DOCUMENTOS DE TRABAJO

Uncovering Our Self-Imposed Limits: Changes in Loan-to-Value and The Mortgage Market

Daniel Oda
Fernando Sepúlveda

N.º 737 Agosto 2014

BANCO CENTRAL DE CHILE

DOCUMENTOS DE TRABAJO

Uncovering Our Self-Imposed Limits: Changes in Loan-to-Value and The Mortgage Market

Daniel Oda
Fernando Sepúlveda

N.º 737 Agosto 2014

BANCO CENTRAL DE CHILE

BANCO CENTRAL DE CHILE

CENTRAL BANK OF CHILE

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
Agustinas 1180, Santiago, Chile
Teléfono: (56-2) 3882475; Fax: (56-2) 3882231

Documento de Trabajo
N° 737

Working Paper
N° 737

UNCOVERING OUR SELF-IMPOSED LIMITS: CHANGES IN LOAN-TO-VALUE AND THE MORTGAGE MARKET*

Daniel Oda
Banco Central de Chile

Fernando Sepúlveda, CFA
Banco Central de Chile

Abstract

We analyze the possible effects of eventual changes in regulatory limits to the loan-to-value ratio (LTV) for residential mortgage loans in Chile. In Chile there are three major types of mortgage loans, but the market is concentrated in the type without regulatory limits to the LTV. However, most mortgage loans are still granted in the 80%-90% LTV range, suggesting that a "no money down" credit policy is infrequent in residential mortgages. Our analysis allows us to infer that a non-negligible fraction of mortgage loans are paired with an unsecured consumer loan to finance their down payment. This implies not only to a higher effective interest rate, but also a significantly higher financial burden during the first few years of the mortgage. Thus, imposing such a constraint on the LTV ratio could prove riskier than expected. Given that even in the absence of restrictions we encounter these unsecured bridge loans, this practice may be exacerbated upon imposing regulatory limitations. Finally, assuming an inelastic supply for residential mortgage loans we estimate that imposing an 80% LTV ceiling would increase the cost of credit by 17-26 basis points and weaken the loan growth rate by 40 basis points, approximately. Complementing LTV restrictions with policies that restrict the use of bridge loans is important if this tool is to be used to limit the buildup of financial risk.

Resumen

Analizamos los posibles efectos de eventuales cambios en los límites sobre la relación préstamo-valor (LTV) para los préstamos hipotecarios en Chile. En Chile existen tres tipos de préstamos hipotecarios de los cuales el mercado se concentra en el tipo que no está sujeto a ningún tipo de límites de LTV. Sin embargo, a pesar de no estar sujeta a límites de LTV, la mayoría de los préstamos hipotecarios se otorgan en el rango de 80 % - 90 % de LTV, lo que sugiere que una política de crédito "sin pie" no es frecuente en las hipotecas. Nuestro análisis nos permite inferir que una fracción no despreciable de los créditos hipotecarios están relacionados con un préstamo de consumo sin garantía para financiar el pie de la hipoteca. Lo anterior supone no sólo a una mayor tasa de interés efectiva, sino también una carga financiera significativamente mayor durante los primeros años de la hipoteca. Esto implica imponer una restricción de este tipo en el ratio LTV

* The authors would like to thank Claudio Raddatz, Gabriel Aparici, Rodrigo Alfaro, Rodrigo Cifuentes and seminar participants at the Workshop on Real Estate Prices and Financial Stability, held in Santiago on Friday April 25 2014, for useful comments and suggestions. We would also like to thank an anonymous referee for valuable comments. The views and conclusions presented in this paper are exclusively those of the authors and do not necessarily reflect the position of the Central Bank of Chile, nor that of the Board of Governors or it's individual members. Emails: dodaze@bcentral.cl y fsepulveda@bcentral.cl

podría ser más riesgoso de lo esperado. Dado que incluso en ausencia de restricciones encontramos estos créditos complementarios, esta práctica puede verse exacerbada al imponer límites regulatorios. Por último, en el supuesto de una oferta inelástica de los préstamos hipotecarios residenciales, podemos estimar que la imposición de un límite máximo de LTV del 80% aumentaría el costo del crédito en 17-26 puntos básicos, y se debilita la tasa de crecimiento del crédito en 40 puntos básicos, aproximadamente. Complementar las restricciones en el LTV con políticas que restrinjan el uso de créditos de consumo complementarios es importante si esta herramienta se usara para limitar el riesgo financiero.

1. Introduction

During these few years following the subprime financial crisis, mortgage markets have been in center of policymaker's and academic economist's attention. This renewed interest is reflected in several authors' work in different areas of the subject, such as analysis of the causes of the crisis, recommendations and evaluation of policy responses, etc. [1]/. In this paper we analyze the effects of applying one of the possible policy responses, namely that of restricting mortgage loan supply via constraining loan characteristics commonly associated with the lending bank's exposure to credit risk.

Typically, the banking sector of an economy is highly regulated in a relatively high developed financial industry, and the theoretical rationality of banking regulation is grounded on basic economics. That essentially boils down to the presence of (negative) externalities; particularly the pervasive effects of a bank failure on the banking system or the economy as a whole, including the individual customers of the failing bank; and asymmetric information between banks and their customers.

Hence, several regulatory measures are put in place in order to safeguard the solvency and liquidity of banking institutions. These measures aim at mitigating banks' vulnerabilities to financial shocks and contain their risk-taking. From this perspective, together with our particular interest on the mortgage market, the main regulatory measures established in the Chilean banking industry are the following:

1) Capital Requirements. In line with the guidance of the Basel Committee on Banking Supervision, banks are legally required to hold an amount of capital of at least 8% of risk-weighted assets (RWA). Within this risk-weighting scheme, residential mortgage loans carry a weighting factor of 60%. These requirements are established in the General Banking Act and are implemented by the Banking Supervisor (Superintendencia de Bancoes e Instituciones Financieras, SBIF) in Chapter 12-1 of the *Recopilación Actualizada de Normas* (RAN).

2) Loan loss provisions. The Chilean provisioning structure moved to a forward-looking system in 2009. The Compendium of Accounting Standards of the SBIF in Chapter B-1 shows how to establish provisions. The models are based primarily on classifying debtors or groups of debtors according to risk categories. According to the category, provisions are calculated based on their probability of default, loss given default, and collateral.

3) Loan-to-Value ratio (LTV) restrictions. The loan amount cannot exceed a given percentage of the value of the residence. As far as the LTV regulation goes, the value of the property is

[1]/ For example, Ellis (2008) and Demyanyk and Van Hemert (2007) elaborate on the causes of the crisis. Whereas Demyanyk and Hemert focus on the specifics subprime mortgages, Ellis (2008) explores more structural factors. Although Ellis (2008) concludes with some "policy lessons"; Crowe et al. (2013) provide an extensive review and analysis of policy tools to contain real estate booms. A more comprehensive set of policy recommendations for the banking industry, beyond mortgage markets, is provided by Turner (2009) from a UK perspective. See also IMF (2011).

defined as the price of purchase or the bank's valuation, whichever is lower. The actual restriction depends on the kind of mortgage loan as we will show below.

4) Debt-to-Income ratio (DTI) restrictions. Only one of the kinds of mortgage loan is subject to a limitation on this ratio. In that case, the loan's monthly payment may not exceed 25% of the debtor´s income.

The residential real estate market in Chile is based on financing of three different kinds of mortgage loans: (1) Mortgage Loan backed by a Letter of Credit, (2) Endorsable Mortgage Loans, and (3) Non-endorsable Mortgage Loans. All these operations are subject to the same general framework of prudential regulation (i.e. capital requirements and provisions) and consumer protection requirements. But are subject to different specific regulatory requirements as of the features of the loan, because differences in the underlying contracts that originate the financial obligation.

Table 1 below summarizes the main points of the applicable regulation, where we can see that non-endorsable mortgage loans are not subject to any specific regulatory requirements on LTV, DTI or term to maturity. For more details on the Chilean mortgage market regulation, see BCCh (2008).

Table 1
Mortgage Loan Regulation

Regulatory feature/instrument	Letter of Credit	Endorsable	Non-endorsable
Regulator	BCCh / SBIF *	SBIF	n.a. **
LTV	< 75%	< 80%	n.a.
DTI	< 25%	n.a.	n.a.
Term to maturity	> 1 yr.	1-30 yr.	n.a.

* BCCh, Central Bank of Chile. SBIF, Banking Supervisor.

** No especific regulation applies

Source: SBIF and Central Bank of Chile

The letter of credit is a security issued by the lending bank. Once issued, the letter of credit is traded in a secondary market and the amount of the loan granted to the borrower equals the market value of the letter of credit at the time of issuance. Hence, this instrument allows the bank to finance a mortgage with third party funds, but retains the credit risk. Market conditions determine the amount to be lent out, and the term to maturity of the loan equals that of the letter of credit.

Given that the letter may be traded in the secondary market, both letter and loan are regulated by the Central Bank of Chile (BCCh) and, complementary, by the SBIF. For our purposes, the main feature of the regulatory framework is that the loans are subject to restrictions on the LTV and DTI ratios. The LTV ratio on these loans must be below 75% and, in the case of loans below USD 130,000 (UF[2]/ 3,000) the DTI ratio may not exceed 25%[3]/.

[2]/ The Unidad de Fomento (UF) is a formal unit of account indexed to Chilean inflation, as measured by the monthly variation in the official CPI. Different agents use the UF to hedge their inflation risk, including banks. Specifically, the Chilean mortgage market is wholly index to inflation as all mortgage loans are expressed in UF. This means that the loans are subject to real interest rates; both principal amount and monthly payments are expressed in UF.

[3]/ Nonetheless, the regulation states that banks classified by the SBIF in the highest solvency category may grant loans backed by letters of credit up to the value of the property, but only to top credit quality customers and subject to other significant requirements, while the SBIF retains power to rescind this possibility if those further requirements are not

Endorsable mortgage loans are financed entirely with the lending bank's resources, but can be transferred or endorsed to another bank. In the case a loan is endorsed, however, the originator retains all responsibility on debt servicing and other loan management activities and, as a result, the debtor keeps the commercial relationship with the originating bank.

Non-endorsable mortgage loans are also fully financed with the bank's resources, but cannot be transferred to another bank. This type of loan is only subject to the General Banking Act, and to the general framework of consumer protection established in Law N° 18,010.

Despite the existence of the three kinds of mortgage loans, the market is heavily dominated by the non-endorsable mortgage loan. In terms of outstanding amounts, we can observe a steadily increasing trend in the market share of these loans since 2001. As can be seen in Table 2, the share of non-endorsable mortgage loans increased from 13% in December 2001 to 88% in December 2013. One could argue that this is due to the lighter regulatory regime, which is reasonable, but we do not engage in that discussion.

Table 2
Market share by type of mortage loan - Outstanding Amounts

Loan type / Period (december)	2001	2005	2009	2013
Non-endorsable loans	13%	51%	78%	**88%**
Endorsable Loans	17%	10%	8%	6%
Letters of Credit	70%	38%	15%	6%
MM USD - Total	7,263	17,595	32,492	49,558

Source: SBIF

This trend of ever increasing relevance of non-endorsable mortgage loans in terms of the outstanding amount of credit, as exposed in Table 2, is tantamount to a shift towards this kind of loan in terms of new operations. In fact, as we show in Annex 1, non-endorsable residential mortgage loans are all but the only form of real estate financing. In the sample period more than 97% of residential mortgages are structured as a non-endorsable loan, both in number of operations and in amounts lent out.

Given this regulatory structure and market developments, we ask ourselves what would be the effects on the market for mortgage loans of changes in the regulation. All of the measures described above may have an effect on loan volumes and interest rates; but also on the behavior of borrowers. In this paper we focus on the effects of tightening or imposing a LTV ratio restriction on the cost of credit and volume of residential mortgage loans and also on the effect such a restriction may have on the riskiness of the banks' loan portfolios due to possible changes in agents' conduct.

2. Data and methodology

In this paper we work with daily loan data collected by the SBIF. The particular file we have access to contains highly detailed information regarding loan characteristics: kind of loan; either unsecured consumer loan, non-endorsable mortgage loan, endorsable mortgage, or mortgage loan

satisfied. For instance, the regulation requires the implementation and partial disclosure of a specific risk policy for these loans. This requirement alone may be quite burdensome. For further details see Chapter II.A.1 of the "Compendio de Normas Financieras" of the BCCh and Chapter 9-1 of SBIF's RAN.

backed by a letter of credit; principal amount, term to maturity and interest rate; all classified by individual customer on a daily basis. The available information dates back to the last quarter of 2012[4]/. We also use the data from the "Encuesta de Crédito Bancario" of the Central Bank of Chile, from which we obtain an empirical distribution for the LTV ratio of the mortgage loans granted during the quarter covered by the survey.

We focus our analysis on the effect that a tighter LTV policy would have on interest rates in the residential mortgage market, and on the demand or volume of mortgage loans. Restrictions on mortgage loan characteristics such as this ratio have recently been suggested by several authors as a way to "lean against the wind" in order to reduce the likelihood of a housing bubble and hence keeping risks in the real estate market from materializing and propagating to the broader financial system. The financial reasoning behind a cap on the LTV ratio is that the more equity the borrower has invested, the larger the price drop necessary for the mortgage to go underwater; thus lower LTV mortgages are less risky for the bank. Additionally, several jurisdictions have imposed restrictions on the LTV ratio after the global financial crisis[5]/. Our interest in this specific ratio attempts to link this kind of policy alternative with the Chilean market conditions.

The literature most directly related to our specific questions, i.e. regarding the effects of changes in LTV regulation on the mortgage market, is not overwhelmingly abundant. Using a VAR approach, Bloor and McDonald (2013) estimate the effects of a recently adopted policy in New Zealand. Following a period of strong growth in housing prices, due to high pressure on the demand side, the Reserve Bank of New Zealand implemented a restriction on high LTV lending requiring commercial banks to restrict the share of new mortgages with LTVs higher than 80% to no more than 10% of their new mortgage flows. The authors' VAR model allows them to estimate that the restriction could reduce housing credit growth by 1-3 percentage points and housing price inflation by 1-4 percentage points[6]/.

One approach to our problem can be found in Igan and Kang (2011). Their empirical strategy is to exploit regulatory changes in the LTV policy in South Korea during the period 2002-2010. The variations in the LTV restriction act as a quasi-experiment, as policy changes differ in magnitude, implementation dates and geographical areas. However, in Chile there have been no recent changes in the LTV limitations, much less different regional policies. Furthermore, as we saw before, the market is strongly tilted towards the kind of mortgage loan that is not subject to any LTV restriction. For these reasons, the methodology of Igan and Kang (2011) cannot be applied as there is no variance in the LTV restrictions in the Chilean mortgage market.

[4]/ The SBIF collects ample amounts of data on domestic banks. The particular file we are working with stems from the "Sistema de Deudores" (SD) database of the SBIF. There is other information that could be of use for our purposes in other files, such as the debtor's monthly income and the valuation of the posted collateral, both associated to an individual and date in the SD. However, this data is not available at the moment due to confidentiality issues.

[5]/ Igan and Kang (2011) show a summary table of the restrictions implemented in 12 countries: Canada, Finland, Hong-Kong SAR, Hungary, India, Israel, Korea, Malaysia, the Netherlands, Norway, Singapore and Sweden.

[6]/ See Craig and Hua (2011) and Wong et al. (2011) for analysis of the Hong-Kong case. A related literature strand is that of the evaluation of the effectiveness of macro-prudential tools. See for example Borio, Furfine, and Lowe (2001) or HKMA (2011). See also IMF (2013) for a review of the Canadian case.

Crowe et al. (2013) provide a thorough review and analysis of policy tools to contain real estate booms; including monetary policy, fiscal tools and specific banking regulatory measures such as capital requirements, dynamic provisions and caps on LTV and DTI ratios. Within the analysis of this last sort of tools, the authors provide evidence on co-movement between LTV caps and housing prices. For a cross section of 21 countries, the authors find that a 10 percentage point increase in the maximum allowable LTV corresponds to a 13% increase in nominal house prices. This figure drops to 5% for a panel of U.S. states. Along this line, an 8-11% figure is estimated by Duca et al. (2011) - as cited by Crowe et al. (2013). However, no direct link to mortgage market conditions is reported. See Kuttner and Shim (2012) for similar results.

Crowe et al. (2013) also discuss implementation challenges, highlighting the possibility of different ways to circumvent the restrictions. One way to avoid restrictions on LTVs is to borrow unsecured above the cap. Hence, we can use an approach similar to that proposed by Soultanaeva and Nordberg (2010), who analyze the effect of tighter LTV restrictions in the Swedish market. The authors assume that the households affected by the change in policy will resort to an unsecured consumer loan in order to cover the down payment. This assumption is also followed by Bloor and McDonald (2013) in one of the VAR scenarios they analyze for the New Zealand case. The result of this assumption is twofold. First, a regulatory restriction that aimed to contain risks in the real estate and mortgage markets may have the opposite effect: by lending unsecured the bank's mortgage portfolio will be riskier, as it will be more exposed to credit risk because during the first few years the "affected" borrowers must meet a higher total payment (*vis-a-vis* had he not taken out the unsecured loan) thus being in a weaker position to withstand a negative shock. Second, a contraction in the LTV limitation translates into a higher cost of credit overall, as expected. Is this assumption reasonable in our case? As we will show below, a first exploration of our data suggests that in the case of Chile it is reasonable to assume that at least some potential debtors will engage in such an operation.

Once we show that "mortgage-related" unsecured consumer loans account for a non-neglectable fraction, we move on to estimate the effects of constraining the maximum LTV ratio. In order to estimate by how much the cost of credit increases, we make two basic assumptions: (1) that the supply of mortgage loans is perfectly inelastic[7]/; and (2) that the actual LTV of the mortgage is in equilibrium, given that the market is dominated by non-endorsable mortgage loans, which are not subject to any regulatory restriction in this respect.

For example, suppose that we impose a maximum LTV of 90%. Given the distribution reported in the next section, which, by the way, does not show a lump around nor above LTVs of 100%, we would have to restraint roughly 10% of the operations. Then the following question arises: which of the operations in the data set are affected? The answer, of course, should be "those that show a LTV higher than 90%".

The problem is that due to data limitations, we do not have access to the actual LTV of each transaction; we only know the empirical distribution. Therefore, we need to assign a LTV ratio to each loan and then apply the restriction. We perform this exercise in two ways: (1) using a random

[7]/ This assumption is based on the finding of Calani-Garcia-Oda (2010).

assignment of LTV, and (2) estimating the value of the collateral as a function of the observable variables.

In the first approach, we do the following statistical exercise: First, we draw an LTV value from the empirical distribution given by the Encuesta de Crédito Bancario of the Central Bank of Chile; then that value is assigned randomly to one of the loans in our data base. This process is carried out for each loan until the data base is exhausted. We repeat this procedure 500 times. In this way we make sure we are replicating the empirical distribution of LTVs. In contrast, if we were to assign a fixed value for the LTV to each transaction, it would not adjust to the observed distribution, neither would it show any effect unless the LTV limitation reaches the chosen value.

In the second strategy we estimate the value of the collateral using the available or observable characteristics of the loan (principal amount, term to maturity, and the interest rate). In order to carry out this exercise, we need a functional form for the collateral value in terms of the other features of the loan. For simplicity we choose a log linear form for the value of the collateral (*C*), as a function of the loan's principal amount (*L*) and other characteristics (*x*):

$$\ln(C) = \alpha + \beta_1 ln(L) + \beta_2 \left(ln(L)\right)^2 + x'\gamma,$$

Where the parameters α, β, and γ must be estimated. With this construct, the LTV ratio can be expressed as a function of the same variables:

$$\text{LTV} = \frac{L}{C} = \frac{L}{exp\left(\alpha + \beta_1 ln(L) + \beta_2 \left(ln(L)\right)^2 + x'\gamma\right)}$$

To estimate the distribution of the LTV, we first define a loss function as the sum of squared errors of the first four moments. Then, the parameters α, β, and γ are estimated by minimizing the loss function. With this equation, we can estimate the LTV of each operation and detect which ones would be subject to the LTV restriction. Once the operations affected by the LTV restriction are identified with this procedure, we can calculate the amount and cost of additional unsecured debt needed to cover the down payment. Also, we obtain an expression for the relation between the LTV of the mortgage and the principal amount of the loan.

$$\frac{\partial \text{LTV}}{\partial L} = \frac{1 - \beta_1 - 2\beta_2 ln(L)}{exp\left(\alpha + \beta_1 ln(L) + \beta_2 \left(ln(L)\right)^2 + x'\gamma\right)}$$

Finally, with the increase in the cost of credit estimated in the way just described, we can determine the effect on the volume of mortgage loans by applying it to a demand function. For this purpose we take the demand elasticity estimated by Calani, Garcia and Oda (2010) who analyze the Chilean mortgage market in the period 2003-09. We recognize that regulatory changes of the kind considered also affect the supply side, but we take the perspective of a partial equilibrium analysis.

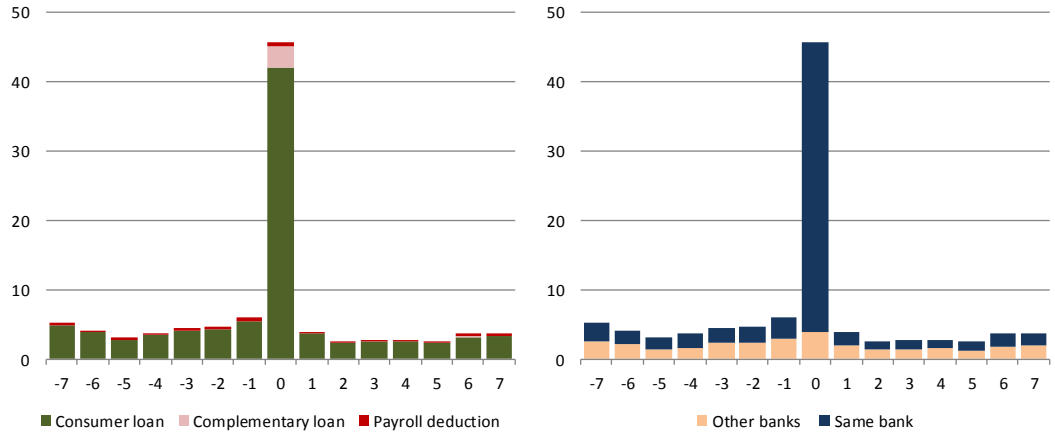
3. Results

3.1 Complementary unsecured loans.

We evaluate the unsecured loans granted to the mortgage debtor during the days immediately before or after the mortgage loan is approved. Our data allows us to identify the different kinds of loans taken out by the same individual on a daily basis.

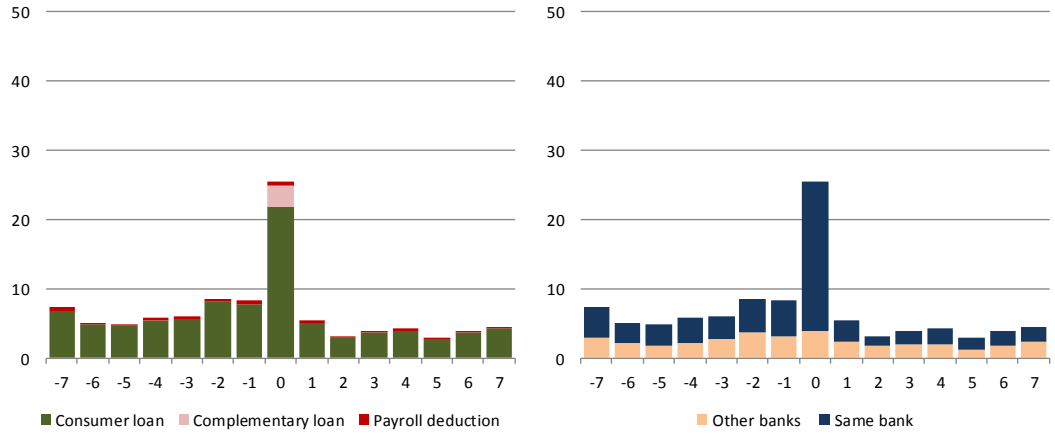
Figure 1 shows that during the 15 day window there is a significant concentration of unsecured loans granted to mortgage debtors on the same day the mortgage was approved. The graphs in Figure 1 show that about 45% of these loans are granted on the same day as the mortgage, and this accounts for approximately 25% of the amount of these loans. Furthermore, we observe a slightly bigger proportion of these unsecured loans being granted before, rather than after, the mortgage.

Figure 1
Graph 1.A
Number of unsecured loans granted to the mortgage debtor around the date of mortgage issuance (2012.IV - 2013.IV) (*)
(percentage)



Source: Authors' calculation with SBIF data.

Graph 1.B
Total amount of unsecured loans granted to the mortgage debtor around the date of mortgage issuance (2012.IV - 2013.IV) (*)
(percentage)



Source: Authors' calculation with SBIF data.

Figure 1 also shows that most of these unsecured loans are granted by the same bank that finances the purchase of real estate. This confirms our intuition that special offers of unsecured loans to finance the down payment on the mortgage are not a rare market practice. Finally, we can account for a small proportion of complementary loans, which are loans secured by the same collateral as the related mortgage, but granted at more stringent conditions usually including a higher interest rate.

Now we must quantify this "related loan" activity in relation to the mortgages taken out by the same debtors during the 15 day window. As we can appreciate in Table 3 below, 16% of the mortgages granted in the period of analysis have a related consumer loan, and 60% of them are taken out in the same bank. Interestingly, we can see a steadily decreasing trend in the use of related unsecured loans during the period; in fact 21.4% of the mortgages granted in Q4 of 2012 were coupled to an unsecured loan, but only 13.7% were in Q4 of 2013.

Table 3
Mortgages and related loans issuance
(number)

	Total	With related loans		Same bank		Other banks	
2012.IV	18,441	3,944	21.4%	2,759	70.0%	1,250	31.7%
2013.I	20,032	3,324	16.6%	2,160	65.0%	1,197	36.0%
2013.II	21,328	3,150	14.8%	1,775	56.3%	1,398	44.4%
2013.III	20,855	3,014	14.5%	1,605	53.3%	1,430	47.4%
2013.IV	22,604	3,086	13.7%	1,627	52.7%	1,477	47.9%
Total	103,260	16,518	16.0%	9,926	60.1%	6,752	40.9%

Source: Authors' calculation with SBIF data.

This decline in the fraction of mortgages associated with an unsecured loan is accompanied by an increase in the absolute number of mortgages granted during 2013 and with a decrease in the absolute number of related unsecured loans in the same period. As an aside, Table 4 presents the mortgage related loans by currency of issuance, where can see that over 90% of the related loans are dealt with in Chilean pesos (CLP), the remainder is expressed in UF.

Table 4
Characteristics of related loans

	Composition (percentage)		**Average loan amount** (USD thousand)	
	UF	CLP	UF	CLP
Complementary loan	1.1	-	12.1	-
Consumer loan	5.9	88.0	5.8	17.9
Payroll deduction	0.0	4.9	4.9	12.3

	Average interest rate (*) (percentage, annual basis)		**Average maturity** (years)	
	UF	CLP	UF	CLP
Complementary loan	7.6	-	23.3	-
Consumer loan	7.7	18.7	23.1	3.3
Payroll deduction	3.0	15.7	2.7	3.8

(*) Nominal interest rate.
Source: Authors' calculation with SBIF data.

Table 5 shows the main characteristics of the mortgages and related loans; panels 5.a to 5.d show average principal amounts, average interest rates, average maturity, and average monthly payment, respectively.

Table 5
Mains statistics of mortgages and related loans

Panel 5.a
Average principal amount
(USD thousand)

	Sole	With related loan		
	Mortgage	Mortgage	Rel. Loan	Mix
2012.IV	102.67	103.83	9.67	113.50
2013.I	103.95	111.66	10.80	122.46
2013.II	103.25	108.83	14.10	122.93
2013.III	101.86	102.33	13.43	115.78
2013.IV	98.97	102.19	13.67	115.86
Total	102.26	105.43	12.20	117.63

Panel 5.b
Average interest rate (*)
(percentage, annual basis)

	Sole	With related loan		
	Mortgage	Mortgage	Rel. Loan	Mix (**)
2012.IV	4.35	4.40	14.17	4.64
2013.I	4.49	4.54	14.86	4.76
2013.II	4.52	4.52	14.44	4.79
2013.III	4.45	4.45	14.41	4.72
2013.IV	4.38	4.39	13.89	4.65
Total	4.44	4.46	14.34	4.71

Panel 5.c
Average term to maturity (*)
(years)

	Sole	With related loan	
	Mortgage	Mortgage	Rel. Loan
2012.IV	22.3	24.0	7.9
2013.I	22.1	23.8	6.0
2013.II	22.1	23.6	4.6
2013.III	21.8	23.8	4.1
2013.IV	22.3	24.1	4.2
Total	22.1	23.8	5.2

Panel 5.d
Average monthly payment
(USD)

	Sole	With related loan		
	Mortgage	Mortgage	Rel. Loan	Mix
2012.IV	629	603	332	674
2013.I	647	660	405	740
2013.II	647	644	585	747
2013.III	643	598	571	695
2013.IV	608	589	524	685
Total	636	617	476	705

(*) Weighted average by loan amount.
(**) Interest rate of a single loan equivalent to both loans (Annex 2).
Source: Authors' calculation with SBIF data.

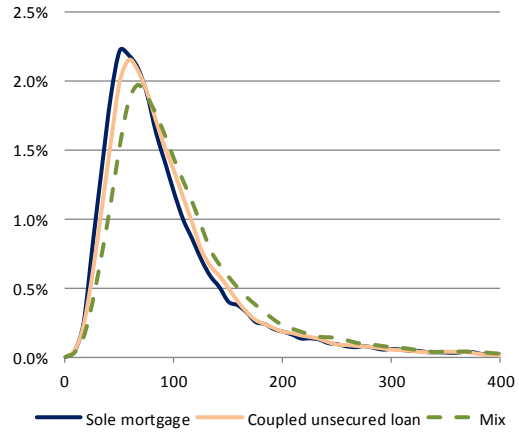
On each of the panels, the "Sole mortgage" column shows the corresponding feature of the mortgage loans that are not coupled to an unsecured loan; while the "With related loan" tri-columns show the same feature in the case of coupling with a related loan.

In panel 5.a we see that when there is a related loan, the mortgage tends to be larger by almost USD four thousand (CLP two million) on average. Of course, this difference increases if we add the related loan, which on average totals up to USD twelve thousand (CLP six million). This observation is confirmed in Figure 2 below, where we see a shift to the right in the distribution of the principal amount.

Additionally, as we can see on panel 5.b, there is practically no difference in the interest rates on the mortgages. However, once the supplementary loan is taken into account, the equivalent interest is 27bp higher on average. The equivalent interest rate is calculated as an internal rate of return by creating a composite loan as we explain in Annex 2.

Another observation is that the mortgages coupled to a related loan have a longer term to maturity by approximately 18 month on average, as shown in panel 5.c. In the same panel we can see that the unsecured loans have an average maturity of 5 years, which decreases almost by half during the period from just below 8 years to slightly over 4 years, this clearly means that the financial obligation on the household is more burdensome during that period, as we discuss below.

Figure 2
Density of principal amounts
(density, USD thousand)



Source: Authors' calculation with SBIF data.

When comparing the sole mortgages with those coupled to unsecured loans, we see that the combination of the following factors: (1) roughly the same interest rate on the mortgages, (2) longer average term to maturity in the mortgages coupled with an unsecured loan, and (3) larger average principal amount in the mortgages coupled with an unsecured loan; generates a somewhat smaller monthly payment on the mortgage when there is a related loan, if only by USD 19 - USD 636 vs. 617 on average - as exposed on panel 5.d. However, taking into account the complementary loan, panel 5.d shows that the household faces a higher financial burden due to the USD 476 additional average payments on the unsecured loan. The overall effect is that debtors face a higher total financial obligation during the life of the unsecured loan by a net amount of USD 457 on average. In terms of the equivalent loan as explained in Annex 2, the aggregate effect is a larger total equivalent payment by about USD 69.

Another interesting fact we can observe relates to the amount of the unsecured loan in relation to that of the mortgage. If we add the amounts lent in the case of mortgages coupled with an unsecured loan, we see that the unsecured portion accounts for about 10% of the total amount, on average (see "total" row on panel 5.a of Table 5).

Given that more than half of the mortgages in the period are granted with an LTV greater than 80%, as we will show in section 3.2 below, the principal amounts on the unsecured loans are consistent with the hypothesis of them being used to cover the down payment on the mortgage. Furthermore, as we see in Table 6 below, this implied down payment increased in the time sample. Finally, Table 7 shows that the average interest rate on the complementary unsecured loans is markedly lower than that of comparable consumer loans not necessarily related to a mortgage.

Table 6
Implied downpayment

	With related loan
2012.IV	8.5%
2013.I	8.8%
2013.II	11.5%
2013.III	11.6%
2013.IV	11.8%
Total	10.4%

Source: Authors' calculation with SBIF data.

Table 7
Average annual interest rate (*)
(percentage, annual basis)

	Complementary loans	Consumer loans (**)
2012.IV	14.17	23.34
2013.I	14.86	22.59
2013.II	14.44	20.06
2013.III	14.41	24.72
2013.IV	13.89	24.80
Total	14.34	23.10

(*) Weighted average by loan amount.
(**) Average interest rate of unsecured consumer loans with a term to maturity over three years.
Source: Authors' calculation with SBIF data.

In summary, from this section we can see that the "complementary loan" assumption is indeed plausible. Also, the analysis shows that potential debtors in this situation would be subject to a materially higher financial burden during the first few years of the mortgage. On average, the complementary loans have a term to maturity of about 5 years, period during which the financial burden on the household is materially higher (by about USD 457, as we saw). The data points out, even if does not prove, that this kind of strategy would probably play an important role in circumventing a regulatory cap on LTVs. This means that there is reasonable ground to believe that imposing such a policy would be risky, both from a prudential banking regulation perspective and systemic risk point of view.

Hence, a cap on LTV would have to be complemented by other requirements in order to be effective in achieving the policy objectives. For instance, this measure could be coupled to a DTI restriction that considers all installment loans, which of course would require that all lenders have access to the relevant financial information associated to potential borrowers. Also, care must be taken so that credit activity is not channeled outside the reach of the regulatory perimeter.

Anyway, as Crowe et al. (2013) point out, regulatory circumvention must be considered as it has been observed in other jurisdictions with this sort of regulatory restrictions. The authors mention examples in the U.S., Hong-Kong SAR and Korea.

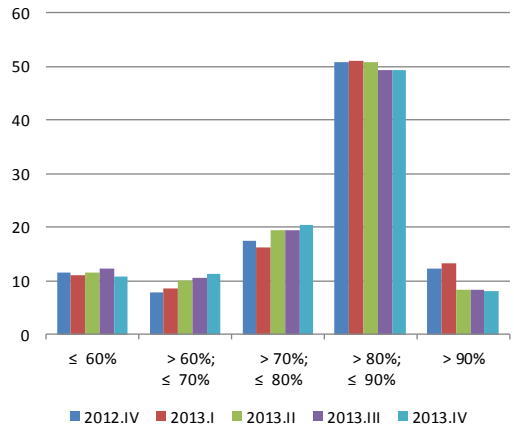
3.2 The Empirical LTV distribution.

The distribution of the LTV ratio is obtained from the quarterly "Encuesta de Crédito Bancario" (lending survey) of the Central Bank of Chile. Hence, it is a self-reported distribution. This question was introduced in the survey for the first time in Q3 of 2012, and is phrased as follows: *"According to the debt/collateral relation at which residential mortgages were granted during the last quarter, indicate the percentage of such loans classified in the following ranges of debt/collateral relation."* For a detailed description and analysis of the lending survey see Jara and Silva (2007)[8]/.

[8]/ The full form of the lending survey containing all questions is publicly available online, but only in Spanish.

Figure 3 shows the distribution of the LTV ratios reported by commercial banks in the lending survey. As we can appreciate, approximately 50% of the mortgage loans are granted at LTV ratios in the range of 80%-90%; and this fraction of loans has remained relatively stable during the period of analysis. Roughly another 20% of the mortgages are granted with LTVs in the range of 70%-80%, and only about 10% of the mortgages show LTVs that exceed 90%.

Figure 3
Empirical LTV distribution
(percentage)



Source: Authors' calculation with data from the bank lending survey of the Central Bank of Chile

Put another way, approximately 90% of the mortgages were issued with LTVs lower than 90%. This self-reported distribution is consistent with the incidental evidence that, in Chile, the common market practice is to issue mortgages with LTV ratios around 85%-90%. Another observation on the LTV distribution is that is a slight preference for lower LTVs in 2013, as operations above 90% have decreased and operations between 60%-80% have increased.

Therefore, given that non-endorsable mortgage loans with no restrictions on the LTV ratio strongly dominate the market, it is reasonable to assume that this configuration is a consequence of market equilibrium.

3.3 LTV restriction: Random assignment.

Our first exercise to quantify the effect of imposing a restriction on the LTV ratio is relatively straight forward. As explained in section 2, we draw LTV values from the empirical distribution and then assign it randomly to one of the loans in the data set. We only use the data of Q4 2013 in order to reduce computing time. Our results are summarized in Table 8.

As expected, the number operations for which the imposed restriction on the LTV ratio becomes binding increases as the hypothetical maximum LTV ratio decreases. If the LTV restriction is applied at 90%, only 8.1% of the operations are affected. This fraction jumps to 57.4% and 77.9% when the restriction becomes more severe, reaching 80% and 70% respectively.

In order to quantify the effects on interest rates we use the average interest rate of the complementary loans. The main result from this exercise is that both the equivalent interest rate and monthly payment of the aggregated loan are higher the more restrictive is the imposed LTV policy.

As we can see in Table 8, when the restriction on LTV is 90%, 80% or 70%; the equivalent interest rate is 12, 17 or 40 bps higher than the mortgage rate on average, which would translate into higher average monthly payments by USD 6, 9 or 20, respectively.

Table 8
Average effect of LTV restrictions - random assigment

	Maximum LTV					
	90%		80%		70%	
		(s.e.)		(s.e.)		(s.e.)
Affected operations	8.1%	(0.000)	57.4%	(0.000)	77.9%	(0.000)
Collateral (USD thousand)	103.44	(1.957)	113.88	(0.564)	118.40	(0.357)
Loan (USD thousand)	98.27	(1.859)	98.26	(0.486)	98.27	(0.295)
LTV (%)	95.00	(0.000)	86.28	(0.000)	83.00	(0.001)
Actual interest rate (% - annual basis)	4.52	(0.010)	4.52	(0.003)	4.52	(0.002)
Estimated interest rate (% - annual basis)	4.64	(0.010)	4.69	(0.003)	4.92	(0.002)
Change (basis points)	**12**	(0.082)	**17**	(0.040)	**40**	(0.058)
Actual monthly payment (USD)	598	(11.363)	598	(3.019)	598	(1.853)
Estimated equivalent monthly payment (USD)	604	(11.480)	607	(3.063)	618	(1.920)
Change (USD)	**6**	(0.117)	**9**	(0.056)	**20**	(0.087)
Estimated initial monthly payment (USD)	709	(13.332)	751	(3.750)	927	(2.950)
Additional initial payment (USD)	**110**	(2.127)	**153**	(0.934)	**328**	(1.312)

Considering the shorter term to maturity of the complementary unsecured loans, during the first few years of the mortgage the financial burden becomes quite higher upon imposing the restrictions, ranging from USD 110 in the case of a 90% LTV constraint, to 153 when the LTV is constrained to 80%, to as much as USD 328 extra in the case of a 70% LTV limitation, also on average.

3.4 LTV restriction: Estimating the reported LTV distribution.

Instead of assigning LTVs to loans at random we can estimate the relation between the LTV and the main features of the loan as described in section 2. We carry out this estimation using four specifications and analyze how well each one approximates the first four moments of the reported distribution. We restrict our analysis to the data from Q4 2013, but the main conclusions do not change over the other quarters[9]/. The results of these estimations are reported in Table 9.

As a first overall observation, we notice that in term of the first four moments of the distribution all specifications generate good results. The column labeled "empirical", in Table 9, indicates the basic statistics of the LTV distribution reported by commercial banks; and, in the following columns, we can see that the models deliver statistics that reasonably approximate those

[9]/ The results for the other quarters are presented in Annex 3.

of the empirical distribution. This behavior of the basic statistics is consistent with the high values reported for the fit rates. From here on, however, we use model 4 because it is the most inclusive.

Table 9
Estimation of the LTV distribution
Dependent variable: Collateral value

	Empirical	Specification			
Independent variables		**1**	**2**	**3**	**4**
ln_principal		0.717	1.972	-0.444	1.509
interest rate			-6.3		62.249
ln_term				-7.414	-0.548
ln_principal*ln_principal		0.081	-0.002	0.027	-0.009
ln_principal*interest			-18.745		-19.770
ln_principal*ln_term				0.242	0.104
interest*interest			550.2		307.0
interest*ln_term				0.635	-7.234
ln_term*ln_term					0.057
_cons		0.173	-1.045	21.744	-0.699
LTV					
Mean	0.783	0.776	0.782	0.782	0.782
Std. Dev.	0.112	0.149	0.114	0.114	0.117
Skewness	-0.781	-0.702	-0.739	-0.697	-0.727
Kurtosis	2.700	3.368	2.982	3.010	3.012
Fit rate (*)		0.913	0.987	0.978	0.983

(*) The fit rate is defined as: 1-(model error/mean error).

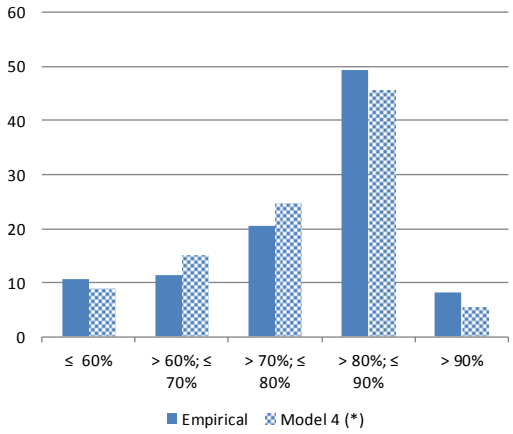
As the model is specified, there is a positive relation between the principal amount and the value of the collateral. There is also a negative relation between the principal amount and the LTV. That means that the more expensive the house, the higher the down payment.

Therefore, we expect that cuts in the LTV will have a greater impact on operations with lower collateral value. If we argue that collateral value is correlated with the household income, then the LTV policy will restrict the lower income percentiles.

However, the results of this approximation are acceptable only in the average. Hence, it is possible that this construed relation between household income and degree of impact of the restrictions is biased, for example, if there are a proportion of high income households that invest in low cost apartments, for rental purposes, with a high down payment.

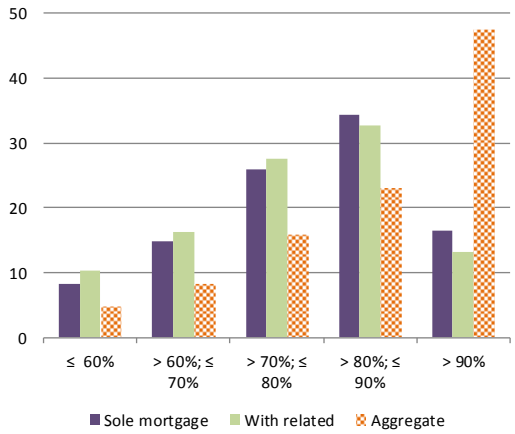
In any case, the estimation approximates the reported distribution very well. Figure 4 shows the fit of the exercise for the last quarter of 2013, in which the estimated LTV is quite close to the survey data. It is important to mention that the result presents continuous values while the reported LTV distribution is divided into buckets. Considering that the common practice consists of LTVs in the range 85%-90%, the method is sensitive to values around this neighborhood. For example, a LTV of 91% is practically indifferent from a value of 90% in a continuous fashion, but is located, in the discretization, in the range over 90%.

Figure 4
Estimation of the LTV distribution
(percentage)



(*) Taking the interval]80, 90] as]80, 92].
Source: Authors' calculation with data from the bank lending survey of the Central Bank of Chile

Figure 5
Estimated LTV distribution by related loan access
(porcentaje)



Source: Authors' calculation with SBIF and BCCh data.

The estimated distribution of the LTV for those with a related loan is not significantly different from those without, which is consistent with the results presented in Figure 2. Conversely, if we add the related loan to the mortgage, as shown in figure 5 below, there is an important increment in the average LTV. Therefore, the reported LTV could be an underestimation if we do not consider all the loans associated with the mortgage operation.

So far the evidence shows that the (hypothetical) use of complementary loans to cover the down payment is reasonable. But in order to implement our exercise we need to determine which will be the interest rate and the term of this new loan. Table 10 below presents a linear estimation of the interest rate and term using the observed characteristics of the mortgage. We use the estimated results for the evaluation shown in Table 11.

Table 10
Estimation of the related loan variables
Ordinary least squares (*)

Variables	Interest rate (**)		Term (**)	
Collateral (USD M)		-0.003		-9.078
		(0.000)		(1.128)
Mortgage interest (**)		3.078		
		(0.200)		
Mortgage term (**)				0.053
				(0.005)
_cons	0.011	0.001	46.790	33.953
	(0.000)	(0.001)	(0.332)	(1.557)
Observations	2973	2973	2973	2973
R2	-	0.177	-	0.052

(*) Wighted by loan amount.
(**) Monthly units.
(***) Standard errors in parenthesis.

As expected, and similar to the random assignment exercise, in this case the number operations for which the imposed restriction on the LTV ratio becomes binding increases as the hypothetical maximum LTV ratio decreases. If the LTV restriction is applied at 90%, as much as 16.1% of the operations are affected. This fraction shoots up to 50.2% and 76.3% when the restriction extends to 80% and 70% respectively.

Table 11
Average effect of LTV restrictions - estimated collateral

	Maximum LTV		
	90	**80**	**70**
Affected operations	16.1%	50.2%	76.3%
Collateral (USD thousand)	47.64	66.35	88.62
Loan (USD thousand)	44.04	57.43	71.52
LTV (%)	92.45	86.55	80.71
Actual interest rate (% - annual basis)	5.11	4.81	4.66
Estimated interest rate (% - annual basis)	5.19	5.07	5.15
Change (basis points)	8	26	49
Actual monthly payment (USD)	319	390	460
Estimated equivalent monthly payment (USD)	321	397	475
Change (USD)	2	7	15
Estimated initial monthly payment (USD)	345	485	667
Additional initial payment (USD)	26	95	207

Likewise, the main result from this exercise is that both the equivalent interest rate and monthly payment of the aggregated loan are higher the more restrictive is the imposed LTV policy.

As we can see in Table 11, when the restriction on LTV is 90%, 80% or 70%; the equivalent interest rate is 8, 26 or 49 bps higher than that of the mortgage rate, on average, which means higher average monthly payments by USD 2, 7 or 15, respectively.

Considering the shorter term to maturity of the complementary unsecured loans, during the first few years of the mortgage the financial burden becomes quite higher upon imposing the restrictions, ranging from USD 26 in the case of a 90% LTV constraint, to 95 when the LTV is constrained to 80%, to as much as USD 207 extra in the case of a 70% LTV limitation.

Finally, using the demand elasticity estimated by Calani, García and Oda (2010) we can calculate the effect on mortgage demand. The first row of Table 12 shows the interest rate elasticity of credit growth, where we can see that for a rise of 1 percentage point in the interest rate there is a drop in the rate of growth of credit of 5.8 to 6.3 percentage points.

In the last row of Table 12 we see that imposing a restriction of 90% on the LTV has virtually no effect on credit demand, as is expected since very little mortgage activity goes on in that range. Also as expected, we obtain a more significant effect with more severe restrictions on the LTV ratio. An LTV policy of 80% would reduce credit growth in 40 basis points, while a 70% rule would reduce it by 129 to 141 basis points.

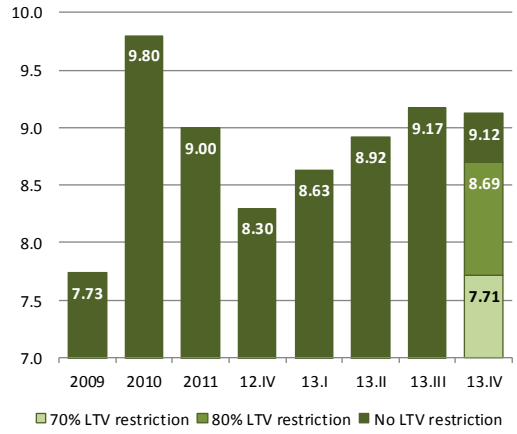
Table 12
Effect on demand for housing credit (*)

	Maximum LTV					
	90		80		70	
$\partial Credit\ growth / \partial Interest\ rate$	-6.3	-5.8	-6.3	-5.8	-6.3	-5.8
Change in the interest rate (%)	0.0	0.0	0.1	0.1	0.2	0.2
Change in annual credit growth (%)	-0.04	-0.04	-0.43	-0.39	-1.41	-1.29

(*) Elasticities from Calani-Garcia-Oda (2010).

To have an idea of the magnitude of these effects on the demand form mortgage loans we compare our results with actual data on credit growth in Figure 6.

Figure 6
Annual growth of mortgage loans
(percentage)



Source: BCCh.

Except for 2009 when the Chilean economy was in recession, annual mortgage loan growth rate hovers around 9% during the last 4 years. For the last quarter of 2013 this growth rate was 9.12%. With our estimation, the growth rate would have been 8.69% upon a restriction of 80% LTV, and only 7.71% if the ceiling on the LTV ratio were 70%.

4. Conclusions

This paper aimed to estimate the effects that an eventual LTV ratio restriction would have on the cost of and demand for mortgage loans. The main assumption is that LTV-restricted households will cover the remainder of the mortgage with an unsecured loan. As we showed, this assumption is not unreasonable given 16% of the mortgages in our sample have an unsecured consumer loan attached. This related loan represents about 10% of the total credit operation in a context where a 10% down payment is the operating rule.

In this context, our analysis shows that this lending/borrowing strategy may become a relevant mechanism to circumvent a regulatory cap on LTVs, especially considering that agents have been able to avoid such restrictions or limitations in other jurisdictions, albeit done in other ways. In view

of this finding, we consider that simply implementing an LTV restriction policy may not fully achieve a reduction in household leverage and financial risk, unless complemented by other requirements in order to be effective in achieving the policy objectives while minimizing negative unintended consequences. For instance, LTV restrictions could be coupled to a DTI restriction that considers all installment loans, another possibility is to establish an overall leverage ceiling. Any of these complementary requirements would involve that all lenders have access to, and are willing to use, the relevant financial information associated to potential borrowers. Another major concern, considering financial stability and prudential regulation goals, is not to push credit activity out of the regulatory perimeter.

Furthermore, our results show that a restriction of 80% on the LTV ratio that is bypassed through the issuance of unsecured loans may increment the cost of credit in about a quarter of a percentage point for those affected by the restriction. This effect is tantamount to a slight increase in the monthly amortization by an amount in the range of a few dollars. However, since the complementary unsecured loans are typically of a much shorter term, the household will face a much higher financial burden during the first five years by an amount in the range of USD 95 to 153 (50 to 80 CLP thousand). This impact is relevant considering that the average income of the Chilean household is approximately USD 1,640 (CLP 810 thousand) according to official estimations[10]/. Our final exercise shows that a ceiling of 80% on the LTV would have a relatively limited effect on credit demand as it may reduce the growth rate in mortgage loans by 40 basis points. This further reinforces the potential need for complementary LTV restrictions with other policies that reduce the scope for bypassing regulation through the use of bridge loans.

References

[1] Calani, M.; García, P. and D. Oda (2010). "Supply and Demand Identification in the Credit Market". BCCh working paper N° 571. April.

[2] BCCh (2008). "Recuadro V.1: Aspectos de la regulación del mercado de créditos hipotecarios en Chile". Banco Central de Chile, Informe de Estabilidad Financiera, Segundo Semestre.

[3] BCCh (2013). "Encuesta Financiera de Hogares: Metodología y Principales Resultados." EFH 2011-12. Banco Central de Chile, Agosto.

[4] Borio, C.; C. Furfine and P. Lowe (2001). "Procyclicality of the financial system and financial stability: Issues and policy options." BIS Papers N° 1.

[5] Bloor, C. and C. McDonald (2013). "Estimating the impacts of restrictions on high LVR lending". Reserve Bank of New Zealand Analytical Notes, AN2013/05.

[6] Craig, R. and C. Hua (2011). "Determinants of Property Prices in Hong-Kong SAR: Implications for Policy". IMF working paper 11/297, International Monetary Fund.

[7] Crowe, C.; G. Dell'Ariccia; D. Igan and P. Rabanal (2013). "How to deal with real estate booms: Lessons from country experiences". Journal of Financial Stability 9 (20013) 300-319.

[10]/ Household financial survey; BCCh (2013).

[8] Demyanyk, Y. and O. Van Hemert (2007). "Understanding the subprime mortgage crisis". Federal Reserve Bank of St. Louis Supervisory Policy Analysis Working Papers no 2007-05.

[9] Duca, J. V.; J. Muellbauer and A. Murphy (2011). "House prices and credit constraints: making sense of the U.S. experience". Economic Journal 121, 533-551.

[10] Ellis, L. (2008). "The housing meltdown: Why did it happen in the United States?. BIS working papers N°259, September.

[11] HKMA (2011). "Loan-to-value ratio as a macroprudential tool – Hong Kong SAR's experience and cross-country evidence." Hong Kong Monetary Authority, BIS Papers N° 57.

[12] Igan, D. and H. Kang (2011). "Do Loan-to-value and Debt-to-income limits work? Evidence from Korea." IMF Working Paper, WP/11/297. International Monetary Fund.

[13] IMF (2011). "Housing Finance and Financial Stability—Back to Basics?" Global Financial Stability Report, Chapter 3. International Monetary Fund, April.

[14] IMF (2013). "Recent experience with macro-prudential tools in Canada: Effectiveness and options going forward". IMF Country Report 13/41, International Monetary Fund.

[15] Jara, A. and C. Silva (2007). "Metodología de la Encuesta sobre Condiciones Generales y Estándares en el Mercado de Crédito Bancario." Central Bank of Chile, Studies in Economic Statistics, N° 57.

[16] Kuttner, K. and I. Shim (2012). "Taming the Real Estate Beast: The Effects of Monetary and Macroprudential Policies on Housing Prices and Credit", in Heath A., F. Packer, and C. Windsor (ed.), Property Markets and Financial Stability, Reserve Bank of Australia, December 2012.

[17] Soultanaeva, A. and A. Norberg (2010). "The impact of a maximum loan-to-value ratio on the borrowers' expenditure." Economic Commentaries, N° 5. Sveriges Riksbank.

[18] Turner, J. A. (2009). "The Turner Review: A regulatory response to the global banking crisis". Financial Services Authority, March.

[19] Wong, E.; T. Fong; K. Li and H. Choi (2011). "Loan-to-Value Ratio as a Macroprudential Tool – Hong Kong's Experience and Cross-Country Evidence". Hong Kong Monetary Authority Working Paper, 01/2011.

Annex 1. Data description.

The data on mortgage and unsecured loans is obtained from the "Debtors System (D)" of the SBIF. This system includes the file "D32" which contains data on the daily loans operations. Information is disaggregated to the level of individual debtor and specific dates of the transactions. The file has detailed information on loan characteristics, such as loan type: letters of credit, endorsable mortgage, non-endorsable mortgages; currency of issuance: CLP or UF; principal amount; term to maturity; and interest rate.

Table A1 shows the main statistics by type of loan. As we can observe, 97% of the loans are non-endorsable mortgages. That means that in practice there is no regulatory restriction in the LTV ratio.

Table A1
Main statistics of mortgage loans by type

Number of loans
(number)

	Mortgage bonds	Endorsable	Non-endorsable	Total
2012.IV	25	351	18,065	18,441
2013.I	2	361	19,669	20,032
2013.II	10	462	20,856	21,328
2013.III	15	420	20,420	20,855
2013.IV	11	561	22,032	22,604
Total	0.1%	2.1%	97.9%	100.0%

Total loans
(USD MM)

	Mortgage bonds	Endorsable	Non-endorsable	Total
2012.IV	3	40	1,854	1,898
2013.I	0	54	2,054	2,108
2013.II	1	68	2,151	2,220
2013.III	3	57	2,066	2,126
2013.IV	1	80	2,166	2,247
Total	0.1%	2.8%	97.1%	100.0%

Average principal amount
(USD thousand)

	Mortgage bonds	Endorsable	Non-endorsable	Total
2012.IV	137.74	114.45	102.64	102.92
2013.I	80.47	149.38	104.43	105.23
2013.II	82.77	146.73	103.14	104.08
2013.III	197.32	135.64	101.16	101.93
2013.IV	123.87	142.75	98.29	99.41
Total	139.68	139.53	101.96	102.76

Average real interest rate (*)
(percentage)

	Mortgage bonds	Endorsable	Non-endorsable	Total
2012.IV	4.2	4.3	4.4	4.4
2013.I	4.4	4.4	4.5	4.5
2013.II	4.3	4.4	4.5	4.5
2013.III	4.4	4.4	4.5	4.5
2013.IV	4.4	4.4	4.4	4.4
Total	4.3	4.4	4.4	4.4

Average term (*)
(years)

	Mortgage bonds	Endorsable	Non-endorsable	Total
2012.IV	18.3	21.3	22.7	22.7
2013.I	17.7	21.2	22.5	22.4
2013.II	14.7	21.9	22.4	22.3
2013.III	20.3	21.0	22.1	22.1
2013.IV	22.8	21.9	22.6	22.6
Total	19.4	21.5	22.4	22.4

Average monthly payment
(USD)

	Mortgage bonds	Endorsable	Non-endorsable	Total
2012.IV	983	729	620	623
2013.I	550	961	643	649
2013.II	656	915	641	647
2013.III	1,293	871	631	637
2013.IV	730	885	598	606
Total	950	881	627	633

(*) Weighted average by loan amount.
Source: Authors' calculation with SBIF data.

Annex 2. Two loan aggregation.

A. The interest rate of a loan equivalent to the combination of two loans

The aggregate discount factor for an amortizing loan with a fixed payment can be written as:

$$\sum_{i=1}^{T} \frac{1}{(1+r)^i} \tag{1}$$

From which we have:

$$\sum_{i=1}^{T} \frac{1}{(1+r)^i} = \sum_{i=1}^{\infty} \frac{1}{(1+r)^i} - \sum_{i=T+1}^{\infty} \frac{1}{(1+r)^i} = \frac{1}{r} - \frac{1}{r(1+r)^T} = \frac{(1+r)^T-1}{r(1+r)^T} \tag{2}$$

Then, we can compute the payment with the following expression:

$$q_i = L_i \frac{r_i(1+r_i)^{T_i}}{(1+r_i)^{T_i}-1} \tag{3}$$

Consider now two regular installment loans for which $T_1 > T_2$,. Then, we have that the equivalent loan amount corresponds to $L_1 + L_2$:

$$L_1 + L_2 = q_1 \left[\frac{(1+r)^{T_1}-1}{r(1+r)^{T_1}}\right] + q_2 \left[\frac{(1+r)^{T_2}-1}{r(1+r)^{T_2}}\right] \tag{4}$$

The effective interest rate r corresponds to the interest rate at which a rational borrower becomes indifferent between the alternatives of taking a single loan for $L_1 + L_2$ or taking two separate loans of L_1 and L_2 at their respective interest rates.

B. The payment when keeping the "same" time to maturity

Suppose you want to keep the time to maturity of the longer-term loan, i.e. the term to maturity of the mortgage. Then we have that the effective payment is given by

$$q = (L_1 + L_2) \frac{r(1+r)^{T_1}}{(1+r)^{T_1}-1} \tag{5}$$

C. The term to maturity when keeping the "same" monthly payment

Suppose the borrower takes out a total loan for $L_1 + L_2$ at a rate r and wants to maintain a payment of q_1, i.e. that of the sole mortgage. Then, the loan parameters are such that

$$L_1 + L_2 = q_1 \left[\frac{(1+r)^T-1}{r(1+r)^T}\right] \tag{6}$$

Annex 3. Results by quarter (2012.IV – 2013.III).

Average effect of LTV limits using estimated collateral

2012.IV	Maximum LTV 90	80	70
Operations affected	23.2%	54.2%	78.1%
Collateral (USD thousand)	50.00	67.81	89.89
Loan (USD thousand)	46.08	59.29	73.21
Loan-to-value (%)	92.15	87.44	81.44
Original interest rate (%)	5.04	4.81	4.64
New interest rate (%)	5.12	5.15	5.27
Original monthly amortization (USD)	306	384	458
New monthly amortization (USD)	308	394	478
Initial new monthly amortization (USD)	330	497	686
Change in the interest rate (bp)	8	35	63
Change in the amortization (USD)	2	10	20
Initial change due to shorter term (USD)	25	113	228

2013.I	Maximum LTV 90	80	70
Operations affected	23.5%	55.9%	78.5%
Collateral (USD thousand)	51.07	69.76	92.14
Loan (USD thousand)	47.19	60.94	75.14
Loan-to-value (%)	92.40	87.36	81.55
Original interest rate (%)	5.17	4.93	4.78
New interest rate (%)	5.25	5.24	5.35
Original monthly amortization (USD)	313	393	472
New monthly amortization (USD)	315	402	491
Initial new monthly amortization (USD)	344	519	730
Change in the interest rate (bp)	8	30	57
Change in the amortization (USD)	2	9	19
Initial change due to shorter term (USD)	31	126	257

2013.II	Maximum LTV 90	80	70
Operations affected	18.7%	51.2%	76.3%
Collateral (USD thousand)	47.16	67.00	89.21
Loan (USD thousand)	43.62	58.12	72.11
Loan-to-value (%)	92.51	86.74	80.82
Original interest rate (%)	5.28	4.97	4.82
New interest rate (%)	5.37	5.24	5.33
Original monthly amortization (USD)	274	363	447
New monthly amortization (USD)	276	371	464
Initial new monthly amortization (USD)	302	470	673
Change in the interest rate (bp)	9	27	51
Change in the amortization (USD)	2	7	16
Initial change due to shorter term (USD)	28	106	225

2013.III	Maximum LTV 90	80	70
Operations affected	19.9%	49.4%	74.3%
Collateral (USD thousand)	43.14	62.47	83.37
Loan (USD thousand)	40.20	54.36	67.46
Loan-to-value (%)	93.18	87.02	80.92
Original interest rate (%)	5.19	4.91	4.75
New interest rate (%)	5.31	5.19	5.26
Original monthly amortization (USD)	263	346	422
New monthly amortization (USD)	265	353	437
Initial new monthly amortization (USD)	295	446	628
Change in the interest rate (bp)	11	29	51
Change in the amortization (USD)	2	7	15
Initial change due to shorter term (USD)	32	100	206

Documentos de Trabajo Banco Central de Chile	Working Papers Central Bank of Chile
NÚMEROS ANTERIORES	PAST ISSUES
La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de Ch$500 si es dentro de Chile y US$12 si es fuera de Chile. Las solicitudes se pueden hacer por fax: +56 2 26702231 o a través del correo electrónico: bcch@bcentral.cl.	Working Papers in PDF format can be downloaded free of charge from: www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for order inside Chile the charge is Ch$500.) Orders can be placed by fax: +56 2 26702231 or by email: bcch@bcentral.cl.

DTBC – 736

The Long-term Divergence Between your CPI an Mine, The Case of Chile
Andrea Bentancor y Pablo Pincheira

DTBC – 735

Probabilidad Clásica de Sobreajuste con Criterios de Información: Estimaciones con Series Macroeconómicas Chilenas
Carlos Medel

DTBC – 734

Vulnerability to Changes in External Financing due to Global Factors
Gabriela Contreras y Francisco Pinto

DTBC – 733

Carry Trade y Turbulencias Cambiarias en el Peso Chileno
José Carreño y Paulo Cox

DTBC – 732

The Yield Curve Information under Unconventional Monetary Policies
Luis Ceballos y Damián Romero

DTBC – 731

Análisis de Flujos en el Mercado Laboral Chileno
Gonzalo Castex y Roberto Gillmore

DTBC – 730

The Changing Nature of Real Exchange Rate Fluctuations. New Evidence for Inflation Targeting Countries
Rodrigo Caputo, Gustavo Leyva y Michael Pedersen

DTBC – 729

Predicción del Empleo Sectorial y Total en Base a Indicadores de Confianza Empresarial
Pablo Pincheira

DTBC – 728

Caracterización del Mercado Laboral en Chile y su Evolución en los Últimos 25 años
Gonzalo Castex y Fabián Sepúlveda

DTBC – 727

Learning About Commodity Cycles and Saving-Investment Dynamics in a Commodity-Exporting Economy
Jorge Fornero y Markus Kirchner

DTBC – 726

Leverage Restrictions in a Business Cycle Model
Lawrence Christiano y Daisuke Ikeda

DTBC – 725

The Elusive Predictive Ability of Global Inflation
Carlos Medel, Michael Pedersen y Pablo Pincheira

DTBC – 724

Foreign Shocks on Chilean Financial Markets: Spillovers and Comovements between Bonds and Equity Markets
Marco Morales, Carola Moreno y Camilo Vio

DTBC – 723

Forecasting Chilean Inflation with International Factors
Pablo Pincheira y Andrés Gatty

DTBC – 722

Financial Frictions and the Transmission of Foreign Shocks in Chile
Javier García-Cicco, Markus Kirchner y Santiago Justel

BANCO CENTRAL
DE CHILE

DOCUMENTOS DE TRABAJO • Agosto 2014