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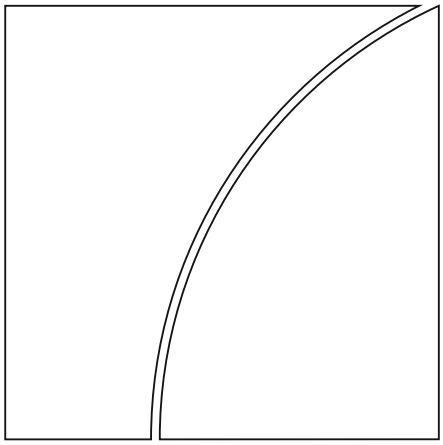

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The impact of warnings published in a financial stability report on loan-to-value ratios

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Monetary and Economic Department

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JEL classification: E58, G21, G28

Keywords: Macroprudential policy, LTV ratios, central bank communication

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The impact of warnings published in a financial stability report on loan-to-value ratios

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Abstract

This paper shows how central bank communications can play a role in macroprudential supervision. We document how specific warnings about real estate markets, published in the Central Bank of Chile's Financial Stability Reports of 2012, affected bank lending policies. We provide empirical evidence of a rebalancing in the characteristics of mortgage loans granted, with a reduction in the number of mortgage loans with high loan-to-value ratios (LTV), along with an increase in loans with lower LTV ratios.

JEL classification: E58, G21, G28.

Key words: Macroprudential policy, LTV ratios, central bank communication.

* Central Bank of Chile.

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1. Introduction

Since the onset of the Great Recession, there has been a heated debate on how to prevent the risk of instability from propagating across financial markets and how best to assure financial stability in the future. Central banks, which have taken a central role in this discussion, have made increasing use of communications as an additional policy tool to restore stability. In particular, through the publication of Financial Stability Reports (FSR) and also in speeches and interviews, policymakers have made efforts to convey their views on the potential risks faced by the financial system.

Considering the relevance to central banks of the effective design and implementation of macroprudential policies, the relative novelty of these tools and the breadth of the definition of macroprudential policies, it is natural to ask how far they have been successful in conveying their messages and achieving the intended effects.

The main aim of this paper is to measure the effect on local financial markets of communicational tools used by the Central Bank of Chile (CBC). In particular, this paper focuses on the local housing market. By using a detailed administrative database of every housing transaction in the country, we study the extent to which warnings issued in the central bank's Financial Stability Reports had an effect on house prices, lending standards, and the volume of mortgage loans.

Since the onset of the subprime crisis, the real estate sector has received increasing attention from academics and policymakers, for at least three reasons. First, the bursting of the housing bubble in several economies initiated a process of deleveraging that led to deep macroeconomic adjustments. Second, as housing is the main asset of the average household; changes in property values considerably affect total household wealth. Third, a significant amount of home purchases are financed with mortgage loans, so that banks are significantly exposed to this sector. Since 2010, the Central Bank of Chile, through its Financial Stability Report (FSR), has documented sustained and above-trend growth rate in house prices. Again through the FSR, the central bank has analyzed the different constituent components of housing prices and warned that recent developments in house price trends should not be extrapolated for future investment decisions, i.e. that agents should not expect the recent trends to continue unchanged in the future.

The paper starts by looking at the evolution of aggregate variables related to the real estate sector around the issuance time of the warnings. Included in this analysis are housing debt decomposed by financing instrument, the number of mortgage loans granted, average housing debt, house prices and volume of home sales. In principle, the warnings did not seem to have any effect on these broad variables, supporting the view that the evolution of these variables was consistent with macroeconomic fundamentals. However, when looking more closely at the distribution of loan-to-value (LTV) ratios of loans granted, the messages conveyed through the FSR seem to have had an impact. Using a detailed administrative database for mortgage loan transactions, this paper shows that FSR warnings had an effect on bank lending policies between 2011 and 2014. In particular, following the FSR warnings, there was a noticeable reduction in the number of loans granted with high LTV ratios. Later, the analysis is formalized using probit and quantile regressions; these estimations confirm the previous findings. The warnings had a statistically significant effect, reshaping the distribution of LTV ratios for loans granted. In particular, during the period there is evidence of a shift out of mortgages with high

LTVs, and into lower ratios. Furthermore, private banks and the state-owned bank responded differently to these messages, most likely due to the mandate under which the latter institution operates.

2. Chilean Real Estate Market

2.1 Housing finance

Since the early 1990s, the Chilean housing market has experienced significant developments in several aspects. In particular, Micco et al (2012) show that: (i) the fraction of overcrowded houses[1] dropped from 24% to 9% between 1990 and 2009, and (ii) the housing deficit[2] decreased from 540 thousand units to 410 thousand units. In addition, the Survey of Housing Finance conducted by the Central Bank of Chile indicates in its 2014 wave that homeownership rate was about 70%. According to Warnock (2014) this figure is at the top among Latin-American countries. A key element of this homeownership rate is the access to housing finance. Several elements must be considered in order to understand the Chilean mortgage market. First, there is a unit of account indexed to inflation (UF[3]) in which banks and financial institutions can grant long-term (20-30 years) loans. Second, most of this market is dominated by banks, having a share of 88% of mortgage loans as of 2010 and a historical average of 90% since early 2000. Given these facts, the following description will be focused on the banking sector. Among banks, a big player is BancoEstado (BE), a state-owned bank with a participation of 24% over total banking mortgage loans (Table 1).

Third, a number of mortgage-instruments are available for financing the purchase of a house: mortgage notes, endorsable mortgage loans, and non-endorsable mortgage loans. Mortgage notes can be used to finance a fraction of the value of the property, having a maximum allowed Loan to Value of 75%; there is also a limit on Dividend to Income (DTI) of 25% for small and medium size loans. Endorsable mortgage loans have a maximum LTV of 80% and no limit on DTI. Finally, non-endorsable mortgage loans have no limit on LTV nor on DTI. During the early 2000s, most housing funding was granted through mortgage notes, but since 2004 there has been an increasing participation of non-endorsable mortgage loans. One reason behind this composition change is the combination of an increased credit demand and the relatively larger flexibility of non-endorsable mortgage loans, in terms of LTV and DTI limits, length of term, interest rates, and minimum down payment requirement. The shift also coincides with the introduction, in November 2002, of a transaction tax exemption to loan renegotiations. According to Flores (2006) who studies the evolution of the housing market financing instruments in more

[1] According to the National Socioeconomic Characterization (CASEN) Survey, conducted in Chile and used by Micco et al. Overcrowded houses are defined as those where the ratio of residents over the number of bedrooms in a house exceeds 2.5.

[2] Micco et al. define housing deficit as the difference between total population and the stock of habitable permanent houses (excluding mobile units and those located in slums).

[3] Unidad de Fomento (UF) is a unit of account used in Chile. Its value in Chilean pesos is indexed to total inflation. It is widely used in determining the value of real estate, housing associated costs, and secured loans.

detail, both new and existing mortgage loans financed through mortgage notes rapidly switched to non-endorsable mortgage loans after the implementation of the tax exemption mentioned above (Graph 1).

Total and mortgage loans by bank, as of December 2010 Table 1

	TOTAL LOANS		MORTGAGE LOANS	
BANK	US$ Millions	Percent	US$ Millions	Percent
Banco Bice	4,516	2.7%	473	1.2%
BBVA	12,277	7.4%	3,342	8.1%
Consorcio	257	0.2%	52	0.1%
De Chile	32,888	19.8%	6,144	15.0%
BCI	20,377	12.2%	4,030	9.8%
BancoEstado	23,647	14.2%	9,762	23.8%
Falabella	1,421	0.9%	482	1.2%
Internacional	1,381	0.8%	7	0.0%
Itaú (Chile)	5,895	3.5%	1,181	2.9%
Paris	383	0.2%	28	0.1%
Ripley	419	0.3%	119	0.3%
Santander - Chile	35,739	21.5%	9,796	23.9%
Security	4,621	2.8%	633	1.5%
Corpbanca	12,504	7.5%	2,144	5.2%
HSBC Bank (Chile)	686	0.4%	2	0.0%
Scotiabank Chile	8,195	4.9%	2,837	6.9%
Others	1,149	0.7%	1	0.0%
Total	**166,355**	**100%**	**41,032**	**100%**

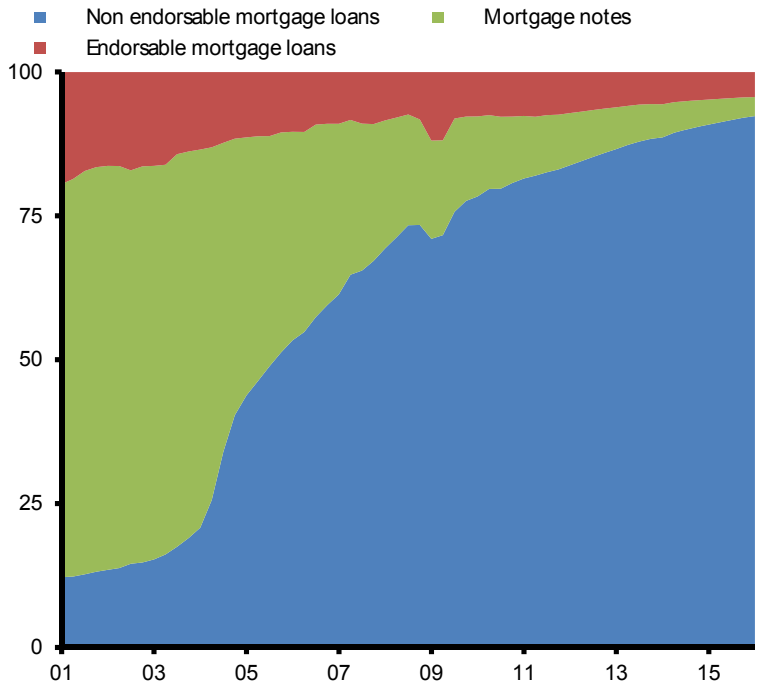
Source: Central Bank of Chile.

In addition to the stock figures presented in Table 1, information on flows between 2011 and 2014 (period under study) shows that eight banks accounted for about 95% of the total transactions and 93% of the total amount lent (Graph 2). This distribution allows us to focus on this subset of banks for our methodological framework, including the state-owned bank (BancoEstado, BE). It should be noted that the participation of BE in the total number of loans is about 33%, but weighted by amount is only 17%. That implies that BE tends to grant loans of relatively small size.

Focusing on the period between years 2011 and 2014, mortgage debt showed steady growth, reaching real annual variations close to 9%. This growth is mainly due to the increase in average debt, as opposed to number of debtors (Graph 3). Although this is consistent with the evolution of housing prices discussed below, there was an increment in the number of mortgage loans by debtor. Indeed, the fraction of debtors with more than one mortgage has increased from 19 to 23% (Graph 4).

Banking housing debt by instrument

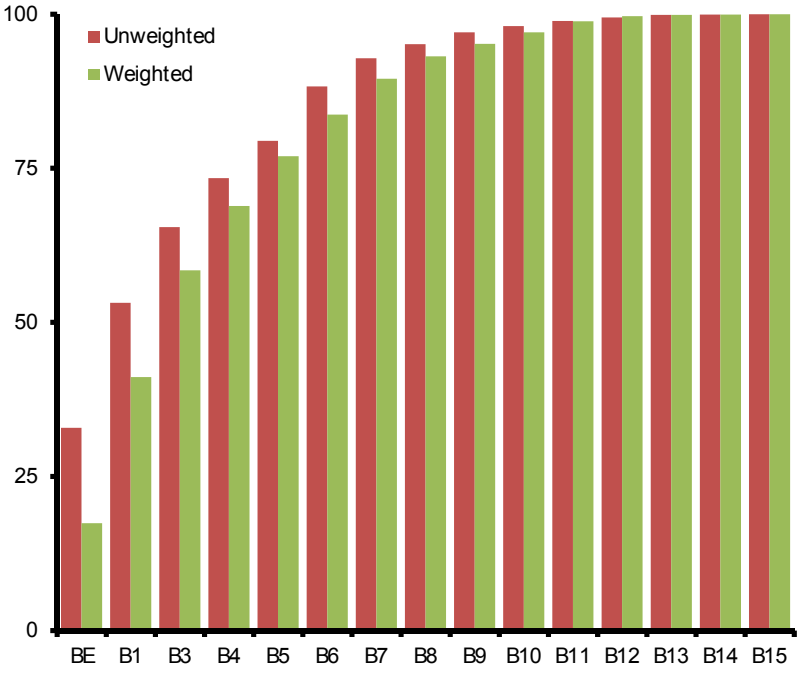
(percent) Graph 1



Source: Superintendency of Banks.

Number of loans by bank in sample[1]

(cumulative percent) Graph 2

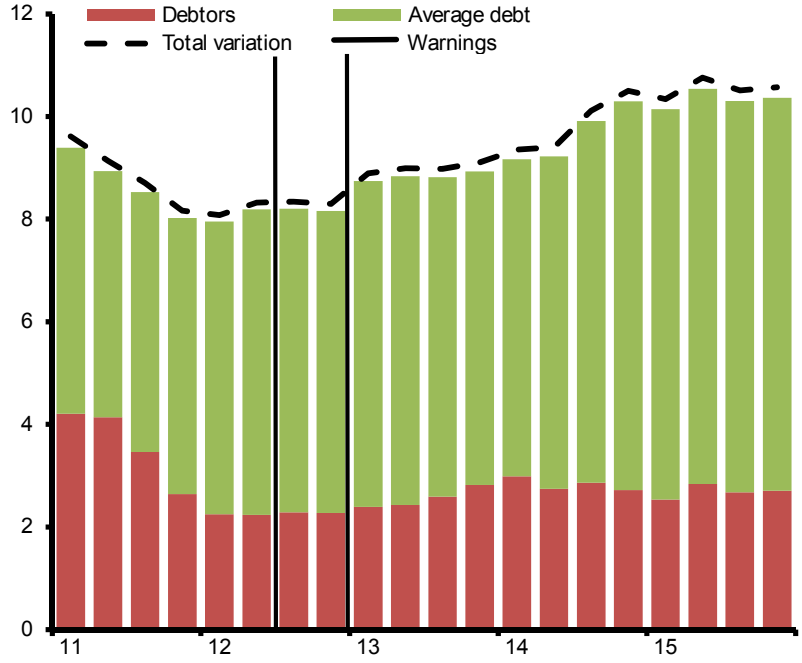


Unweighted is the cumulative percentage of number of loans granted by each bank. Weighted is the cumulative percentage of the number of loans granted, weighted by the total sum of loan flows corresponding to each bank.

Source: Chilean Tax Authority.

Mortgage loans

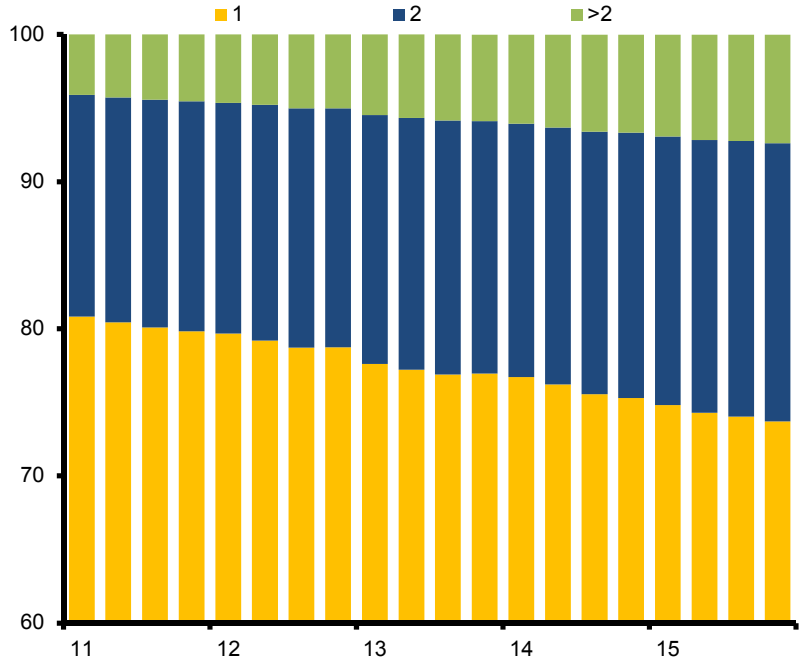
(real annual variation, percent) Graph 3



Source: Central Bank of Chile.

Mortgage loans by debtor

(percent) Graph 4



Source: Superintendency of Banks.

2.2 Housing Price Index

The Chilean Tax Authority maintains a detailed administrative database of every housing transaction in the country. The database includes information related to the transaction, such as price, location of the house, etc. It also includes information about the characteristics of the house, such as: size (measured in squared meters), or type (apartment, town house). Finally, in this database there is information related to the conditions of the loan (if applies), such as: maturity and bank name. With this information it is straightforward to compute the LTV ratio per transaction.

Using the Chilean Tax database, the Central Bank of Chile calculates the housing price index (HPI) using a methodology known as stratified method or mix-adjustment[4]. This methodology measures the variations of prices of different types of houses by splitting the sample in groups by certain characteristics, such as, price, geographical location, size, etc. This methodology, therefore, controls for changes in the composition of the sold houses between periods not in groups. For each group average price is computed and we obtain an aggregate index by weighting averages across groups. Further, the sample is divided into seven geographic zones: North, Center, South and the Metropolitan Area (M.A.)[5] which is divided in M.A. East, M.A West, M.A Downtown and M.A South[6]. Also, each zone is divided between town-houses and apartments, getting a grand total of 14 groups. This allows the CBC to construct the HPI by zone and type of house, the aggregation is performed weighting these by squared meters. In addition to this index, there is a private estimate of house prices generated by the Chilean Chamber of Construction (CChC). The latter is computed only for M.A. and it is based on new houses only. In addition, the index includes houses that are still under construction (promises), we use this additional source since the latter information is not available in our Chilean Tax database.

According to the different sources mentioned above, aggregate prices have shown growth rates consistent with increasing national private income and low long-term interest rates (Graphs 5 and 6)[7]. The previous factors, combined with changes in the sales tax policy had an impact on the sale of housing units in Santiago, which have shown a positive trend since 2009 (Graph 7). However, the national figures hide substantial heterogeneity across zones, which is probably influenced by differences in the behavior of demand and the relative supply in each of them. Del Negro and Otrok (2007) documented this heterogeneity in the U.S. Their findings indicate that the factors driving house prices switch over time from local to national sources; the national variation does not seem to be linked to monetary policy changes. Allen et al. (2009) also explore this regional price heterogeneity using Canadian data, they find little evidence of long run correlation between different cities and also document a disconnect between house prices, interest rates and other macroeconomic variables. Local factors such as union wage levels, new housing prices and number of building permits issued seem to be more closely related to local house prices. Regarding our dataset, despite differences in methodologies of both indexes, they show similar trends. However, the one computed by CChC shows fewer fluctuations, most likely because it is based on a fitted model.

4 For more details about methodology see Central Bank of Chile (2013).

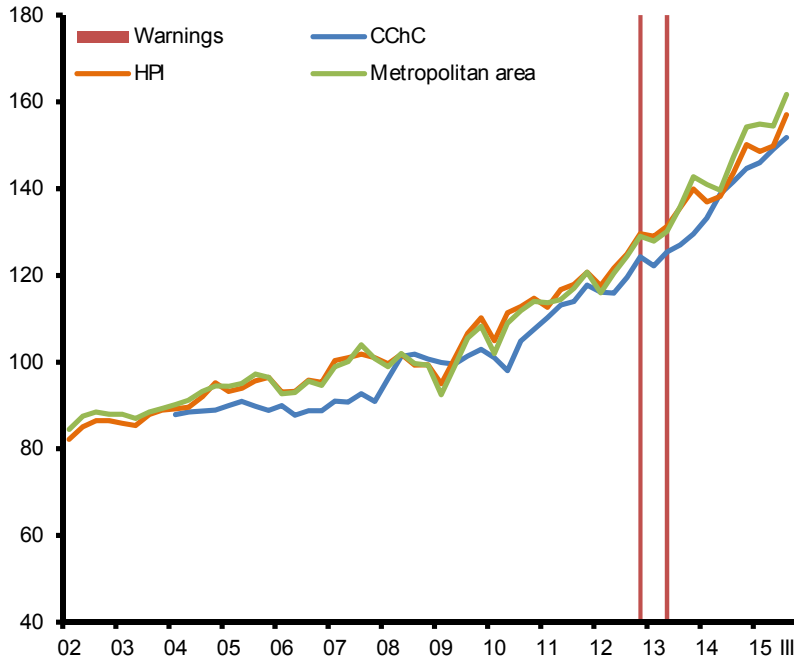
5 The Metropolitan Area is the most densely populated in Chile.

6 More details about the subdivision into zones see Central Bank of Chile (2013). A detailed map depicting the different zones is included for reference in Appendix 1.

7 For further details see Chapter III in Financial Stability Report (2013:S2).

Comparison of HPIs (*)

(index; 100 = 2008) Graph 5

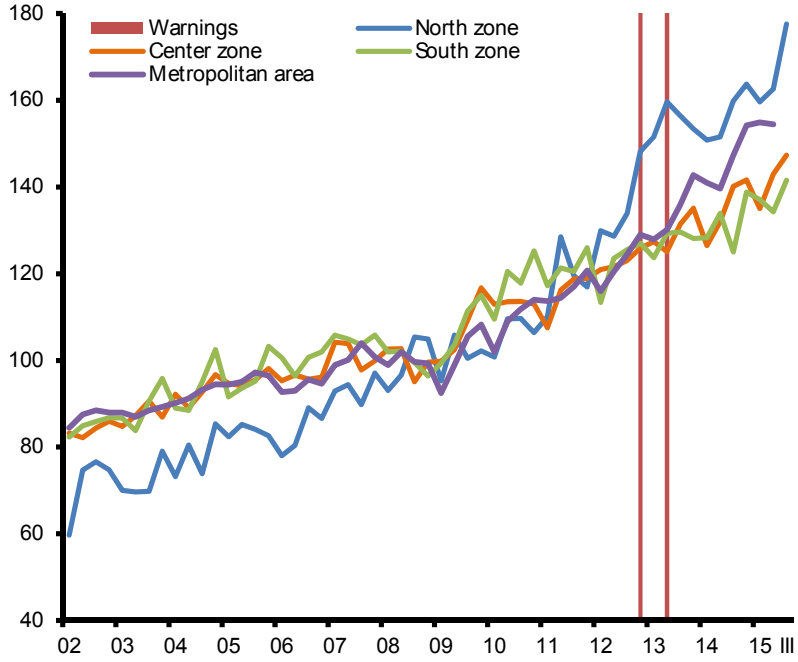


(*) Central Bank of Chile information as of June 8, 2016. CChC uses a hedonic methodology to calculate the index, as opposed to the other indices where a stratified methodology is utilized.

Sources: Central Bank of Chile and CChC.

House price index by zone (*)

(index; 100 = 2008) Graph 6



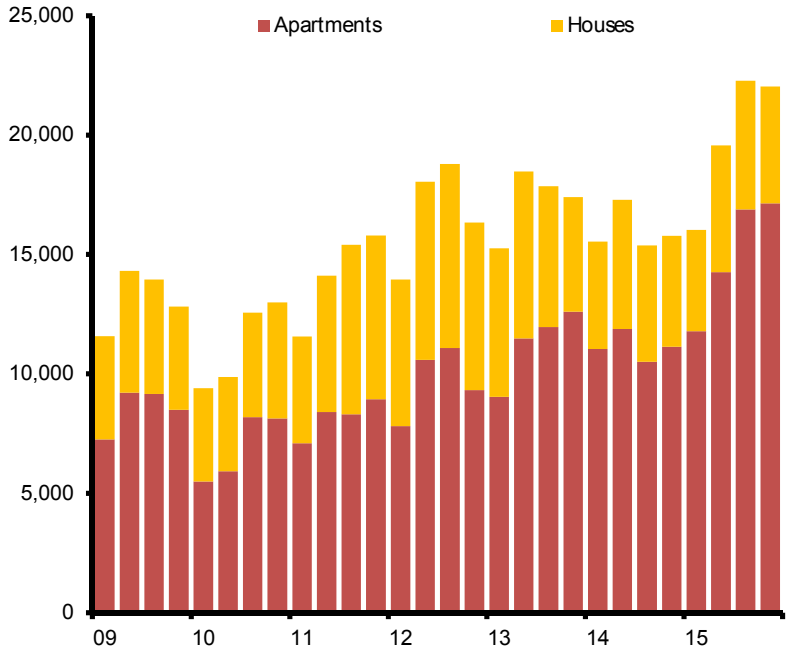
(*) Central Bank of Chile information as of June 8, 2016.

Source: Central Bank of Chile.

Between 2011 and 2014, new home sales and construction in Santiago remained close to 60,000 per year. The production of new homes, including gross commitments, grew strongly during the period. . Finally, relative to disposable income, housing prices were stable within our sample and in the lower range of indicators for a wide set of countries.[8]

Sales by type of property

(units) Graph 7



(*) Include promises.

Source: Chilean Chamber of Construction.

2.3 Warnings in the Financial Stability Report

Twice a year, the CBC publishes its Financial Stability Report (FSR). The objective of the FSR is to provide information to the general public, on a half-yearly basis, on recent macroeconomic and financial events that could affect the financial stability of the Chilean economy. In addition, the FSR presents policies and measures that support the normal operation of the internal and external payment system. In the first and second half of 2012 two warnings were published in the FSR, they were associated with the real estate market and its developments (Table 2). Both referred to the existence of potential risks in the housing market, and the second one explicitly mentioned lending standards. The warnings were also included in the Reports' summaries, not just within the corresponding chapters. Regarding the resonance of the warnings in the media, they were widely covered in newspapers, television news and specialized magazines. These messages were also delivered by the Members of the Board in their presentations and speeches in the days following the issuance of the Reports. It is hard to quantify the intensity of the messages just by reading the warnings. That is why we will take a quantitative approach in order to do this.

[8] For further details see Chapter III in Financial Stability Report (2015:S1).

FSR Warnings

Table 2

First Half 2012 (June 18, 2012)	Second Half 2012 (December 18, 2012)
"Aggregate housing prices move in tandem with the economy's level of interest rates and income. At some districts in the central and eastern area of the Santiago Metropolitan Region prices are outgrowing their historic trends, possibly due to constraints in the land available. It is important to keep in mind that the materialization of the risk scenario described in this Report could lead to a breakdown in current price trends. The potential implications of this are price adjustments influencing the profits of executed projects and, additionally, the collaterals backing mortgage loans".	"The Report highlights that aggregate housing prices indices have maintained their pace of expansion, in line with the dynamism of the economy, and that in many districts prices are rising above historic trends. These increases occur in a context of high growth in housing demand and a significant expansion of activity in this sector. […] This, together with somewhat less stringent lending standards for mortgage credit. These developments could lead to financial vulnerabilities in the real estate and construction industry, or in those households searching for a home".

Source: Central Bank of Chile.

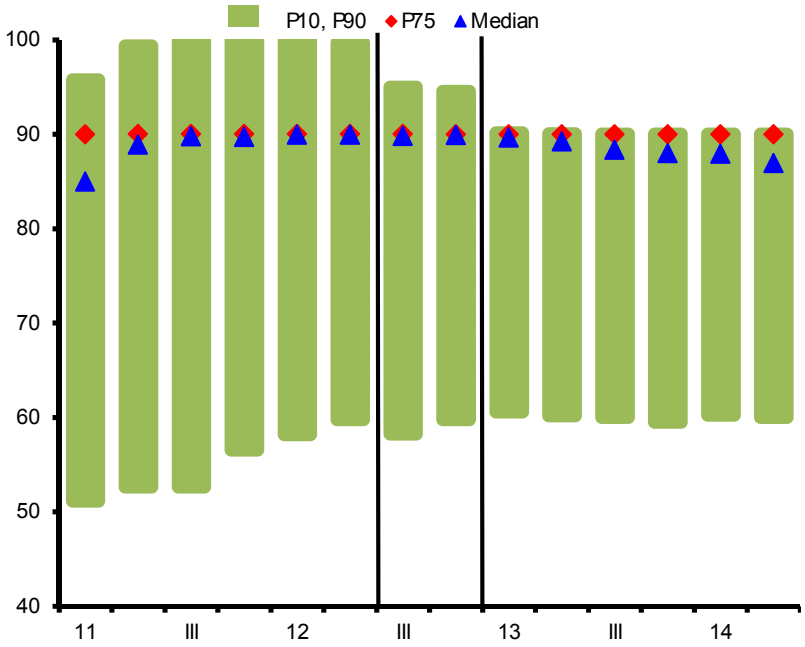
As we showed in the previous section, these warnings do not seem to have had an effect on aggregate house prices or the total volume of mortgage loans granted. The warning issued in June 2012 is marked in Graph 5 with a red bar; there is no noticeable effect on aggregate housing prices. The same lack of variation is observed when house prices are decomposed by zone (Graph 6). The second warning – also marked with a red bar – does not appear to have an impact on prices either. Graph 3 shows the growth rate of mortgages loans accelerating following the issuance of warnings. Thus, the aggregate figures suggest that warnings had no impact, and Central Bank communication through the FSR was ineffective as a macroprudential tool. There are two possible explanations for this. First, the warnings may not have had enough power because market participants did not value the messages delivered in the FSR. This would imply a failure of warnings as a feasible macroprudential tool. Second, these warnings may have had no impact on these aggregate variables because the warnings did not point to an existing imbalance in the market, but to the risks of such an imbalance. Thus, it is expected that warnings of this sort would affect the lending policies of banks, for instance on Loan to Value ratio.

By considering the information of the eight largest banks in this market, the distribution of LTV ratios for newly originated mortgages showed some variation around the two warning events. In particular, the high-end of the LTV distribution (90th percentile) fell after the first warning and then dropped again after the second warning (Graph 8). It is worth noting that the 75th percentile did not react to these warnings, being a compression of high LTV's. Prior to the first warning, about 10% of mortgage loans were granted with an LTV of 100%, after the warnings around 10% of loans were granted with an LTV of 90%. Concerned about a possible bias in our results due to the presence of the state owned bank (BE), which in previous crisis episodes has shown a different behavior compared to the rest of the banking system[9], we removed it from the sample. When re-estimating with this trimmed sample, the impact remains (Graph 9).

[9] Also in the past, it was documented that BE had a higher NPL ratio in its portfolio of housing loans compared to other banks. Moreover, in the same post crisis period, credit growth would have been weaker without BE. These facts are evidence of a different behavior of BE in terms of lending conditions (see Financial Stability Report First Half 2010).

LTV full sample (*)

(percent) Graph 8

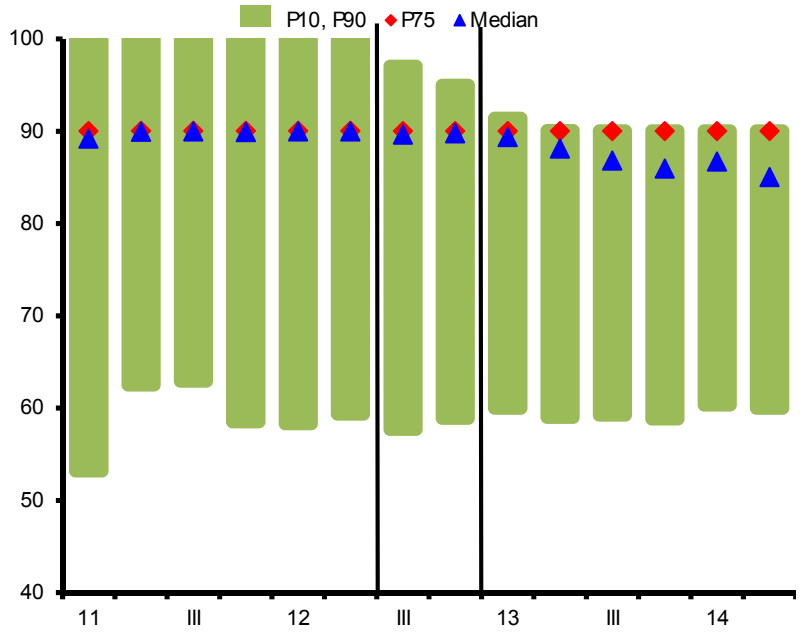


(*) Vertical lines indicate the warnings dates.

Source: Central Bank of Chile.

LTV without BE (*)

(percent) Graph 9

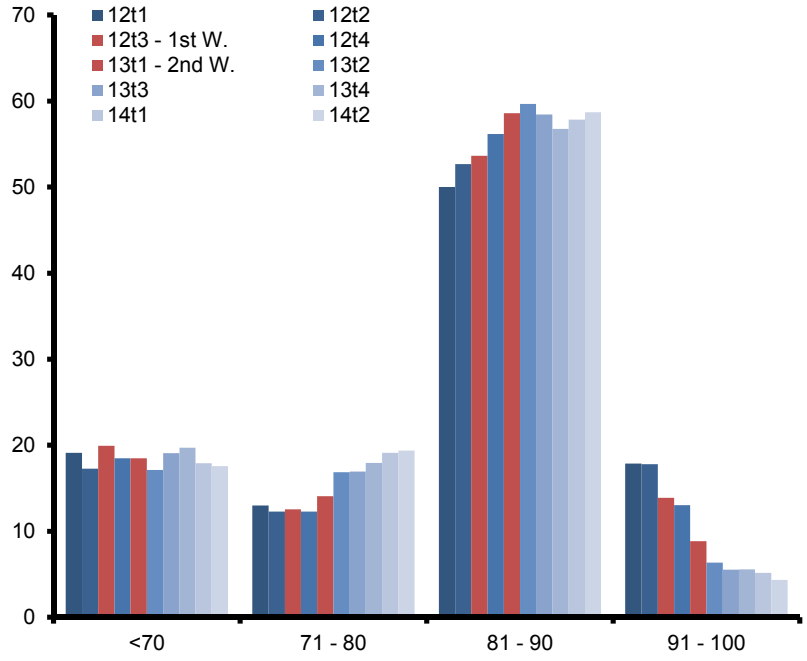


(*) Vertical lines indicate the warnings dates.

Source: Central Bank of Chile.

Distribution of LTV ratio, full sample

(percent) Graph 10



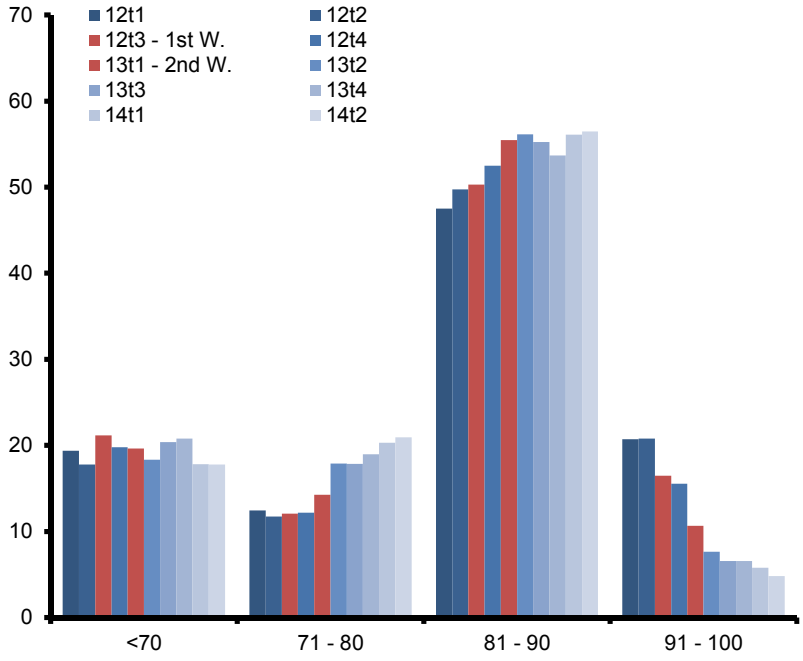
Source: Central Bank of Chile.

Before taking the econometric approach, let us assess the impact of warnings by computing LTV ratio brackets. From doing this, it becomes clear that banks tended to reallocate loans into brackets with lower LTVs. In particular, the impact of the first warning translated into a reduction in the high LTV bracket (above 90%) that was somehow compensated by an increase in the low LTV bracket (below 70%). One quarter after the first warning, the share of loans in the 81-90% bracket began to increase[10]. A similar pattern is observed after the second warning (Graph 10). Results are robust to the exclusion of BE (Graph 11). In the next section we use quantile regressions to evaluate the statistical significance of the change in the 90th percentile we illustrated graphically. This exercise will also allow us to control for bank fixed-effects. A probit analysis will also be conducted in order to evaluate the statistical significance of these findings from a slightly different approach.

[10] In Graphs 10 and 11 the red columns correspond to 2012Q3 and 2013Q1, respectively. These are the periods that followed the issuance of the warnings since the Financial Stability Reports were published by the end of each of the previous quarters.

Distribution of LTV ratio without BE

(percent) Graph 11



Source: Central Bank of Chile.

3. Empirical Results

As previously mentioned, a large fraction of loans (over 30% as of 2012Q1) were granted with a LTV ratio of 90% or higher. Furthermore, about 10% of these loans are associated with an LTV ratio of 100%. The graphical evidence suggests that warnings in the FSR about real estate market vulnerabilities made by the Central Bank of Chile had an impact on the high end of the LTV distribution. To document whether these warnings had a significant impact, two different methodologies are used in this section. First, a binary probit model is estimated in order to quantify the effectivity of public warnings about potential housing market vulnerabilities had in diminishing the probability that a high LTV ratio loan was granted. In this model a positive outcome is defined as the granting of a loan with an LTV ratio exceeding a given threshold. Second, as we showed in the previous section, the central moments of the LTV ratio distribution remained unchanged with the effects concentrated on its upper tail. Thus, a quantile regression is estimated in order to compute the impact of the public warnings on the median and several other percentiles of the LTV ratio distribution. Attending to the historical behavior of the state owned bank, a robustness exercise excluding BancoEstado is conducted for both probit and quantile estimations. In the estimations below we use the Chilean Tax Authority data. Regarding our implicit counterfactual scenario, following others in the related literature, such as Best et al. (2015), Wong et al. (2015) and Price (2014), we define an implicit counterfactual of no change in the LTV distribution after the issuance of the warnings. This is underlying the definition of our dummy variables. The pre-warning level can be computed as the

case where the corresponding dummy variable is equal to zero. The sample includes all mortgage loan transactions that took place between 2011 and 2014 with daily frequency.

3.1 Binary Modeling for Loan to Value Ratio

In this section we estimate a probit model. We do not use OLS since the LTV variable is bounded above at 100 by the Chilean regulation. Our dependent variable is binary, it is equal to 1 when the LTV ratio associated to a transaction is higher than a given threshold, and 0 otherwise. We construct two dependent variables for two LTV thresholds, namely LTV90 and LTV80 for 90 and 80% thresholds, respectively. All of the results corresponding to probit models are estimated coefficients, they are not marginal effects.

As independent variables, we construct two dummy variables, one for each FSR warning. The first one was issued in 2012Q2, and the second in 2012Q4. Each of the corresponding dummy variables is equal to 1 after the respective warning is issued and 0 otherwise[11]. In tables 3 and 4 results are presented for the sample containing all 8 banks, as well as the sample excluding BE. For the LTV90 estimation, in column 1 we can see the first warning reduced the probability of a loan being granted with an LTV higher than 90%. In columns 2 and 3 we report how the second warning also had a significant negative effect on the probability of occurrence. The sign for the first warning switches to positive; however the joint effect of both warnings remains negative and statistically significant. Furthermore, the estimation excluding BE shows a robust result, with a larger magnitude for the total effect than the one obtained with the full sample. The fact this effect is larger without the state owned bank could be due to its mandate, and segment of the mortgage loan market where it operates. Next we show the estimation results for the 80% threshold in Table 4. For the model in column 1, with the first warning only, the effect is positive. This result is puzzling, but could be explained by a reallocation of loans, with banks granting more loans with lower LTV to compensate for the reduction in those with a higher ratio. This result follows the same pattern when we include both warnings in columns 2 and 3; there is a positive sign for the first warning and negative for the second, both statistically significant. When we estimate excluding BE, the impact of each warning over the probability of occurrence is individually negative and significant. Once again this could be due to the mandate that rules the state owned bank BE.

[11] In the result tables shown below the dummy variables are labeled 2012Q3 and 2013Q1, respectively, to reflect the fact that they are equal to one starting on the quarter that follows the issuance of each warning.

Probit - (LTV90) Table 3

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-0.07***	0.04***	0.06***	-0.22***	-0.06***	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
2013q1		-0.16***	-0.16***		-0.21***	-0.22***
		(0.01)	(0.01)		(0.01)	(0.01)
Constant	-0.25***	-0.25***	-0.04***	-0.19***	-0.19***	0.02***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Bank FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

Note: Table shows in Columns (2) and (3) how the second warning had a significant and negative effect on the right tail of the LTV distribution. Columns (5) and (6) show how this effect is larger when we exclude the state-owned bank.

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Probit - (LTV80) Table 4

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	0.05***	0.09***	0.11***	-0.12***	-0.08***	-0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
2013q1		-0.05***	-0.06***		-0.05***	-0.07***
		(0.01)	(0.01)		(0.01)	(0.01)
Constant	0.50***	0.50***	0.62***	0.62***	0.62***	0.69***
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

Note: Table shows in Columns (2) and (3) how the second warning had a significant and negative effect on the right tail of the LTV distribution. Columns (5) and (6) show how this effect is also negative and significant for the first warning.

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

3.2 Quantile regression

The main objective of the analysis in this sub-section is to study how the FSR warnings affected the distribution of LTV ratios for newly originated mortgage loans, focusing on the upper tail of this distribution. In particular, we consider quantile regression analysis for the 90, 75 and 50th percentiles[12]. We show additional results for the 85 and 80th percentiles in Appendix 2.

[12] We consider the quantile regression framework, as opposed to linear regression, because our focus is on upper-tail events. The quantile regression estimation algorithm we utilize is the one available by default in Stata 14.

As dependent variable we use the LTV ratio of granted mortgage loans. Independent variables are the same we used when estimating the probit model, dummy variables for each of the two warnings issued by the Central Bank of Chile. As we showed in Graphs 9 and 10, the median and 75th percentile LTV ratios remain almost constant after both warnings. This is a desirable outcome since the warnings did not aim towards correcting a misalignment in the less risky brackets of LTV. Instead, the second warning explicitly mentioned the somewhat less stringent lending standards for mortgage credit, which in turn is associated with the upper tail of the LTV ratio distribution.

Our results in Table 5 suggest that the FSR warnings were relevant reducing the LTV of loans granted with ratios above 90% (graphically shown above in Graph 8). Column 2 shows how both warnings significantly reduced the 90th percentile of the LTV ratio distribution, for this specification we cannot reject that the effects of both warnings are equal to each other. The effect of the second warning becomes relatively larger in Column 3, with respect to the first, when we add bank level fixed effects, in fact now we reject the null of equal effects. Similar to the probit specification, the effect of the second warning becomes larger, relative to the first one, when we exclude BE from the sample (columns 4 through 6)[13], which historically has had a behavior different from that of private banks. As mentioned above, this different effect could be due to the explicit mention to less stringent lending standards included in the second warning. This element, combined with the different nature of the state owned bank, are plausible explanations to why the effects are larger when BE is excluded.

Quantile Regression - (Q90)

Table 5

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-9.87***	-4.95***	-0.63***	-9.48***	-3.89***	-1.07***
	(0.05)	(0.08)	(0.14)	(0.03)	(0.05)	(0.18)
2013q1		-4.95***	-1.36***		-6.06***	-5.00***
		(0.09)	(0.15)		(0.05)	(0.19)
Constant	99.95***	99.95***	100.00***	100.00***	100.00***	100.00***
	(0.04)	(0.03)	(0.11)	(0.02)	(0.02)	(0.12)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

Note: Table shows in Columns (2) and (3) how the second warning had a significant and negative effect on the right tail of the LTV distribution. Columns (5) and (6) show how this effect is relatively larger for the second warning, compared with the first, when we exclude the state-owned bank.

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

[13] In both Columns 5 and 6 we reject the null of equal effects stemming from the first and second warnings.

Quantile Regression - (Q75) Table 6

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-0.02***	-0.01***	-0.00	-0.04***	-0.02***	-0.01
	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.06)
2013q1		-0.02***	-0.01		-0.02***	-0.02
		(0.00)	(0.04)		(0.00)	(0.06)
Constant	90.02***	90.02***	90.97***	90.04***	90.04***	90.97***
	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.04)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

Note: Table shows how the negative effect of the warnings approaches zero as we move closer to the center of the LTV distribution.

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q50) Table 7

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-0.27***	0.38***	0.02	-1.27***	-0.14	-0.01
	(0.05)	(0.08)	(0.12)	(0.04)	(0.09)	(0.13)
2013q1		-1.00***	-0.13		-1.80***	-1.15***
		(0.08)	(0.13)		(0.09)	(0.14)
Constant	89.54***	89.54***	89.99***	89.95***	89.95***	90.00***
	(0.03)	(0.03)	(0.09)	(0.03)	(0.04)	(0.09)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

Note: Table shows how the negative effect of the warnings approaches zero as we move closer to the center of the LTV distribution.

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Then, we estimate the model for the 75th percentile, looking for movements distinct to those in the 90th percentile in an a priori less risky bracket. As shown in Table 6, the magnitude of the effects is smaller than those previously obtained for the 90th percentile. When we add bank level fixed effects in column 3, the warning coefficients are no longer statistically significant. Also, we no longer observe an important difference in estimated coefficients after removing BE (columns 4 through 6).

Finally, results for the 50th percentile in Table 7 suggest that the first warning had a positive and statistically significant effect over the granting of mortgage loans, but still negative when aggregating the impact of both warnings (column 2). When we add bank fixed effects, the effects of both warnings are no longer significant (column 3). Once again this could be due to the warnings being aimed towards a riskier segment of credit. After excluding BE from the sample (columns 4 through 6),

the effect of the first warning is not statistically significant. The second warning still has a negative and significant coefficient.

Besides the exercises presented above, we perform three additional variations. First, we re-define the warning issuance dummy variable to be equal to one since the day the FSR is presented to the Congress and released to the market and analysts (referred to as 'week – for each warning´ in Appendix 3). This variation is implemented in order to isolate other contemporaneous developments that could also affect the LTV distribution. Secondly, also aimed towards refining the identification of the effect, we re-estimate the models using a tighter window of periods around the issuance of the warnings, just one quarter after and before the warnings to be more precise (referred to as 'tighter window' in Appendix 3). Finally, for completeness we estimate the quantile regression including the two refinements just described together (namely with the dummy variable re-definition and a tighter window around the FSR presentation date, referred to as 'week and tighter window' in Appendix 3).

The results are roughly the same as in the original estimations, confirming that the warnings had a statistically significant impact on the 90th percentile of the LTV distribution, with the second warning having a larger impact than the first one when BE is excluded. Among all the additional exercises considered, the most relevant difference is detected when we estimate using a tighter window and include bank fixed effects. Particularly, in this case none of the warnings have a significant effect over the LTV distribution. In general, the results obtained with the two variations combined are similar to those obtained using a tighter window.

Final remarks

The structure and behavior of the mortgage market are crucial elements to consider when analyzing the home purchasing decision. In 2012, given the developments in the housing market, the Central Bank of Chile through its Financial Stability Report raised concerns regarding potential vulnerabilities in certain geographical areas. On an aggregate level, in the real estate market as a whole, these warnings do not seem to have had an effect on the volume of home sales or loans granted. However, at the micro level, empirical evidence suggests that the number of loans granted with high LTV ratios was significantly reduced after the relevant warnings were published in these reports. The mechanism underlying the latter result is one of coordination among banks, where initially they did not internalize the potential social cost of granting high-LTV loans. The warnings served as a way of alleviating this market failure through communication. After the warnings were published, by the end of 2013 discussions on the adjustment of the loan loss provision policy started.[14] By the end of 2015, the proposed modifications were made public by the Superintendency of Banks and Financial Institutions. Among other changes, provisions were to be calculated separately for residential loans, by using a standardized method for all banks that explicitly takes into account the share of non-performing loans and their LTV ratios.[15] The new regulation went into effect in January 2016.

[14] Superintendencia de Bancos e Instituciones Financieras, Chile. Compendio de Normas Contables, Capítulo B-1 / 18.12.2013.

[15] Superintendencia de Bancos e Instituciones Financieras, Chile. Circular N° 3.598 / 24.12.2015.

Based on different methodologies, we conclude that the issued warnings had a significant effect on bank lending policies. This finding is in line with the central bank's decision to point out the existence of potential risks arising from less stringent lending standards in the extremes of the distribution.

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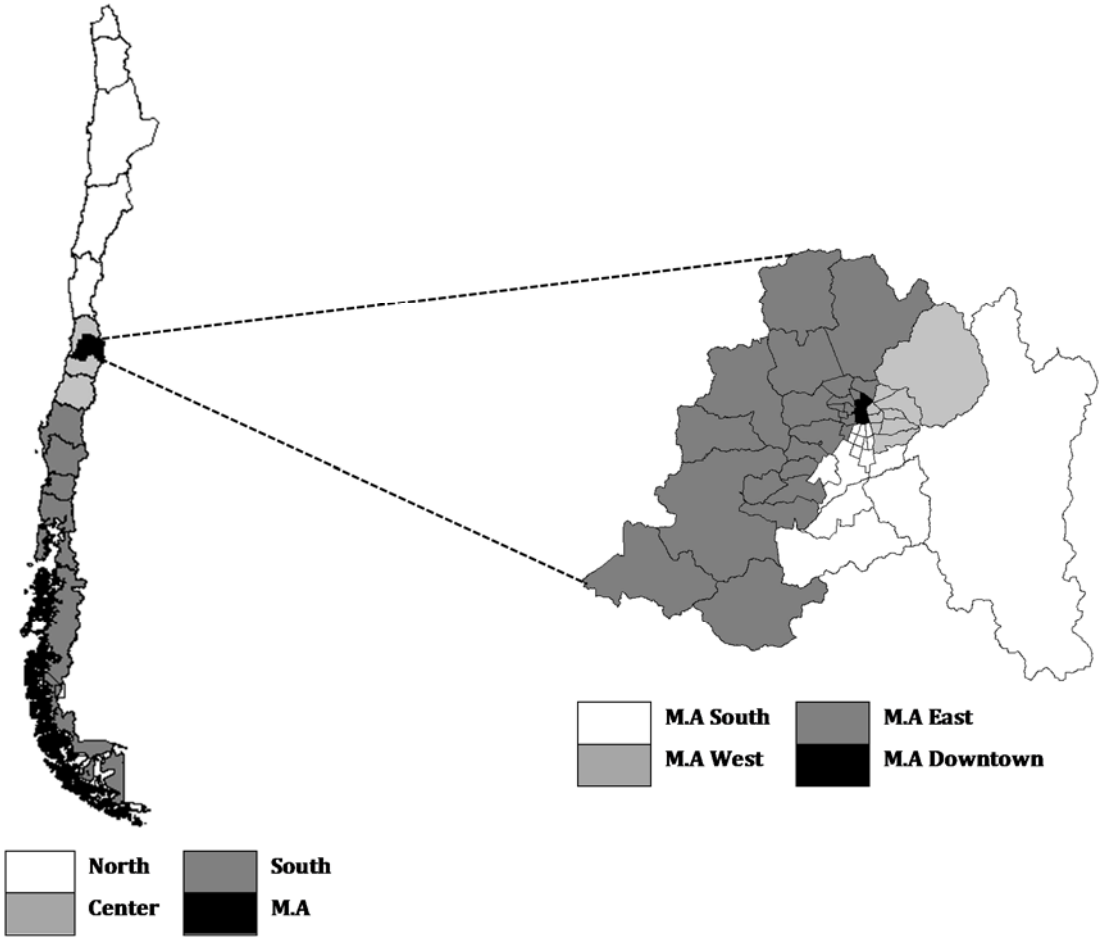
Appendix 1

Chilean geographic zones



Source: Author´s elaboration.

Appendix 2

Quantile Regression - (Q90)

Table A1

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-2.94***	-2.76***	-0.04	-5.07***	-3.16***	-2.23***
	(0.14)	(0.24)	(0.05)	(0.10)	(0.20)	(0.12)
2013q1		-0.18	-0.04		-1.92***	-0.42***
		(0.25)	(0.05)		(0.21)	(0.13)
Constant	92.97***	92.97***	100.00***	95.10***	95.10***	100.00***
	(0.10)	(0.10)	(0.03)	(0.07)	(0.08)	(0.08)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q80)

Table A2

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-0.05***	-0.02***	-0.01	-0.83***	-0.79***	-0.10
	(0.00)	(0.00)	(0.05)	(0.06)	(0.10)	(0.09)
2013q1		-0.03***	-0.02		-0.04	-0.03
		(0.00)	(0.05)		(0.11)	(0.09)
Constant	90.06***	90.06***	95.09***	90.84***	90.84***	95.16***
	(0.00)	(0.00)	(0.04)	(0.04)	(0.04)	(0.06)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Appendix 3

Week – for each warning

Quantile Regression - (Q90)

Table A3

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-9.90***	-4.97***	-0.03	-9.15***	-2.33***	0.00
	(0.05)	(0.08)	(0.13)	(0.06)	(0.06)	(0.18)
2012-18-12		-4.97***	-1.92***		-7.60***	-5.71***
		(0.08)	(0.14)		(0.06)	(0.19)
Constant	100.00***	100.00***	100.00***	100.00***	100.00***	100.00***
	(0.04)	(0.03)	(0.10)	(0.04)	(0.02)	(0.12)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q85)

Table A4

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-2.96***	-2.46***	-0.04	-5.10***	-2.07***	-1.51***
	(0.14)	(0.24)	(0.05)	(0.10)	(0.21)	(0.12)
2012-18-12		-0.51**	-0.04		-3.04***	-1.03***
		(0.24)	(0.05)		(0.22)	(0.13)
Constant	92.99***	92.99***	100.00***	95.13***	95.13***	100.00***
	(0.10)	(0.10)	(0.04)	(0.07)	(0.09)	(0.08)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q80)

Table A5

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-0.05***	-0.02***	-0.01	-0.83***	-0.78***	-0.09
	(0.00)	(0.00)	(0.05)	(0.06)	(0.10)	(0.09)
2012-18-12		-0.03***	-0.02		-0.06	-0.04
		(0.00)	(0.05)		(0.10)	(0.09)
Constant	90.06***	90.06***	95.09***	90.84***	90.84***	95.17***
	(0.00)	(0.00)	(0.04)	(0.04)	(0.04)	(0.06)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q75)

Table A6

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-0.02***	-0.00**	-0.00	-0.04***	-0.02***	-0.01
	(0.00)	(0.00)	(0.04)	(0.00)	(0.00)	(0.06)
2012-18-12		-0.02***	-0.02		-0.02***	-0.02
		(0.00)	(0.04)		(0.00)	(0.06)
Constant	90.02***	90.02***	90.97***	90.04***	90.04***	90.97***
	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.04)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q50)

Table A7

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-0.13**	0.45***	0.03	-1.14***	-0.08	0.00
	(0.05)	(0.08)	(0.12)	(0.05)	(0.09)	(0.13)
2012-18-12		-0.93***	-0.08		-1.70***	-1.01***
		(0.08)	(0.12)		(0.09)	(0.13)
Constant	89.49***	89.49***	89.98***	89.94***	89.94***	90.00***
	(0.03)	(0.03)	(0.09)	(0.03)	(0.04)	(0.09)
Banks FE	-	-	Yes	-	-	Yes
N	198,299	198,299	198,299	157,985	157,985	157,985

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Tighter window

Quantile Regression - (Q90)

Table A8

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-8.21***	-5.00***	0.00	-5.04***	-3.89***	0.00
	(0.31)	(0.06)	(0.17)	(0.19)	(0.24)	(0.16)
2013q1		-4.93***	-0.07		-5.72***	-3.75***
		(0.06)	(0.16)		(0.23)	(0.16)
Constant	100.00***	100.00***	100.00***	100.00***	100.00***	100.00***
	(0.26)	(0.05)	(0.19)	(0.15)	(0.17)	(0.17)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q85)

Table A9

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-4.72***	-4.56***	-0.09	-5.75***	-3.90***	-1.65***
	(0.08)	(0.13)	(0.06)	(0.17)	(0.30)	(0.10)
2013q1		-0.17	-0.03		-1.91***	-0.35***
		(0.13)	(0.06)		(0.30)	(0.10)
Constant	94.77***	94.77***	100.00***	95.84***	95.84***	100.00***
	(0.07)	(0.10)	(0.07)	(0.14)	(0.22)	(0.11)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q80)

Table A10

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-0.09***	-0.08***	-0.03	-1.68***	-1.66***	-0.42***
	(0.02)	(0.02)	(0.09)	(0.12)	(0.14)	(0.14)
2013q1		-0.02	-0.02		-0.03	-0.02
		(0.02)	(0.09)		(0.14)	(0.14)
Constant	90.11***	90.11***	95.81***	91.71***	91.71***	96.12***
	(0.01)	(0.01)	(0.10)	(0.10)	(0.10)	(0.15)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q75)

Table A11

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-0.03***	-0.02***	-0.02	-0.04***	-0.03***	-0.03
	(0.00)	(0.00)	(0.08)	(0.00)	(0.00)	(0.11)
2013q1		-0.02***	-0.01		-0.02***	-0.01
		(0.00)	(0.08)		(0.00)	(0.11)
Constant	90.03***	90.03***	91.70***	90.05***	90.05***	91.72***
	(0.00)	(0.00)	(0.09)	(0.00)	(0.00)	(0.12)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q50)

Table A12

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012q3	-0.12***	-0.04	-0.01	-0.36***	-0.17**	-0.01
	(0.03)	(0.04)	(0.10)	(0.06)	(0.07)	(0.14)
2013q1		-0.18***	-0.03		-0.51***	-0.12
		(0.04)	(0.10)		(0.07)	(0.13)
Constant	89.97***	89.97***	90.00***	89.97***	89.97***	90.00***
	(0.03)	(0.03)	(0.11)	(0.05)	(0.05)	(0.14)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Week and tighter window

Table A13: Quantile Regression - (Q90)

Table A13

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-7.37***	-4.97***	0.00	-5.00***	-2.33***	0.00
	(0.44)	(0.10)	(0.18)	(0.06)	(0.36)	(0.18)
2012-18-12		-4.93***	-0.07		-6.81***	-3.24***
		(0.09)	(0.15)		(0.31)	(0.15)
Constant	100.00***	100.00***	100.00***	100.00***	100.00***	100.00***
	(0.39)	(0.08)	(0.20)	(0.05)	(0.28)	(0.18)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q85)

Table A14

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-4.94***	-4.46***	-0.14**	-6.72***	-3.89***	-0.96***
	(0.04)	(0.13)	(0.07)	(0.23)	(0.35)	(0.14)
2012-18-12		-0.50***	-0.04		-3.03***	-0.80***
		(0.11)	(0.06)		(0.30)	(0.12)
Constant	95.00***	95.00***	100.00***	96.95***	96.95***	100.00***
	(0.04)	(0.11)	(0.07)	(0.20)	(0.28)	(0.14)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q80)

Table A15

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-0.21***	-0.19***	-0.03	-2.08***	-2.04***	-0.68***
	(0.03)	(0.03)	(0.10)	(0.11)	(0.14)	(0.15)
2012-18-12		-0.02	-0.02		-0.05	-0.02
		(0.02)	(0.09)		(0.12)	(0.13)
Constant	90.24***	90.24***	95.81***	92.11***	92.11***	96.33***
	(0.02)	(0.02)	(0.11)	(0.10)	(0.11)	(0.15)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q75)

Table A16

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-0.03***	-0.02***	-0.02	-0.05***	-0.03***	-0.03
	(0.00)	(0.00)	(0.09)	(0.01)	(0.01)	(0.12)
2012-18-12		-0.02***	-0.01		-0.02***	-0.01
		(0.00)	(0.08)		(0.01)	(0.11)
Constant	90.04***	90.04***	91.70***	90.05***	90.05***	91.71***
	(0.00)	(0.00)	(0.10)	(0.01)	(0.01)	(0.13)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

Quantile Regression - (Q50)

Table A17

	Full Sample			Without BE		
	(1)	(2)	(3)	(4)	(5)	(6)
2012-18-06	-0.08**	-0.03	-0.00	-0.28***	-0.11	-0.01
	(0.03)	(0.04)	(0.11)	(0.07)	(0.07)	(0.15)
2012-18-12		-0.14***	-0.02		-0.43***	-0.05
		(0.03)	(0.09)		(0.06)	(0.13)
Constant	89.97***	89.97***	90.00***	89.97***	89.97***	90.00***
	(0.03)	(0.03)	(0.12)	(0.06)	(0.06)	(0.15)
Banks FE	-	-	Yes	-	-	Yes
N	60,074	60,074	60,074	48,155	48,155	48,155

*, **, *** indicate statistical significance at 10, 5, and 1% levels, respectively. Standard error in parenthesis.

Source: Author's calculations.

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