busts in the housing market

	40% Five-Year Price Increase (Real)									
	T=0	T+1			T+3			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Five-year period counts	818	795	-	100.00%	749	-	100.00%	703	-	100.00%
40% price increase		1	-	0.13%	41	-	5.47%	106	-	15.08%
29% price decline		1	-	0.13%	16	-	2.14%	29	-	4.13%
Five-year periods with a real price increase	121	120		15.09%	117		15.62%	97		13.80%
40% price increase		1	0.83%	0.13%	11	9.40%	1.47%	19	19.59%	2.70%
29% price decline		0	0.00%	0.00%	8	6.84%	1.07%	8	8.25%	1.14%
Five-year periods with a 29% price decline	34	32		4.03%	32		4.27%	32		4.55%
40% price increase		0	0.00%	0.00%	3	9.38%	0.40%	9	28.13%	1.28%
29% price decline		0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%

Table D4: Market year counts and probabilities of market booms (one-year) and financial crises in the housing market

	40% One-Year Price Increase (Real)									
	T=0	T+1			T+3			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Market-year counts	879	857	-	100.00%	813	-	100.00%	769	-	100.00%
40% price increase		0	-	0.00%	44	-	5.41%	106	-	13.78%
Crisis (all types)		202	-	23.57%	202	-	24.85%	196	-	25.49%
Banking crisis		132	-	15.40%	132	-	16.24%	131	-	17.04%
Currency crisis		73	-	8.52%	73	-	8.98%	70	-	9.10%
Inflation crisis		10	-	1.17%	10	-	1.23%	7	-	0.91%
Sovereign debt crisis		5	-	0.58%	5	-	0.62%	5	-	0.65%
Years with a 40% price increase	0	0		0.00%	0		0.00%	0		0.00%
40% price increase		0	NA	0.00%	0	NA	0.00%	0	NA	0.00%
Crisis (all types)		0	NA	0.00%	0	NA	0.00%	0	NA	0.00%
Banking crisis		0	NA	0.00%	0	NA	0.00%	0	NA	0.00%
Currency crisis		0	NA	0.00%	0	NA	0.00%	0	NA	0.00%
Inflation crisis		0	NA	0.00%	0	NA	0.00%	0	NA	0.00%
Sovereign debt crisis		0	NA	0.00%	0	NA	0.00%	0	NA	0.00%

Table D5: Market year counts and probabilities of market booms (three-year) and financial crises in the housing market

	40% Three-Year Price Increase (Real)									
	T=0	T+1			T+3			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Three-year period counts	835	813	-	100.00%	769	-	100.00%	725	-	100.00%
40% price increase		0	-	0.00%	40	-	5.20%	100	-	13.79%
Crisis (all types)		202	-	24.85%	196	-	25.49%	181	-	24.97%
Banking crisis		132	-	16.24%	131	-	17.04%	124	-	17.10%
Currency crisis		73	-	8.98%	70	-	9.10%	60	-	8.28%
Inflation crisis		10	-	1.23%	7	-	0.91%	4	-	0.55%
Sovereign debt crisis		5	-	0.62%	5	-	0.65%	5	-	0.69%
Three-year periods with a 40% price increase	46	46		5.66%	46		5.98%	44		6.07%
40% price increase		0	0.00%	0.00%	6	13.04%	0.78%	6	13.64%	0.83%
Crisis (all types)		6	13.04%	0.74%	14	30.43%	1.82%	18	40.91%	2.48%
Banking crisis		1	2.17%	0.12%	10	21.74%	1.30%	11	25.00%	1.52%
Currency crisis		4	8.70%	0.49%	5	10.87%	0.65%	6	13.64%	0.83%
Inflation crisis		1	2.17%	0.12%	1	2.17%	0.13%	2	4.55%	0.28%
Sovereign debt crisis		0	0.00%	0.00%	0	0.00%	0.00%	0	0.00%	0.00%

Table D6: Market year counts and probabilities of market booms (five-year) and financial crises in the housing market

	40% Five-Year Price Increase (Real)									
	T=0	T+1			T+3			T+5		
	Count	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability	Count	Conditional Probability	Unconditional Probability
Five-year period counts	791	769	-	100.00%	725	-	100.00%	681	-	100.00%
40% price increase		0	-	0.00%	36	-	4.97%	95	-	13.95%
Crisis (all types)		196	-	25.49%	181	-	24.97%	172	-	25.26%
Banking crisis		131	-	17.04%	124	-	17.10%	115	-	16.89%
Currency crisis		70	-	9.10%	60	-	8.28%	57	-	8.37%
Inflation crisis		7	-	0.91%	4	-	0.55%	4	-	0.59%
Sovereign debt crisis		5	-	0.65%	5	-	0.69%	5	-	0.73%
Five-year periods with a 40% price increase	109	109		14.17%	108		14.90%	89		13.07%
40% price increase		0	0.00%	0.00%	8	7.41%	1.10%	16	17.98%	2.35%
Crisis (all types)		22	20.18%	2.86%	37	34.26%	5.10%	30	33.71%	4.41%
Banking crisis		10	9.17%	1.30%	25	23.15%	3.45%	20	22.47%	2.94%
Currency crisis		12	11.01%	1.56%	14	12.96%	1.93%	10	11.24%	1.47%
Inflation crisis		1	0.92%	0.13%	2	1.85%	0.28%	2	2.25%	0.29%
Sovereign debt crisis		0	0.00%	0.00%	1	0.93%	0.14%	0	0.00%	0.00%

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