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Housing finance and real-estate booms: A cross-country perspective☆

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ABSTRACT

The recent global financial crisis has highlighted the potential conflict between improving access to housing finance and maintaining financial stability. Using a new dataset on housing finance and house prices for a sample of more than 50 countries, this paper analyzes the dynamic relationship between household credit and house-price booms. It also examines the potential role of some housing finance characteristics on the likelihood of house-price booms and on how they ended. The following stylized patterns are highlighted. First, credit and house-price booms are tightly linked. Second, house-price booms have occurred more often with a twin credit boom (simultaneous booms in both household and firm credit) than with a solo boom in household credit. Third, house-price booms seem to be more likely in countries with higher loan to value ratios and mortgage funding models based on securitization or wholesale sources. Finally, we find that the majority of house-price booms end up with a recession, and that both twin credit booms and non-retail deposit funding predict a worse landing.

1. Introduction

Housing finance is considered one of the villains of the most recent global financial crisis. Before the crisis, booming mortgage markets fueled, and were supported by, rising house prices and economic activity. When the bubble burst, the spiral inverted. Falling house prices led to household debt overhang and tighter lending standards, and led several overleveraged financial institutions into distress. This pattern, most evident in the United States, was present in many countries hard hit by the crisis; albeit with variations in the underlying drivers and innovations that led to the house-price boom. The recessions and massive increases in public debt that ensued from the housing-burst fallout led to a renewed debate about financial regulation, consumer protection, and more generally the role asset prices (including the housing market) should play in macro policy decisions.

Yet at least until the crisis, there was a widespread consensus in favor of policies in support of housing finance markets (ranging from interest tax deductibility of mortgage loans to publicly supported securitization markets). Many considered access to housing finance as essential to promoting home ownership, which in turn was seen as beneficial to social stability and, ultimately, economic growth. However, a tension emerges between increasing access to housing finance and containing the dangers associated with fast-growing household indebtedness. Deeper housing finance markets allow cheaper access to housing credit and promote home ownership. But house-price (real-estate) boom episodes have often ended in busts with important macroeconomic consequences, especially when the boom was financed through fast credit growth.[1]

In order to assess the potential conflict between improving access to housing finance and maintaining financial stability we need, as a start, a better understanding of the stylized facts related

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[1] While real-estate booms can also pertain to commercial properties, in this paper we focus on residential housing booms and will use the terms "house-price" booms and "real-estate" booms interchangeably. Also, following the literature we use the term boom and not bubble as the latter term might insinuate a predominant role of non-fundamentals such as speculation. See Glaeser et al. (2008) and Glaeser and Nathanson (2015) for the need to include irrational behavior (e.g. temporary increase in optimism about future prices) in theoretical models with elastic supply of houses.

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to bank credit and house-price booms around the world, as well as the interaction of available housing finance characteristics (e.g., maximum observed LTV ratios, government support, bank funding characteristics, etc.) and the likelihood of house-price booms and how they ended. This paper is a step in this direction. It exploits new data on house prices, housing finance characteristics, and bank credit for more than 50 countries and documents the following stylized facts.

First, we separately identify bank-credit and house-price booms across countries and time, and find that they are tightly linked. Controlling for a set of economic factors—such as US interest rates, VIX, GDP growth, etc.—in a panel setting, we find that lagged credit growth is a strong predictor of house-price booms. Exploiting available data breakdowns, we distinguish between bank private credit booms (i.e. boom in total credit to the private sector) and household credit booms, with the latter being a good proxy for the evolution of housing finance credit.[2]

Second, we find that house-price booms have more often than not occurred with a boom in private credit rather than with a solo boom in household credit. That is, in the majority of cases house-price booms were nested within a generalized boom in credit. From a policy perspective, that is a key finding, especially given that inflation typically remained subdued during most booms. Having said that, household credit booms are a stronger predictor of house-price booms. In other words, while a boom in household credit increases the likelihood of a house-price boom, booms in household credit usually occur together with booms in firm credit.

Third, in addition to the importance of household-credit booms in the likelihood of house-price booms, other variables seem to be playing a role. Among the house finance characteristics added to the estimations, three seem to play a role. First, the higher the maximum observed LTV, the higher the probability of a house-price boom. Second, the presence of full recourse seems to lower the probability of real estate booms (this is probably capturing borrowers' higher risk exposures in overvalued house markets when they are subject to full recourse). Lastly, mortgage finance models mainly relying on securitization strategies and wholesale funding are typically more scalable, and seems to increase the probability of real estate booms.

Finally, we examine how house-price booms typically end and the factors associated with these outcomes. We find that most house-price booms end up with a downward correction in prices and recessions. House-price booms accompanied by a boom in total private credit were more prone to large adjustments and recessions. In a panel data setting, we examine the drivers of "bad" house price booms and find that household indebtedness, booms in total private credit, and some non-retail deposit funding are strong predictors of recessions following a boom. Interestingly, the duration of the house-price boom is not a significant predictor of how it will end.

Our paper complements and supplements the findings in several strands of literature on housing. A strand of empirical and theoretical literature has helped bring to light the macroeconomic importance of the housing market, but such studies tend to be focused on one country (see, e.g., Black et al., 1996; Ortalo-Magne and Rady, 1998, 1999; Case, 2000; Davis and Heathcote, 2005; Iacoviello, 2005; Piazzesi et al., 2007; Goodhart and Hofmann, 2008; Mian and Sufi, 2011; Glaeser and Sinai, 2013). Some of these single country studies have also shown the importance of the role of supply factors—from local land regulations to the availability of land as a function of terrain elevation and presence of water—in the evolution of house prices (see, e.g., Glaesser et al, 2006; Saiz, 2010). Our paper cannot control for supply considerations directly, but our cross-country approach offers external validity to the literature for other factors. In this sense, our paper is more linked to both the growing cross-country literature on credit booms (see, e.g., Gourinchas et al., 2001; Mendoza and Terrones, 2008; Dell' Ariccia et al., 2012) and house-price booms (e.g., Agnello and Schuknecht, 2011 and Crowe et al., 2013). Our contribution is to bring these two areas together and study the relation between both types of booms, as well as examining these booms from a macro-prudential perspective.

Our findings bear on the debate on how macroeconomic policy should respond to house-price and housing market developments. First, policies supporting the deepening of mortgage markets should be accompanied by vigilance against a relaxation of lending standards (e.g., LTV ratios); especially, during episodes of fast household/mortgage credit growth. Second, macroprudential policies, and in particular housing-finance regulation, are a good first line of defense when handling mortgage booms, as their narrow focus gives them an advantage over monetary policy. Yet, considering that these episodes often occur in the context of rapid and broad economic growth, these measures will often have to be accompanied by monetary policy tightening. Last, but not least, longer-term structural measures, such as proper fiscal incentives and house supply policies may bear heavily on the probability of booms occurring and the potential costs of busts.

The rest of the paper is structured as follows. Section 2 describes the characteristics of data used, including the compiled cross-country housing finance variables. Section 3 identifies real-estate boom and credit boom episodes. It then examines their interaction and macroeconomic impact, and factors that might explain how they end. Section 4 discusses the policy implications of our findings and how they bear on the current discussion about macro-prudential policies.

2. A large cross-country dataset

Our objective of analyzing the dynamic relationship between house financing and house-price booms over the period 1970–2012 for a large sample of countries requires the combination of three large and unique types of data: i) Housing finance credit; ii) House prices, and iii) Country finance market characteristics that could affect the provision of housing credit. The final sample of 53 countries is the result of the limitations faced in putting together the three types of data.

2.1. Housing finance credit

The purchase of a house is the largest transaction of most households' lifetime. These purchases are typically funded through mortgage loans, but long time-series on mortgage credit are lacking in most countries. To increase time-series and cross-sectional coverage, we rely instead on household credit for estimating house finance related credit booms. Household credit is a good proxy since mortgage credit typically represent a very large part of household credit. Available data for recent years indicate that the median mortgage-to-household credit ratio is about 70% in our sample during 2011, and the two credit variables are highly correlated.[3] This suggests that approximating housing finance credit with household credit is appropriate given the data constraints.

The source of most of the bank credit data, including the household bank credit breakdown, is a new BIS database. As denoted in

[2] Using household mortgage credit would have been preferable since they are typically used for house purchases, but long-time series are not available for many countries. We instead use household credit, which is highly correlated with mortgage credit given that mortgages represent about 70% of household credit in our sample when both type of data are available. See next section for more details.

[3] The correlation ranges from 0.46 to 0.99, with a median of 0.99 and only six countries with a correlation below 0.9.

Table 1
Data sources and covered periods.

Country	Household credit		Private credit		Mortgage		House price	
	Period	Source 1/	Period	Source 1/	Period	Source 1/	Period	Source 1/2/
Argentina	88Q1-11Q4	Other	88Q1-11Q4	BIS	94Q1-11Q4	Other	88Q1-11Q4	GPG
Australia	70Q1-12Q3	BIS	70Q1-12Q3	BIS	90Q1-12Q3	Haver	70Q1-12Q3	OECD
Austria	00Q1-12Q3	BIS	00Q1-12Q3	BIS	01Q3-12Q3	Haver	00Q1-12Q3	OECD
Belgium	70Q4-12Q3	BIS	70Q4-12Q3	BIS	92Q4-12Q3	Haver	70Q4-12Q3	OECD
Brazil	01Q1-12Q3	Other	01Q1-12Q3	BIS	05Q1-12Q3	Other	01Q1-12Q3	other
Bulgaria	95Q4-12Q4	Other	95Q4-12Q4	other	95Q4-12Q4	Other	95Q4-12Q4	GPG*
Canada	70Q1-12Q3	BIS	70Q1-12Q3	BIS	70Q1-12Q3	Haver	70Q1-12Q3	OECD
China	03Q1-12Q3	BIS	03Q1-12Q3	BIS	04Q3-12Q3	Haver	03Q1-12Q3	GPG*
Colombia	02Q3-12Q2	Other	02Q3-12Q2	other	02Q3-12Q2	Other	02Q3-12Q2	GPG*
Croatia	96Q2-12Q4	Haver	96Q2-12Q4	Haver	99Q3-12Q4	Haver	96Q2-12Q4	GPG
Cyprus	06Q1-12Q2	Haver	06Q1-12Q2	Haver	06Q1-12Q2	Haver	06Q1-12Q2	GPG*
Czech Republic	99Q1-12Q1	BIS	99Q1-12Q1	BIS	99Q1-12Q1	Haver	99Q1-12Q1	GPG*
Denmark	70Q1-12Q3	BIS	70Q1-12Q3	BIS	93Q1-12Q3	Haver	70Q1-12Q3	OECD
Estonia	03Q3-12Q4	Haver	03Q3-12Q4	Haver	03Q3-12Q4	Haver	03Q3-12Q4	OECD
Finland	70Q4-12Q3	BIS	70Q4-12Q3	BIS	03Q1-12Q3	Other	70Q4-12Q3	OECD
France	70Q1-12Q3	BIS	70Q1-12Q3	BIS	93Q1-12Q3	Haver	70Q1-12Q3	OECD
Germany	70Q1-12Q2	BIS	70Q1-12Q2	BIS	70Q1-12Q2	Haver	70Q1-12Q2	OECD
Greece	97Q1-12Q2	BIS	97Q1-12Q2	BIS	97Q1-12Q2	Haver	97Q1-12Q2	OECD
Hong Kong	93Q1-12Q3	BIS	93Q1-12Q3	BIS	96Q2-12Q3	Other	93Q1-12Q3	GPG
Hungary	98Q1-12Q2	BIS	98Q1-12Q2	BIS	00Q1-12Q2	Haver	98Q1-12Q2	GPG
Iceland	03Q3-12Q4	Haver	03Q3-12Q4	Haver	08Q4-12Q4	Haver (annual)	03Q3-12Q4	GPG*
India	01Q4-12Q3	BIS	01Q4-12Q3	BIS	02Q4-11Q4	Haver (annual)	01Q4-12Q3	GPG*
Indonesia	90Q1-12Q3	BIS	90Q1-12Q3	BIS	11Q1-12Q3	Other	90Q1-12Q3	GPG*
Ireland	71Q2-12Q3	BIS	71Q2-12Q3	BIS	03Q1-12Q3	Haver	71Q2-12Q3	OECD
Israel	99Q4-12Q4	Haver	99Q4-12Q4	Haver	99Q4-12Q4	Haver	99Q4-12Q4	GPG*
Italy	70Q1-12Q3	BIS	70Q1-12Q3	BIS	98Q2-12Q3	Haver	70Q1-12Q3	OECD
Japan	70Q1-12Q3	BIS	70Q1-12Q3	BIS	75Q4-12Q3	Haver	70Q1-12Q3	OECD
Latvia	04Q1-12Q4	Haver	04Q1-12Q4	Haver	04Q1-12Q4	Haver	04Q1-12Q4	GPG
Lithuania	94Q1-12Q4	Haver	94Q1-12Q4	Haver	04Q1-12Q4	Haver	94Q1-12Q4	GPG
Luxembourg	05Q1-12Q3	BIS	05Q1-12Q3	BIS	05Q1-12Q3	Haver	05Q1-12Q3	GPG*
Malaysia	00Q1-12Q3	Haver	00Q1-12Q3	BIS	00Q1-12Q3	Haver	00Q1-12Q3	GPG*
Malta	03Q4-12Q3	Haver	03Q4-12Q3	Haver	03Q4-12Q3	Haver	03Q4-12Q3	GPG*
Mexico	05Q1-12Q3	BIS	05Q1-12Q3	BIS	05Q1-12Q3	Other	05Q1-12Q3	GPG*
Netherlands	70Q1-12Q2	BIS	70Q1-12Q2	BIS	03Q1-12Q2	Haver	70Q1-12Q2	OECD
New Zealand	70Q1-11Q2	Other	70Q1-11Q2	IFS	98Q2-11Q2	Other	70Q1-11Q2	OECD
Norway	70Q1-12Q3	BIS	70Q1-12Q3	BIS	97Q1-11Q4	Haver	70Q1-12Q3	OECD
Philippines	00Q1-12Q4	Other	00Q1-12Q4	other	00Q1-12Q4	Other	00Q1-12Q4	GPG
Poland	04Q1-12Q3	BIS	04Q1-12Q3	BIS	04Q1-12Q3	Haver	04Q1-12Q3	other
Portugal	88Q1-12Q3	BIS	88Q1-12Q3	BIS	07Q4-12Q3	Other	88Q1-12Q3	OECD
Russia	00Q1-11Q4	Other	00Q1-11Q4	BIS	05Q4-11Q4	Other	00Q1-11Q4	GPG*
Singapore	91Q1-12Q3	BIS	91Q1-12Q3	BIS	91Q1-12Q3	Other	91Q1-12Q3	GPG*
Slovenia	04Q1-12Q4	Haver	04Q1-12Q4	Haver	04Q1-12Q4	Haver	04Q1-12Q4	OECD
South Africa	80Q1-12Q3	BIS	80Q1-12Q3	BIS	80Q1-12Q3	Haver	80Q1-12Q3	GPG
South Korea	86Q1-12Q3	BIS	86Q1-12Q3	BIS	05Q4-12Q3	Haver	86Q1-12Q3	OECD
Spain	71Q1-12Q3	BIS	71Q1-12Q3	BIS	92Q4-12Q3	Haver	71Q1-12Q3	OECD
Sweden	70Q1-12Q3	BIS	70Q1-12Q3	BIS	01Q4-12Q3	Other	70Q1-12Q3	OECD
Switzerland	75Q2-12Q3	BIS	75Q2-12Q3	BIS	85Q2-12Q3	Haver	75Q2-12Q3	OECD
Thailand	91Q1-12Q3	BIS	91Q1-12Q3	BIS	03Q4-12Q3	Haver	91Q1-12Q3	GPG*
Turkey	07Q2-12Q3	BIS	07Q2-12Q3	BIS	07Q2-12Q3	Haver	07Q2-12Q3	GPG
UK	70Q1-12Q3	BIS	70Q1-12Q3	BIS	87Q1-12Q3	Haver	70Q1-12Q3	OECD
Ukraine	01Q1-12Q4	Haver	01Q1-12Q4	Haver	06Q1-12Q4	Haver	01Q1-12Q4	GPG
Uruguay	99Q2-11Q2	Other	99Q2-11Q2	Other			99Q2-11Q2	GPG
USA	70Q1-12Q3	BIS	70Q1-12Q3	BIS	70Q1-12Q3	Haver	70Q1-12Q3	OECD

Sources: BIS, Global Property Guide, OECD, Haver Analytics, National sources, and IMF.
Notes: 1/ "Other" corresponds to national sources (e.g., central banks, banking supervisors, etc.) 2/ Global Property Guide (GPG) house price indices compiled from national government sources are denoted with a "*".

Table 1, we complemented this BIS dataset by a using Haver Analytics and other country-specific sources (e.g., countries' Central Banks) for a total of 14 countries and 19 countries out of 53 countries for private credit and household credit, respectively. The bank credit data are at quarterly frequency, with some countries starting in 1970Q1.

2.2. House prices

The data on house prices comes mostly from either the Organization for Economic Co-operation and Development (OECD) or Global Property Guide (GPG). Both datasets measure the prices of residential properties over time. Measuring the evolution of property prices in a country is not a simple task, since, unlike goods in a consumer basket index, two residential properties are not exactly the same and the price of a property is only observed when it is transacted. Moreover, despite recent advances, there are often differences in the coverage of the indices (e.g., geographical, type of properties, etc.), so the choice of source data faces trade-offs, in respect of comprehensiveness and coverage.[4] In this context, we use OECD house price indices, which covers the prices for the sale of newly-built and existing dwellings, as much as possible. For the

[4] For more details, see Silver (2016).

other countries, when the data was not available in OECD or the time series were short, we either use information from GPG or national sources. The used data in GPG was compiled mostly from official sources (in 16 out the 25 cases as shown in Table 1, which also displays the sources and the time periods used for each country). We also selected the largest geographical coverage available.

2.3. Housing finance characteristics

Specific housing finance characteristics may contribute to the differences in the evolution and interaction between household credit and house prices across-countries. In some countries, the mortgage market receives little-to-no support from the government while, in others, households are given strong incentives that may tilt their decisions toward ownership and indebtedness and away from renting. Differences also exist in default laws, the maturity of loans, their relative size, and the types of funding used by lenders. We collected data on six house financing characteristics for the countries in our sample for 2005 or the closest year to 2005 for which data are available. We focus on the pre-crisis period because, in the next section, we link these characteristic with the end-of-the-2000s house-price booms.[5] The data was collected from various sources (e.g., IMF, Hofinet, OECD, European Mortgage Federation (EMF), National Statistics, and Central Banks), and double-checked and complemented by a survey compiled by staff from the International Monetary Fund working on each of the 53 countries in our sample. These six housing finance characteristics for which we successfully compiled the data for the 53 countries in the sample are the following:

Maximum Observed LTV: The country-specific upper limit of LTV can serve as a proxy for borrowing constraints (especially for new borrowers). In many instances the maximum observed LTV corresponds to its legal limit (when such limit exists).[6] As shown in Table 2, most countries seem to be in the 70–80 and 90–100 LTV buckets. The maximum observed LTV ranges from 70% (Colombia, Hong Kong, and Hungary) to 125% (the Netherlands). The median maximum observed LTV is 83%. Cerutti et al. (2015) documented that larger maximum LTV was consistently positively correlated with the depth of the mortgage markets in a similar sample of countries.

Term to maturity: The maturity of mortgage loans varies between 7 years (Turkey) and 45 years (Sweden), with a median of 25 years. This heterogeneity is also likely to be linked to differences in financial development and home affordability, and they could facilitate house-price booms by increasing households' tolerance to indebtedness.

Interest type: Mortgage rates can be fixed through the life of a loan, or vary over time with changes linked to key interest rates. In our sample, the standard mortgage rate is variable in 30 countries, fixed in 12 countries; while in the remaining 14 countries both contracts are observed. Variable rates are more common in emerging economies (see Table 2). The presence of fixed rates could in principle increase the likelihood of house-price booms since it could alleviate credit risk.

Funding model: Countries' funding models for house finance are also heterogeneous. In many countries (44 countries out of our sample of 53 countries), retail deposits are the primary source of funding mortgages, but in other countries non-deposit funding is main source of financing. As shown in Table 2, retail deposits are the primary source not only in most emerging markets but also in some advanced economies, such as Canada, France, and Germany. The alternative funding models are diverse, and they include securitization in the United States and Colombia, mortgage bonds in the form of covered bonds in Sweden and Denmark, wholesale funding markets (loans from other banks or corporations) in Australia and South Africa; and other sources which are usually linked with government related institutions, such as Infonavit in Mexico and the Housing Development Board in Singapore.

Degree of lender recourse on mortgages: The rights of lenders to pursue a borrower's assets (other than the house securing the mortgage) in case of a default, referred to as the right to recourse, also varies across countries (and sometimes, across jurisdictions within the same country, such as across different states in the United States). In about 44 of the 53 countries in the sample, there is full recourse on mortgages. Full recourse increases borrowers' incentives to honor the terms of the contract and has been associated with lower default rates (see Duygan-Bump and Grant, 2008, for evidence from Europe).

Mortgage interest tax deduction: In 33 of the countries in our sample, households are allowed to deduct mortgage interest payments from their taxable income. Interest deductibility is more common in advanced economies than in emerging market countries (about two-thirds versus half of the cases in our sample; see Table 2) and it varies substantially from country to country. In many cases, deductions are capped to a maximum (for example, Poland and South Korea), and the United States and Norway are the only cases that allow for nearly full deductibility without taxing imputed rents (IMF, 2011). Government support to mortgage markets can go beyond interest rate deductibility, and include subsidies (for example, to first-time buyers or other selected groups), a government agency providing guarantees and/or loans, capital-gain tax deductibility, and state-owned institutions playing a major role in mortgage markets (IMF, 2011). But cross-country data availability limits our focus to interest deductibility.

3. Housing finance and real-estate booms

There are several reasons why real-estate and housing finance markets sit at the nexus of macroeconomic and financial stability. First, size matters. Real-estate-related lending accounts for a large share of household credit and often a major portion of a financial sector's activities. Second, leverage matters. Through mortgages, households are allowed leverage limits much higher than with other asset classes. Further, real estate is collateral for not only households and construction companies, but also for firms in other sectors. And major housing lenders are typically commercial banks, which are themselves leveraged. In this context, housing finance markets might become excessively large or increase swiftly due to lax lending standards or distorted incentives (for example, implicit leverage subsidies linked to interest deductibility) harboring vulnerabilities for the overall economy.

This section explores the relationship between household credit, house-price dynamics, and real-sector performance; and the extent to which it is influenced by housing finance characteristics.

3.1. Defining and identifying credit booms and real-estate booms

There is no widely accepted definition of what constitutes a real-estate or a credit boom. These episodes are generally defined as large and persistent deviations of house prices and credit aggregates from some historical norm. And previous literature has employed different definitions of historical norm (different filters, different time windows, country-specific or not) and different approaches to measure these deviations (different thresholds, real versus nominal growth, absolute levels and values relative to GDP).

[5] There have been some changes after the crisis in some countries (e.g., in the use of LTVs; see Cerutti et al., 2017 for more details). However, there is not enough data to capture their impact in terms of house price booms and busts.

[6] The legal limit corresponds to the maximum-observed LTV in about half of the countries in the sample. Overall legal limits were not often changed until the late 2000s.

Table 2
House finance characteristics.

Country 1/	MaxLTV	Term to maturity	Tax deduction	Full recourse	Interest type	Funding type
Argentina (EM)	80	20	Yes	No	Variable	Retail Deposit
Australia (AE)	100	25	No	Yes	Variable	Wholesale
Austria (AE)	80	25	No	Yes	Fixed	Retail Deposit
Belgium (AE)	100	20	Yes	Yes	Fixed	Retail Deposit
Brazil (EM)	90	25	No	No	Fixed	Retail Deposit
Bulgaria (EM)	81	15	No	Yes	Variable	Retail Deposit
Canada (AE)	95	25	No	Yes	Mixed	Retail Deposit
China (EM)	80	15	No	No	Variable	Retail Deposit
Colombia (EM)	70	15	Yes	Yes	Fixed	Securitization
Croatia (EM)	50	30	Yes	Yes	Mixed	Retail Deposit
Cyprus (AE)	80	30	No	No	Mixed	Retail Deposit
Czech Republic (AE)	100	20	Yes	Yes	Mixed	Retail Deposit
Denmark (AE)	80	30	Yes	Yes	Mixed	Mtg. Bonds
Estonia (AE)	90	30	Yes	Yes	Variable	Retail Deposit
Finland (AE)	80	20	Yes	Yes	Variable	Retail Deposit
France (AE)	100	20	No	Yes	Fixed	Retail Deposit
Germany (AE)	80	15	No	Yes	Fixed	Retail Deposit
Greece (AE)	80	15	Yes	Yes	Variable	Retail Deposit
Hong Kong (AE)	70	15	No	Yes	Variable	Other
Hungary (EM)	70	20	No	Yes	Mixed	Mtg. Bonds
Iceland (AE)	100	40	Yes	Yes	Fixed	Retail Deposit
India (EM)	110	20	Yes	No	Mixed	Retail Deposit
Indonesia (EM)	90	20	No	No	Variable	Retail Deposit
Ireland (EM)	100	40	Yes	Yes	Mixed	Retail Deposit
Israel (AE)	95	20	No	Yes	Mixed	Retail Deposit
Italy (AE)	80	22	Yes	Yes	Variable	Retail Deposit
Japan (AE)	80	30	Yes	Yes	Mixed	Retail Deposit
Latvia (EM)	100	30	No	Yes	Variable	Retail Deposit
Lithuania (EM)	100	25	Yes	Yes	Variable	Retail Deposit
Luxembourg (AE)	80	25	Yes	Yes	Variable	Retail Deposit
Malaysia (EM)	80	35	Yes	No	Variable	Retail Deposit
Malta (AE)	80	30	No	Yes	Fixed	Retail Deposit
Mexico (EM)	100	25	Yes	No	Variable	Other
Netherlands (AE)	125	30	Yes	Yes	Fixed	Retail Deposit
New Zealand (AE)	85	30	No	Yes	Variable	Retail Deposit
Norway (AE)	85	20	Yes	Yes	Variable	Retail Deposit
Philippines (EM)	80	30	No	Yes	Variable	Other
Poland (EM)	100	32.5	Yes	Yes	Variable	Retail Deposit
Portugal (AE)	90	30	Yes	No	Variable	Retail Deposit
Russia (EM)	100	20	Yes	Yes	Mixed	Retail Deposit
Singapore (AE)	80	35	Yes	Yes	Variable	Other
Slovenia (AE)	70	10	No	Yes	Variable	Retail Deposit
South Africa (EM)	100	30	No	Yes	Variable	Wholesale
South Korea (AE)	70	20	Yes	No	Variable	Retail Deposit
Spain (AE)	100	20	Yes	Yes	Variable	Retail Deposit
Sweden (AE)	95	45	Yes	Yes	Variable	Mtg. Bonds
Switzerland (AE)	80	20	Yes	Yes	Fixed	Retail Deposit
Thailand (EM)	100	20	Yes	Yes	Mixed	Retail Deposit
Turkey (EM)	75	7.5	No	Yes	Fixed	Retail Deposit
UK (AE)	110	25	No	Yes	Variable	Retail Deposit
USA (AE)	100	30	Yes	No	Mixed	Securitization
Ukraine (EM)	100	20	Yes	No	Fixed	Other
Uruguay (EM)	70	25	No	Yes	Variable	Retail Deposit

Source: IMF, Hofinet, OECD, EMF, and National Statistics.
Notes: 1/Following IMF WEO classification, "AE" denotes Advanced Country, and "EM" Emerging Market.

Here we focus on the real growth of both house prices and credit and define boom episodes as deviations from a country-specific standard. Specifically, we identify episodes by comparing the real evolution (measured at year-over-year rates) of credit and house prices at quarterly frequency. We classify an episode as a boom if the following two conditions are satisfied: (i) the real growth rate of credit (house prices) is greater than 10 (5) percent, or *two* standard deviations of the country-specific distribution of credit (house prices) real growth rates in a given quarter; and (ii) the real growth rate of credit (house prices) is above 10 (5) percent or *one* standard deviation of the country-specific distribution of credit (house prices) real growth rates for a period of at least 2 years. The first condition ensures that a boom episode contains at least a quarter with an annual growth rate above 10% or two standard deviations for credit, and above 5% or two standard deviations in the case of house prices. The second conditions rules out very short-lived spikes in credit and house prices.[7]

3.2. Occurrence of credit booms

We apply this definition to the 53 countries for which house-price, household-credit, and corporate-credit data are available on a quarterly basis. The sample starts as far back as the 1970s, for some countries, and extends to 2012. We focus our attention on three different types of credit booms: (i) household-credit booms; (ii) corporate-credit booms; and (iii) overall private-sector-credit

[7] As shown in Annex I, our results are robust to changing the ad hoc thresholds to the upper quarter of the distributions and reducing the minimum duration of booms to six quarters.

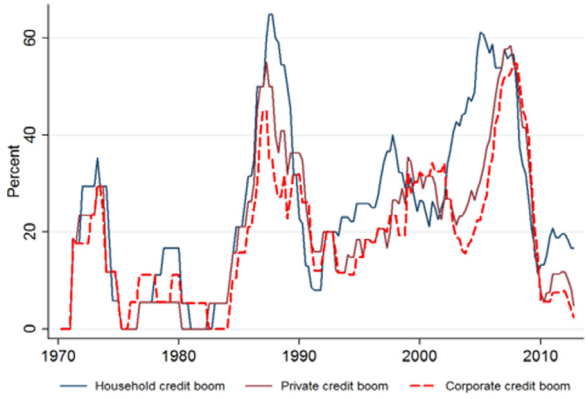

Fig. 1. Occurrence of credit booms during 1970–2012 (as percentage of countries in the sample).

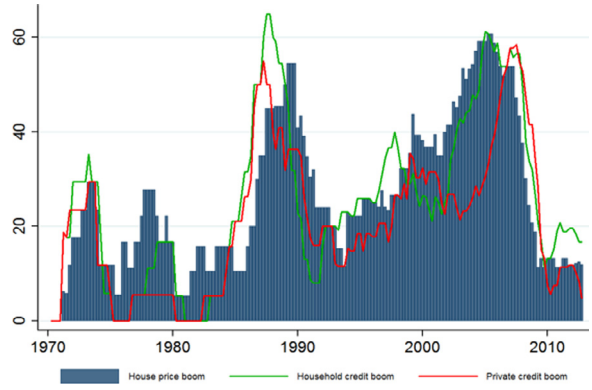

Fig. 2. Occurrence of house price booms and credit booms (as percentage of countries in the sample).

booms. Although private credit is the sum of household and corporate credit, we include it separately in the analysis. First, it is a useful benchmark, since total private credit is the variable most often used in previous studies on credit booms. Second, private-credit booms generally coincide with generalized credit overheating episodes in which both household and corporate credit are booming.

Based on our definition, we find 83 household-credit booms, 68 corporate-credit booms, and 67 private-credit booms during the period 1970–2012. Reflecting the composition of our sample (heavy in advanced economies), most episodes (about 60–65%) occur in advanced countries. However, once we control for this bias, emerging markets appear to be in a boom state more often than advanced economies (the portion of quarterly observations classified as booms is roughly double that of advanced economies).

The higher frequency of household-credit booms is reflected in Fig. 1, which shows the proportion of countries that are experiencing credit booms during each quarter.[8] The higher occurrence of credit booms after the 1980s could be at least partly attributed to the wave of banking and mortgage deregulation as well as to financial innovations such as the rise in securitization (for more details see IMF, 2008; Agnello and Schuknecht, 2011, and Muellbauer and Murphy, 1997). The picture also suggests that booms tend to come in bunches, suggesting that global factors play at least some role (Mendoza and Terrones, 2008).

3.3. Occurrence of house-price booms

We identify 85 house-price booms. Most countries in the sample experienced at least one of these episodes. And, as shown in Fig. 2, the all-time peak in the relative occurrence of house-price booms was during the period just before the recent global financial crisis (in 2005, there were booms in more than half of the sampled countries). Not surprisingly, booms were rare in the immediate aftermath of the global financial crisis: less than 10% of the countries were experiencing a credit boom as of 2012: Q4.[9]

Household-credit booms and house-price booms tend to occur together. Moreover, they seem more in sync than private-credit booms and house-price booms. This aligns with findings that household credit is a better proxy for understanding house-price fluctuations than the commonly used private-sector credit.[10]

3.4. Interaction between real-estate booms and credit booms

The rest of this section explores the historical relationship between credit booms and house-price booms and the macroeconomic performance around these episodes. Then, it studies the factors that can help predict whether house-price booms will turn into recessions and/or financial crises.

3.5. Can credit booms help predict house-price booms?

The following probit model is estimated in order to capture the potential effect of credit booms into housing price booms:

$$(housing\ boom = 1)_{it} = \alpha + \beta X_{it-4} + \gamma Y_t + \theta credit\_boom_{it-4} + \varepsilon_{it}$$

in which the dependent variable *house-price boom* is a dummy equal to one when there is a real-estate boom and 0 otherwise; and *credit_boom* corresponds to the four-quarters lag credit-boom dummy in household or private credit. The control variables include housing finance characteristics and other variables used in the house-price boom literature (the log of per-capita real GDP, the level of short-term interest rates, household indebtedness, the VIX, GDP growth, CPI inflation, and the current account balance in percent of GDP).

Since the objective of the exercise is to explore the predictive power of these variables, we lag all the "slow moving" regressors by four quarters. To some extent, this may also help to reduce endogeneity. Yet, one should use caution in interpreting the results as causal relationships. Finally, since the time dimension of the estimated panel is relatively large (about 100 observations on average), fixed-effect estimates do not suffer from the incidental parameters bias problem, hence the Fernandez-Val (2009) Probit bias-corrected estimator is not necessary.[11]

The results are shown in Table 3, and they indicate that household-credit booms are statistically significant predictors of

[8] Although the overall peaks on the incidence of household-credit booms seems to precede other credit booms since the mid-1990s, this pattern is not uniform within individual countries. There are 17 cases of household-credit booms preceding house prices booms, and 10 cases in which the opposite took place.

[9] These countries were Brazil, Hong Kong, India, Israel, Malaysia, and Norway.

[10] Following the literature, we also regress the yearly change in house prices (using quarterly data) on lag changes in house prices, credit, employment, and the level of interest rates. We find that household-credit growth is a strong predictor of house-price growth. A 1 percent increase in household credit is associated with about 0.2 percent increase in house prices in the following year. We compare private credit with household credit and find that the latter is a much stronger and more robust predictor of house-price growth.

[11] Results are robust to the selection of the number of lags. In the regression without house finance characteristics we include country fixed effects in addition to the time-varying variables.

Table 3
Triggers of house-price booms.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
HH Credit Boom (lag)	0.784***	0.734***	0.753***	0.758***	0.567***	0.533**	0.550**	0.529**	0.524**	0.575***	0.656***
	(0.237)	(0.241)	(0.240)	(0.236)	(0.210)	(0.212)	(0.216)	(0.211)	(0.209)	(0.206)	(0.223)
Private Credit Boom (lag)	0.310	0.516**	0.302	0.494**	0.447**	0.447**	0.459**	0.440**	0.446**	0.433**	0.462**
	(0.224)	(0.225)	(0.235)	(0.233)	(0.212)	(0.217)	(0.217)	(0.217)	(0.218)	(0.206)	(0.215)
HH Indebtedness (lag)	-0.0331***	-0.0439***	-0.0288***	-0.0363***	-0.0169***	-0.0155***	-0.0131***	-0.0130***	-0.0135***	-0.0161***	-0.0239***
	(0.00947)	(0.0109)	(0.00953)	(0.0114)	(0.00392)	(0.00359)	(0.00330)	(0.00331)	(0.00366)	(0.00390)	(0.00491)
Log of GDP per capita (lag)	1.642**	1.299	0.672	0.713	0.315***	0.382***	0.284**	0.271**	0.269**	0.292**	0.525***
	(0.676)	(0.987)	(0.637)	(1.033)	(0.109)	(0.141)	(0.124)	(0.120)	(0.120)	(0.115)	(0.128)
US Fed Fund Rate	-0.0358*		-0.0289								
	(0.0204)		(0.0270)								
VIX Index		-0.0210***		-0.0201***	-0.0303***	-0.0307***	-0.0304***	-0.0303***	-0.0302***	-0.0300***	-0.0311***
		(0.00648)		(0.00662)	(0.00601)	(0.00582)	(0.00577)	(0.00574)	(0.00573)	(0.00590)	(0.00626)
Current Account (lag)			0.0578***	0.0716***	0.0317**	0.0234*	0.0274**	0.0250*	0.0252*	0.0394***	0.0483***
			(0.0161)	(0.0217)	(0.0141)	(0.0129)	(0.0130)	(0.0129)	(0.0136)	(0.0128)	(0.0133)
GDP growth (lag)			0.0723***	0.0668***	0.0424***	0.0420***	0.0422***	0.0429***	0.0419***	0.0465***	0.0420***
			(0.0163)	(0.0179)	(0.0149)	(0.0153)	(0.0153)	(0.0148)	(0.0144)	(0.0149)	(0.0157)
CPI Inflation (lag)			-0.0754***	-0.0331	0.00606	0.0140	0.0188	0.0187	0.0184	0.0121	-0.00314
			(0.0228)	(0.0284)	(0.0224)	(0.0194)	(0.0201)	(0.0212)	(0.0204)	(0.0199)	(0.0205)
Max observed LTV					0.0250***						0.0307***
					(0.00759)						(0.00735)
Full recourse						-0.444*					-0.578**
						(0.254)					(0.269)
Tax deduction							-0.149				-0.396*
							(0.202)				(0.222)
Interest type								-0.00574			-0.104
								(0.124)			(0.121)
Term to maturity									0.00623		-0.00220
									(0.0136)		(0.0140)
Funding_Mortg Bond										0.149	0.498
										(0.400)	(0.442)
Funding_Securitization										0.799***	1.000*
										(0.128)	(0.534)
Funding_Wholesale										0.865***	0.598**
										(0.184)	(0.293)
Funding_Other										-0.491	-0.423
										(0.375)	(0.398)
Country Fixed Effects	YES	YES	YES	YES	NO	NO	NO	NO	NO	NO	NO
Observations	4406	3081	4218	3021	2335	2335	2335	2335	2335	2335	2335
R-sq	0.191	0.252	0.254	0.289	0.222	0.193	0.186	0.184	0.185	0.211	0.269

Notes: The table reports the estimates of a probit model over the period 1970q1–2012q4, with robust standard errors that are clustered at the country level. The dependent variable takes the value of one during house-price booms. Lagged variables correspond to 4 quarters lags. *** indicates significance at 1%, ** at 5%, and * at 10%, respectively. The omitted funding model variable in columns (10) and (11) is retail deposits.

real-estate booms. The presence of a household-credit boom increases the probability of a real-estate boom to 57% against an unconditional probability of 29%. Across specifications, household-credit booms are better predictors of house-price booms than private-credit booms. The level of household debt to GDP is also a statistically significant predictor, but its coefficient is negative, signaling that initial high household leverage levels seem to decrease the occurrence of real-estate booms. The role of global factors simultaneously driving house-price booms across countries is also reflected in the expected negative signs of the US Federal Funds rates and VIX, which are statistically significant across most specifications. This is in line with the literature. For example, Agnello and Schuknecht (2011) also find that international liquidity plays a significant role and increases the probability of house-price boom episodes.

Finally, lagged GDP growth is positively associated with the probability of a real-estate boom, indicating that real-estate booms tend to start during or in the immediate aftermath of periods of buoyant economic growth. The coefficient of the current account balance is also positive and statistically significant across specifications, signaling that, on average real-estate booms have a larger probability to start during favorable external conditions. This relation clearly does not hold in all countries. While in many countries (for example, Germany and South Korea) house-price booms have been associated with current account surpluses, in other countries, such as the United States, house-price booms have typically been associated with current account deficits (Ferrero, 2012).

In order to include housing finance characteristics (only available for recent years) in the regressions, we run estimations (columns 5–11) for the period 2000–2012 without including country fixed effects. Results are similar to the full sample with respect to the importance of household-credit booms, household leverage levels, GDP growth, and current account-balance variables. Among the house financial characteristics added to the estimations, there three type of variables that are statistically significant: the maximum observed LTV, the presence of full recourse, and some type of funding models. The higher the maximum observed LTV, the higher the probability of a real-estate boom. This is most likely capturing the effect of relaxed lending standards on house prices, and is supported by other studies (Crowe et al., 2011; and IMF, 2011) that have found a positive relationship between LTV limits and house price increases over time. The presence of full recourse seems to lower the probability of real estate booms, which is probably capturing borrowers higher risk exposures in overvalued house markets when they are subject to full recourse. The funding models dummies, where retail deposit is the omitted category, indicate that countries with funding models based on securitization or wholesale sources are more likely to experience house

Table 4
Characteristics of house-price booms.

Boom classification	Number of episodes	Duration		Average growth of house price		Average growth of household credit		Average growth of firm credit		Average growth of private credit	
		Mean	Median	Mean	Median	Mean	Median	Mean	Median	Mean	Median
House-price booms without any credit boom	18	13.6	10.5	10.1	8.7	4.7	5.9	4.8	5.4	5.2	5.3
House-price booms with only household credit boom	16	13.9	13.0	9.4	9.0	11.2	10.5	2.8	3.8	5.6	6.3
House-price booms with private credit boom	49	18.3	15.0	14.8	13.3	20.0	14.5	12.9	11.2	14.8	13.1
No house-price boom episodes	–	–	–	-1.7	-1.1	5.2	4.3	3.8	3.2	4.3	3.5

Source: IMF staff estimations based on Bank for International Settlements; central bank data; Haver Analytics; and IMF IFS.
Notes: A total of 85 house-price booms were identified. In addition of the 83 house-price booms presented in the table, there are two house-price booms which were associated with corporate credit booms (Hong Kong 2004:Q1–05:Q4 and Singapore 2006:Q3–08:Q2). They are not reflected in the table because their small sample does not provide enough observations for meaningful comparisons with the other type of house-price booms.

price booms. This is also in line with the literature which highlight that securitization strategies and wholesale funding are typically more scalable during booms.

3.6. Classifying real-estate booms based on the evolution of credit

So far the analysis has highlighted that credit booms, especially household-credit ones, are good predictors of real-estate booms. In the rest of the section, we further explore this interaction by identifying the characteristics and consequences of real-estate booms as a function of whether they coincided with: (i) no credit booms; (ii) *only* corporate-credit booms, (ii) *only* household-credit booms, and (iv) private (twin household and corporate) credit booms.

Most real-estate booms in the sample coincide with private (twin household and corporate) credit booms.[12] Table 4 shows that 49 of the 85 real-estate booms coincide with private-credit booms. There are 16 real-estate booms accompanied by household-credit (but not aggregate) booms. And only two house-price booms in the sample are associated with booms limited to corporate credit (Hong Kong 2004: Q1–05: Q4 and Singapore 2006: Q3–08: Q2). While they may make for interesting case studies, these findings are too few in number for a meaningful comparison with the other type of house-price booms. Finally, 18 real-estate booms happened without any type of credit booms.[13]

Real-estate booms associated with different types of credit episodes also differ with regard to size and duration. On average, house-price booms accompanied by private-credit booms (about 18 quarters) last longer than the other two cases (about 14 quarters). The average real increase in house prices during booms accompanied by a private-credit boom (14%) is higher than in episodes with only household-credit booms (9%) and without any credit boom (10%). Similarly, as also shown in Fig. 3, the average real household-credit growth is much larger in the case of house-price booms accompanied by private (twin household-corporate) credit

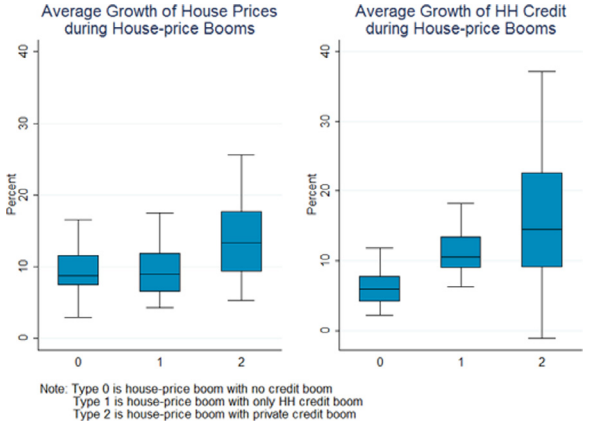

Fig. 3. Change in house prices and HH credit during housing booms.

booms (about 21%) than in the case of house-price booms with only household-credit booms (11%) or without any credit booms (5%).

3.7. Macroeconomic performance during real-estate booms

As discussed previously, real economic activity, aggregate credit, and house-price fluctuation are closely linked through wealth effects and the financial accelerator mechanism (see, among others, Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997; Gilchrist and Zakrajsek, 2008; Mian and Sufi, 2011; Quint and Rabanal, 2014). In an upturn, better growth prospects improve borrower creditworthiness and collateral values. Lenders respond with an increased supply of credit and, sometimes, looser lending standards. More abundant credit allows for greater investment and consumption and further increases house prices and collateral values. In a downturn, the process is reversed.

In this context, not surprisingly, economic activity is significantly higher during real-estate booms compared to non-boom years (see Table 5 and Fig. 4). Real GDP growth during house-price booms is higher than during non-boom periods by about 1¼ to 2 ½%. These differences are statistically significant (see *p*-values in the lower part of Table 5). In addition, the different performances among house-price boom types shows that house-price booms that coincide with private-credit booms register higher (statistically significant) real-GDP growth than episodes accompanied by household-credit booms or occurring in the absence of a credit boom.

Consistently, consumption and investment growth are higher during house-price booms with private-credit booms than in tran-

[12] In the presence of a housing boom, a private-credit boom episode coincides almost always with simultaneous household and corporate credit booms. There are only four exceptions, when the very high growth in household credit growth triggered a private-credit boom without the presence of a corporate credit growth. These cases are Canada 1973:Q1–76:Q1, Czech Republic 2006:Q3–08:Q4, Denmark 2004:Q1–07:Q1, and Greece 2005–07:Q1.

[13] Many of these episodes may have been driven by country-idiosyncratic shocks and/or structural characteristics. For example, Germany's boom during 1990:Q1–92:Q2 was supported by post-reunification fiscal measures—temporary generous tax breaks for remodeling or building real estate in the former East Germany or Berlin. The house-price booms in Canada during the period 2002:Q2–08:Q2 reflected some regional economic booms, together with a conservative residential mortgage market in terms of regulation, and with lack of some fiscal incentives such as tax deductibility of mortgage interests (see IMF, 2009). There are also about six house-price booms during which there was a simultaneous spike in credit, but it was not persistent enough to satisfy our credit-boom criteria.

Table 5
Macroeconomic performance during house-price booms.

Boom classification	Type	Number of observations	Macro performance during the boom					
			Average RGDP growth	Average inflation	Average change of exchange rate (NC/$)	Average consumption growth	Average investment growth	Average current account (percent of GDP)
House-price booms without any credit boom	0	18	3.95	5.95	0.22	3.65	4.51	1.01
House-price booms with only household credit boom	1	16	4.06	3.69	-4.10	1.02	1.74	-0.81
House-price boom with private credit boom	2	49	5.84	5.08	-1.30	2.26	5.00	-1.88
Non boom episodes	3	–	2.67	5.23	2.02	1.31	1.19	0.01
Joint coefficients tests			*(p values)*					
Type 0 and 3 are the same			**0.03**	0.56	0.27	**0.07**	**0.08**	0.39
Type 1 and 3 are the same			**0.01**	**0.03**	**0.00**	0.25	**0.05**	0.45
Type 2 and 3 are the same			**0.00**	0.74	**0.00**	**0.02**	**0.00**	**0.06**
Type 0 and 1 are the same			0.87	0.12	**0.02**	**0.05**	0.14	0.25
Type 0 and 2 are the same			**0.04**	0.41	0.39	0.16	0.77	0.10
Type 1 and 2 are the same			**0.05**	0.12	**0.09**	**0.08**	**0.02**	0.56

Source: IMF staff estimations based on Bank for International Settlements; central bank data; Haver Analytics; and IMF IFS.
Notes: A total of 85 house-price booms were identified. In addition of the 83 house-price booms presented in the table, there are two house-price booms which were associated with corporate credit booms (Hong Kong 2004:Q1–05:Q4 and Singapore 2006:Q3–08:Q2). They are not reflected in the table because their small sample does not provide enough observations for meaningful comparisons with the other type of house-price booms. Bold figures denote statistically significant levels of at least 10 percent.

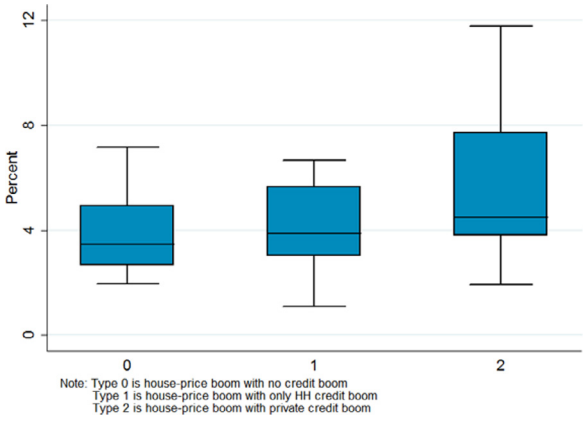

Fig. 4. Average growth of real GDP during house-price booms.

Fig. 5. Change in house prices after housing booms.

quil times (see *p*-values of joint coefficient test for "Type 2 and 3 are the same" in Table 5). There is also evidence of an appreciation of the exchange rate with house-price booms that were accompanied by credit booms. This is consistent with the literature (for example, Dell' Ariccia et al., 2012) that highlights that credit booms are associated with real exchange-rate appreciations and current-account deteriorations.

Finally, the analysis shows that inflation typically remains subdued and is not much different from levels that prevail in tranquil times. This is in line with the recent empirical evidence documenting how credit and asset-price imbalances can grow under seemingly tranquil macroeconomic conditions (low and stable inflation and output gap). It suggests that, should monetary policy lean against the wind to contain these kind of episodes, a trade-off might emerge (at least in the short-run) with its traditional price-stability objective. (See Bayoumi et al., 2014, for a review of the debate on the role of monetary policy in containing asset-price booms.)

3.8. Performance in the aftermath of real-estate booms

House prices generally decline after real-estate booms (although not in all cases), and in several cases, the adjustment is substantial. Fig. 5 (left-hand side) displays the correction in house prices observed within a 3-year window after the end of real-estate booms. Real-estate booms that occur with private-credit booms (type 2 in the figure) tend to be followed by the largest falls in house prices. Further, there is little evidence that these sharp declines are systematically followed by rebounds (Fig. 5, right panel).

Drops in house prices are generally accompanied by recessions (in our sample, 49 out of 78 house-price booms ended up in reces-

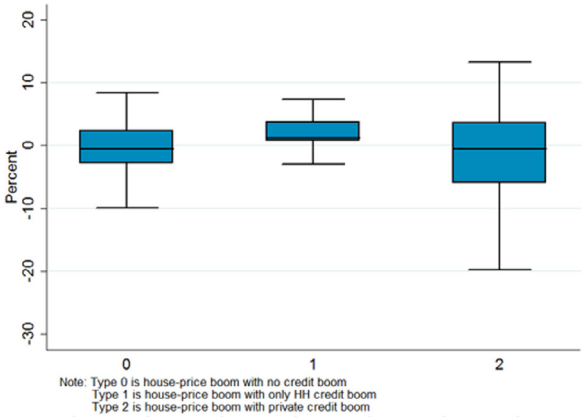

Fig. 6. Lowest annual change in real GDP after housing booms.

sions).[14] Yet, there is substantial heterogeneity in the performance of real GDP post real-estate booms (see Fig. 6). This largely depends on whether a bust occurs. Indeed, output losses in recessions accompanied by housing busts are two to three times greater than in "normal" recessions (Claessens et al., 2009).

3.9. Can we tell bad real-estate booms from good ones?

The previous analysis has shown that the end of a real-estate boom is often related to significant falls in house prices and economic recessions. The question then arises whether these "bad" booms can be distinguished from "good" ones (those that do not end up in recessions) ahead of time. We address this question by exploring whether a boom's characteristics, such as duration, associated type of credit boom, and housing finance characteristics, can help predict whether it will lead to a recession.[15] We do so by estimating the following probit model:

$$(bad\ housing\ boom = 1)_i = \alpha + \beta X_i + \theta_1 credit\_boom\_type\_1_i + \theta_2 credit\_boom\_type\_2_i + \varepsilon_i$$

in which the dependent variable, *bad house-price boom*, is a dummy equal to one when a real-estate boom ends in a recession, and 0 otherwise; and the dummies *credit_boom_type 1* and *2*, provides information on the characteristics of the house-price boom based on the evolution of credit. Based on the previously defined breakdown, *credit_boom_type 1* is equal to 1 for house-price booms with only household-credit booms (Type 1), *credit_boom_type 2* is equal to 1 for house-price booms with private (twin household and firm) credit booms (Type 2). As additional control variables, we include the log of per-capita real GDP (measured at the end of the house-price boom), the duration of the house-price boom, household credit to GDP (as proxy of indebtedness, measured also at the end of house-price boom), and housing finance characteristics.

The results, presented in Table 6, can be summarized as follows. First, the type of credit boom accompanying a real-estate boom seem to be a predictor of how the latter could end. Real-estate booms accompanied by private-credit booms (twin household-corporate credit) are more likely to end in recessions than house-price booms accompanied by only household-credit booms or without any credit booms. Second, the coefficients of house-price boom duration are not consistently statistically significant across specifications. This is capturing the fact that the duration of booms is also a function of global factors that often put an end to different booms independently of their duration. Third, the higher the level of household indebtedness, the higher the probability of a house-price boom ending in a recession. Finally, with respect to house financing characteristics that are estimated for the period 2000–2012, the results (see columns 5–11) indicate that the funding type could have a role in how housing booms have ended. The specification of distinguishing by the different type of funding is not reported because funding through securitization, mortgage bonds, and wholesale perfectly predict recessions. This is partially captured in column 10 where the coefficient is negative but not statistically significant because other funding categories are not as likely to be associated with recessions. Instead, the interaction variables between the credit boom type and retail funding are statistically significant. So, it is clear that booms in countries that rely most on bank retail deposits have a lower probability of ending in recessions. Perhaps this reflects the fact that wholesale, mortgage bonds, or securitization funding strategies are not only more scalable during booms, but can also dry up fast during recessions and crises (as during the global financial crisis).[16]

4. Policy implications

The recent global financial crisis has placed the housing market at the center stage of economic policy discussions on financial stability. While the advantages of a deep mortgage market cannot be ignored, it is now also widely recognized that housing credit excesses can happen and that their far-reaching negative consequences warrant a reassessment of how macroeconomic policy should look at real-estate market developments. Against this background, we analyzed the dynamic relationship between household credit and house-price booms, as well as the potential role some housing finance characteristics on the likelihood of house-price booms and how they ended.

The findings in this paper indicate some of the housing finance characteristics that favor mortgage market deepening, by increasing access and affordability, may also promote fast credit growth and eventually entail greater risks to financial stability. This seems to be especially the case of lending standards through LTV ratios as well as funding strategies relying on securitization and wholesale sources that seem to correlate with "excessively" rapid house credit growth. Moreover, we also find that house-price booms that are funded through securitization and wholesale markets are more likely to end badly (that is, in recessions).

In this context, housing finance regulation—which is nowadays a widely accepted part of the macroprudential policy arsenal—could play a role in reducing the frequency and severity of house-price boom episodes. Unlike monetary policy that requires an overall increase in interest rates to dampen household/mortgage credit, if effective, macroprudential policies could target directly house-

[14] The end of a housing boom is followed by a recession if the real GDP growth (year-over-year) of two or more consecutive quarters is negative within a 3-year interval after the end of the boom.

[15] Following the credit boom literature (for example, Dell'Ariccia et al., 2012) we also computed how many housing boom were followed by a banking crisis within the three-year period after the end of the boom. In our sample, about one in five housing booms (about 13 cases) are followed by a systemic banking crisis. However, this analysis is not reported because we did not find any clear link between a house-price boom ending in a systemic banking crisis and our set of underlying house-price boom characteristics. This finding is in line with Drehmann and Juselius (2013) who do not find house price growth as a good predictor of systemic banking crisis.

[16] There are three factors that could potentially contribute to the observed relation between the funding of mortgages and the outcome of the boom. First, as shown in Hahm et al. (2011), episodes of rapid increases in leverage are typically financed through wholesale funding. Second, wholesale funding exposes banks to liquidity shocks resulting in sharper contraction in credit during crises (see for example, Cornett et al., 2011; Dagher and Kazimov, 2012). Third, to varying degrees across countries, some of the non-retail lending is channeled through less regulated non-bank entities. These finance companies have been shown to have contributed disproportionally to the deterioration in lending standards during the U.S. mortgage boom (see Dagher and Fu, 2011).

Table 6
Drivers of bad house-price booms.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
HH Indebtedness	0.0110*	0.0110*	0.0481***	0.0495***	0.0487***	0.0526***	0.0534***	0.0500***	0.0530***	0.0468***	0.0510**
	(0.00665)	(0.00655)	(0.0166)	(0.0172)	(0.0173)	(0.0176)	(0.0131)	(0.0181)	(0.0159)	(0.0170)	(0.0249)
House-price boom duration	-0.0000182	-0.0000331	0.0749	0.0765	0.0819*	0.0843*	0.0683	0.0862*	0.0841*	0.0789	0.0605
	(0.0174)	(0.0175)	(0.0486)	(0.0492)	(0.0451)	(0.0457)	(0.0476)	(0.0484)	(0.0506)	(0.0485)	(0.0612)
Type 1 (with only HH credit boom)	-0.0137		-0.327		-0.276	-0.216	-0.572	-0.301	-0.282	-0.0946	3.962**
	(0.512)		(0.853)		(0.853)	(0.886)	(0.805)	(0.852)	(0.836)	(0.784)	(1.624)
Type 2 (with private credit boom)	0.573	0.580*	1.992**	2.203***	2.149***	2.375**	1.948**	1.996**	2.167**	2.143***	7.178***
	(0.432)	(0.315)	(0.814)	(0.689)	(0.816)	(0.924)	(0.770)	(0.808)	(0.849)	(0.763)	(1.390)
Log of GDP per capita	0.0331	0.0332	0.104	0.103	0.111	0.133	0.0170	0.104	0.102	0.0954	0.0864
	(0.0747)	(0.0750)	(0.114)	(0.110)	(0.113)	(0.121)	(0.128)	(0.108)	(0.121)	(0.113)	(0.111)
Max observed LTV					-0.0120						
					(0.0232)						
Full recourse						0.477					
						(0.544)					
Tax deduction							0.754				
							(0.601)				
Interest type								-0.173			
								(0.326)			
Term to maturity									0.0276		
									(0.0436)		
Funding_Retail deposits										-0.443	0.821
										(0.641)	(1.398)
Type 1*Retail deposits											-4.810**
											(2.019)
Type2*Retail deposits											-5.715***
											(1.518)
Observations	77	77	33	33	33	33	33	33	33	33	33
R sq	0.051	0.051	0.318	0.314	0.324	0.330	0.350	0.322	0.328	0.325	0.360

Notes: The table reports the estimates of a probit model over the cross-section of house-price booms during the period 1970q1–2012q4 for columns (1–2) and 2000q1–2012q4 for columns (3–6), with robust standard errors. The dependent variable takes the value of one for house price booms that ended in recessions. *** indicates significance at 1%, ** at 5%, and * at 10%, respectively. A constant was estimated but not reported.

hold leverage and indebtedness and the risk profile of mortgage originators and investors (Dell' Ariccia et al, 2012; Cerutti et al., 2015).

While these findings confirm previous work identifying macroprudential policies as useful tools for containing systemic vulnerabilities, our historical analysis also highlights that the role of monetary policy should not be downplayed. About 60% of the real-estate booms in our sample occurred together with private-credit booms. Moreover, in those episodes, the occurrence of a private-credit boom was not only associated with simultaneous household- and corporate-credit booms, but also with rapid and broad economic growth. These signs of overheating in other sectors could call for monetary policy tightening (Crowe et al., 2011; Dell' Ariccia et al, 2012; IMF, 2013) after weighing the potential benefits and risks to financial stability. Indeed, monetary policy tightening could have both positive and negative effects on financial stability, and these need to be weighed before resorting to such policy during a boom. Monetary tightening can weaken the financial condition of households and firms, increasing their interest rate burden, and induce deleveraging and reduce the value of legacy assets. Further, the absence of inflation pressure during many real-estate booms may mean that containing house-price and credit pressures through interest rate hikes may come at the cost of greater deviations from monetary policy's primary objective of price (and output) stability. That said, recent experience suggests that low and stable inflation and output gap are no longer sufficient statistics for macroeconomic stability. And proposals in favor of including real-estate prices in monetary policy response functions (Iacoviello, 2005; Aspachs-Bracons and Rabanal, 2011) deserve serious consideration; especially, should macroprudential policies prove only partly effective.

Finally, dealing with real-estate booms effectively requires a broad mix of policies that goes beyond the use of macroprudential and monetary policies, and may also involve realignment of incentives over the long run. Well-paced country-specific measures to strengthen supply-side responses would mitigate the impact of demand shocks over the long run. Abrupt supply-side modification at the peak of house-price booms or at the beginning of house-price busts could exacerbate the correction in house prices. More generally, the policy mix should also include measures to minimize distortions linked to special treatment of housing and homeownership.

Annex I: Robustness analysis of booms definitions

This Annex explores whether the findings in this note are robust to the specific definition of boom episodes discussed in Section 3.

Existing literature employs various approaches to identify credit and house-price booms and alternative thresholds. To some extent, this is more art than science. Here we compare our baseline boom episodes to the boom dummies generated by using two different filters (a backward-looking cubic trend and a Hodrick–Prescott filter) and different thresholds (separating one-quarter of the real growth rate distribution of each variable and using a minimum boom duration of six quarters instead of eight quarters). In general, the list of episodes we identify is not very sensitive to the methodology used. The major booms are captured under all methodologies. As expected, differences appear in small- and medium-sized booms where different thresholds matter more (Table A.2).

Perhaps a more important concern is that, depending on which booms each methodology/threshold leaves out, the incidence of post-bust recessions may be different. However, this does not seem to be a problem for our sample (see Table A.1). The incidence of recessions remains similar across methodologies, varying in a relatively close range from 59% to 67%.

Table A.1
Number of booms and recessions.

Boom episodes identified using:	Total number of booms	Followed by recession within 3 years of boom end (%)
Baseline (8 quarters)	85	64.1
Topthird (6 quarters)	104	64.2
Topquarter (8 quarters)	70	59.1
Cubic trend (8 quarters)	87	67.1
HP trend (8 quarters)	89	66.7

Note: The number of quarters corresponds to the minimum boom duration used in each methodology. Baseline corresponds to the threshold separating top 1/3 of the real growth rate distribution of each variable and using a minimum boom duration of 6 quarters.

Table A.2
Correlations across different methodologies.

House price	Simple correlation						Tetrachoric correlation				
	Baseline	Top third	Top quarter	Cubic trend	HP trend		Baseline	Top third	Top quarter	Cubic trend	HP trend
Baseline	1					Baseline	1				
Topthird	0.939	1				Topthird	1.000	1			
Topquarter	0.802	0.754	1			Topquarter	1.000	1.000	1		
Cubic trend	0.918	0.883	0.726	1		Cubic trend	0.994	0.984	0.955	1	
HP trend	0.907	0.872	0.717	0.975	1	HP trend	0.993	0.981	0.952	0.999	1
Household credit											
	Baseline	Top third	Top quarter	Cubic trend	HP trend		Baseline	Top third	Top quarter	Cubic trend	HP trend
Baseline	1					Baseline	1				
Topthird	0.966	1				Topthird	1.000	1			
Topquarter	0.898	0.867	1			Topquarter	1.000	1.000	1		
Cubic trend	0.842	0.829	0.776	1		Cubic trend	0.977	0.968	0.967	1	
HP trend	0.819	0.836	0.757	0.844	1	HP trend	0.972	0.974	0.965	0.972	1
Corporate credit											
	Baseline	Top third	Top quarter	Cubic trend	HP trend		Baseline	Top third	Top quarter	Cubic trend	HP trend
Baseline	1					Baseline	1				
Topthird	0.921	1				Topthird	1.000	1			
Topquarter	0.994	0.915	1			Topquarter	1.000	1.000	1		
Cubic trend	0.825	0.817	0.820	1		Cubic trend	0.976	0.964	0.974	1	
HP trend	0.806	0.784	0.800	0.891	1	HP trend	0.972	0.951	0.971	0.987	1
Private credit											
	Baseline	Top third	Top quarter	Cubic trend	HP trend		Baseline	Top third	Top quarter	Cubic trend	HP trend
Baseline	1					Baseline	1				
Topthird	0.936	1				Topthird	1.000	1			
Topquarter	0.955	0.893	1			Topquarter	1.000	1.000	1		
Cubic trend	0.834	0.803	0.794	1		Cubic trend	0.975	0.958	0.966	1	
HP trend	0.773	0.753	0.736	0.879	1	HP trend	0.956	0.936	0.943	0.985	1

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