

DEBT CAP REGULATIONS IN MORTGAGE LENDING

Donát Kim¹

ABSTRACT

In this paper I study debt cap regulations in retail mortgage lending in Hungary introduced by the National Bank of Hungary. I believe the introduction of debt cap regulations was justified, but the toolkit applied should be reviewed. After studying international examples and reviewing the literature, I have concluded that LTV (loan-to-value) regulation correspond to European practice and researchers' findings. While the introduction of LTI (loan-to-income) ratio should be considered to replace PTI (payment-to-income) ratio, as it is more stable in time and there is no incentive to switch between the increase of risk factors and the increase of the maximum amount regulated by law by PTI regulation.

JEL codes: G21, G28, G51, G53, K23

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1 INTRODUCTION

Compared to international regulatory authorities, the National Bank of Hungary is proactive in its regulatory politics. The number one actor of financial stability has marked views on the threats to and future role of our financial system. In this paper I review the debt cap regulations in mortgage lending as one of the many instruments used by the National Bank. According to the 2016 *Macroprudential Report*, the grounds for the introduction of debt cap regulations was to 'prevent repeated retail over-lending' like at the 2008 financial crisis. In addition, it is 'able to prevent over-indebtedness of individual households so it can mitigate the impact of the cyclical aspects of the financial mediation system' (MNB, 2016). The objective of this paper is to analyse if the debt cap regulations are in line with the objective, with particular attention to the mitigation of default rates in mortgage lending.

¹ Donát Kim, PhD student, Budapest Corvinus Doctoral School of Economics, Business and Informatics. E-mail: donat.kim@uni-corvinus.hu.

Three indicators and their variants are prevalent in mortgage lending. In this country, the loan-to-value ratio (Hungarian: HFM) and the payment-to-income ratio (Hungarian: JTM) relate to mortgage lending. I argue in my paper that HFM regulations are efficient and based on consensus, meanwhile, the introduction of income related to the loan amount rather than to the repayment amounts would be more adequate to test borrowers' creditworthiness. Applying the LTI ratio is less incentive in terms of channelling borrowers towards a riskier loan product. Due to its simpler calculation, economic policy regulation is easier to be planned for regulators, while borrowers can also calculate the maximum loan amount easier. Since the available maximum loan amount is given, borrowers will face conversion in terms of expenses to risk. Reviewing European regulations, you can see that LTV regulations are nearly similar in the countries of the European Economic Area, though in many countries discounts are provided for first home buyers. On the contrary, the countries apply alternately PTI and LTI regulations, furthermore PTI regulations often are hand-in-hand with maximisation of maturity. For this reason, I analysed how different debt cap regulations can predict default risk. According to international literature, LTV rules at disbursement are significant, however, the assessment of PTI at disbursement is not consistent in the 21 studies I have reviewed. PTI at disbursement was significant to estimate default in three cases (Linn-Lyons, 2020; Chamboko-Bravo, 2020 és Kelly-O'Toole, 2018), but it was not significant at 10 percent significance level in three other studies (Demyanyk-Loutskina, 2016; Berkovec-Canner-Hannan-Gabriel, 2018 és Yilmazer-Babiarz-Kiss, 2012), while it was omitted from the final econometric model in several cases. However, the current PTI ratio was significant in all cases where it was included as an independent variant, so in terms of loan monitoring it is an effective ratio to predict default.

Next, I analysed two trends observed in mortgage lending in Hungary, the spread of variable rate loans and the lengthening of maturity, which were analysed in the November 2017 *Financial Stability Report*, and the 2020 *Macprudential Report*, respectively. I believe both trends are coherent with the efforts of certain borrowers to maximise loan amounts available under the PTI rule. Summing up the above, I have concluded that the National Bank of Hungary should consider the introduction of a maximum LTI ratio instead of the PTI regulations. The LTI debt cap is currently applied in several European countries, so a wide range of knowledge is available for its introduction. Its advantage as opposed to PTI is that LTI at disbursement is static, it is not exposed to the cycle component of the risk environment. In addition, my study could be a useful starting point for researchers of the topic and bank risk managers because of the wide range of the data processed and the summary of international literature in this paper.

In the first part of my paper, following a description of debt cap regulations in Hungary, I review the European stage. Next, I briefly summarise fixed rate and variable rate interests and the walk-away-right as two major issues in international literature. In the third part I present the relevant studies using Scopus for systematic search and briefly sum up major findings. In the fourth part I point out the risks of income related instalments with the help of model calculations and elementary statistics. Finally, I sum up the major findings in the conclusion.

2 DEBT CAP INDICATORS

In the field of retail lending, mortgage loans for housing are the most important and most significant in the product range of commercial banks since assistance to buying homes is a central issue for most governments. However, regulations and support for home buying are highly varied in the different countries.

The common feature of retail mortgage loans is that their ticket sizes are high compared to the borrower's work income, they are standardised, secured by mortgage rights and long term. They are disbursed to natural persons at interest rates lower than unsecured loans. The types, interest rates, repayment schedules, cover, purpose, or legal limitations of the contracts may change significantly from country to country. The objective of macroprudential regulations is to mitigate systematic risk. Compiled by the different regulatory authorities, they are based on the local environment and quite varied depending on the additional risks, extreme lending expansion or toxic asset categories found with credit institutions. Regulatory authorities have a choice of two sets of instruments: they can either drive the sector with capital adequacy requirements, or they can introduce restrictive measures or counter non-desirable schemes. The so termed debt cap regulations belong to the latter category.

It is obvious that banking regulations and credit risk management highly rely on the debt cap regulations establishing a connection between borrowers' financial position and the main parameters of the loan product disbursed.

The first is the loan-to-value ratio, or HFM indicator, comparing the initial own funds of households to the loan requested. It is calculated by dividing the amount of the loan to be disbursed by the estimated value of the property mortgaged. From now on, it will appear as LTV ratio in this paper. The second one is the payment-to-income (PTI) or mortgage-payment-to-income (MTI), debt-service-to-income (DSTI), debt-service-coverage ratio (DSCR) or debt-to-income (DTI), abbreviated as JTM in Hungarian. Here you have the monthly debt service in the numerator and the verified monthly income in the denominator. In certain cases, DTI and PTI ratios are managed separately, because the latter is only calculated

for the debt service of one loan, while repayments of all loans are considered for DTI. I will use the term PTI from now. Finally, I analyse the loan-to-income (LTI) ratio. There is no term or acronym for it in Hungarian banking terminology, however, it is the ratio of the loan amount disbursed to the verified annual net income. Sometimes DTI is used as an alternate of LTI ratio. Since both international literature and the banking profession use the English terms and because there is no Hungarian equivalent for LTI, I am going to use the English acronyms from now on.

The LTV ratio indicates the borrower's own funds, i.e., the minimum loss incurred by the borrower in case of non-payment, so it is linked to willingness-to-pay, since higher own funds reduce the borrower's moral risk. Compared, PTI and LTI create a link between the borrower's income position and the loan. PTI is typically monitored monthly, while LTI is checked at the beginning of the loan as it will show how many years of the client's total (current) net income would be sufficient to recover the total loan amount. These indicators are intricately linked to the client's ability to pay.

3 REGULATIONS IN HUNGARY AND EUROPE

I have collected the current debt cap regulations from the website of the ESRB (European Systemic Risk Board), where summaries of the current macroprudential legal provisions of 31 countries are available. The data were downloaded from the website on 06.03.2021, however, the data base was last updated on 22.02.2021, so the data content can be deemed topical. Debt cap regulations were divided into four large groups, such as loan-to-value (LTV), loan-to-income (LTI or DTI), debt service (DSTI or PTI) and length of maximum maturity. In this paper I do not discuss the temporary measures implemented in connection with COVID-19 and I also omitted the analysis of macroprudential regulations related to consumer loans or non-mortgage housing loans.

In Hungary, the PTI (JTM) and LTV (HFM) type regulations are in effect. However, contrary to the accepted legal practice of European countries, debt cap regulations are subject to the loan type, its denomination, interest period and the borrower's income. The following table presents maximum PTI ratios subject to monthly net income and interest period.

Table 1
PTI rules in Hungary

Monthly net income	Interest period		
	Up to 5 years	5 years – 10 years	10 years – end of maturity
Up to 500th HUF	25%	35%	50%
500th HUF or above	30%	40%	60%

Source: MNB Directive No 32/2014. (IX. 10.)

For Euro-denominated loans, the initial PTI ratio can have 15% to 30% as maximum value, for other currencies it is 5% to 15%. Their progressive pricing – like that of Forint loans – depends on the borrower's income and the interest period. With LTV there are different limit values for financial leases and loans presented in the following table.

Table 2
LTV regulations in Hungary

Currency	Loan	Financial lease
Forint	80%	85%
Euro	50%	55%
Other	35%	40%

Source: MNB Directive No 32/2014. (IX. 10.)

The Hungarian macroprudential regulations specifically stipulate that if child support loan was applied for not more than 90 days prior to buying the property, 75% of it can be used as own funds, or 100% of it if the loan application is older than 90 days.

Macroprudential regulations were also identified in MNB Directive No 32/2014 (IX.10.) For PTI, the maximum ratio was set at 60% like in the regulations currently in effect, but no differentiation was made by interest periods, and the income margin was set at HUF 400,000 rather than HUF 500,000. As of 01 October 2018, differentiation by interest periods was introduced and the net income was raised to HUF 500,000 on 01 July 2019. LTV rules have remained essentially unchanged.

After the Hungarian regulations, I have summed up the LTV, LTI, PTI and maturity figures of different countries based on the ESRB database in the next table. The table only includes mandatory legislative provisions, recommendations are indicated in the footnotes.

Table 3
Debt cap regulations in EEA countries

Country	LTV maximum ratio	LTI maximum ratio	PTI maximum ratio	Maximum maturity
Austria ²				
Belgium ³				
Bulgaria				
Cyprus ⁴	80%		80%	
Czech Republic ⁵	90%		50%	
Denmark ⁶	95%			
United Kingdom		4.5		
Estonia	85%		50%	30 years
Finland	90%			
France		7	35%	25 years
Greece				
The Netherlands	100%			30 years
Croatia				
Ireland ⁶	80 (90%)	3.5		
Iceland ⁷	85 (90%)			
Poland ⁸	80-90%		40-50%	35 years
Latvia ⁹	90%	6	40%	30 years
Lichtenstein ¹⁰	80%			

2 In Austria, the relevant Guidelines recommend 80% for LTV, 30-40% for PTI and 35 years as maximum maturity.

3 In the Belgian Recommendation LTV is set at 90%, LTI at 9 times the loan amount and PTI at 50%.

4 In Cyprus and Slovakia, the income in the denominator is adjusted by the average cost of living for PTI/DSTI ratios.

5 As of 01 April 2020, the Czech Republic revoked the 9-times LTI recommendation, but the 30-year maximum maturity is still in effect.

6 In the Guidelines, the LTI ratio is recommended at below 7, if it is higher than 4, special management is recommended.

7 In Ireland and Iceland, the values for first home buyers are in brackets.

8 In Poland, a client may draw a loan with 50% PTI if their salary is above average in their region, or with 40% PTI if it is below average. LTV is 80% but can go up to 90% if there is sufficient liquid cover.

9 In Latvia 95% LTV is possible with state guarantee.

10 In Lichtenstein loan disbursement is possible with less than 80% LTV, but the loan file must be marked „exception to policy”.

Country	LTV maximum ratio	LTI maximum ratio	PTI maximum ratio	Maximum maturity
Lithuania	85%		40%	30 years
Luxembourg ⁶	90 (100%)			
Hungary	80% - 85%		25-60%	
Malta ¹¹	90% - 85%		40%	25-40 years
Germany				
Norway	85%	5		
Italy				
Portugal ¹²	90%		50% - 60%	40 years
Romania ¹³	85%		40%	
Spain				
Sweden	85%			
Slovakia ⁴	90%	8-9	70%	30 years
Slovenia ¹⁴			50%-67%	

Source: https://www.esrb.europa.eu/national_policy/shared/pdf/esrb.measures_overview_macro-prudential_measures.xlsx

The Hungarian regulations are among the most complex, which drives clients to opt for categories deemed less risky by the authorities.

Incentives for a favourable composition of loan products can be found in other countries too, but they are different from Hungarian practice, because additional rules relate to the portfolio of the institutions in those cases. In Slovakia, the Czech Republic, Estonia, France, Latvia, Luxembourg, Malta, and Norway the ratios are stipulated, i.e., what part of a portfolio can be made up of the loans of the segment deemed the riskiest. In Lithuania, the stress PTI of the portfolios

11 In Malta clients are divided into category I or II based on complex legal criteria. Category I aims to support home buying, 40-year maturity or maturity until retirement age are allowed. LTV may be 90% in category I and 85% in category II reduced to 75% as of 01.07.2021. For PTI, clients in category II must comply, in addition, with the impact of a 150-bp interest shock.

12 In Portugal, the LTV ratio for properties purchased for purposes other than owner-occupation is 80%. In 20 percent of new disbursements, credit institutions have the possibility to lend at a PTI above 50 percent but below 60 percent.

13 In Romania LTV is 85% for loans denominated in LEI, 80% for hard-currency-denominated loans provided the borrower has also income in the currency, 75% for EUR loans and 60% for other currencies. For PTI, the limit is 20% for currency loans unless there is natural hedge income.

14 In Slovenia PTI is 50% until the double of the minimum wage and 67% above that. Higher PTI than the legal maximum can be allowed up to 10% of a new disbursement, but it cannot exceed 67%. 80% LTV recommendation is also in effect.

is analysed, assuming 5% reference interest rate in the stress test. There is some room for manoeuvre in the countries listed, still, the regulations prevent extreme systematic risk. It is also noticeable that there is a higher number of regulations in the post-Socialist countries. Finding the reasons for such difference would be an interesting area for research. They might be a lower level of financial awareness of the population in those countries, or a negative risk competition by institutions on the mortgage market, a higher demand for rules by the population or the paternalistic approach of the state.

4 OTHER MODELLING ASPECTS OF MORTGAGE LENDING

Before starting to analyse the impact of different ratios as seen in international literature, one must understand the different practices of mortgage lending in the different countries. Different lending provisions and contract terms may cause major deviations on default. Let me call attention here to two outstanding contract terms, one is the walk-away-right and the other is the type of interests.

In a simplified way, the walk-away-right – or limited liability for mortgage loans – means the borrower can decide to cede their property to the credit institution, and the credit institution forecloses the collateral. In that way, the borrower has no more obligations to the credit institution independent of whether the value of the property is lower than the outstanding loan debt. This lending scheme is typical in certain states of the US. In Europe, in contrast, the borrower must repay the loan amount. So, if the borrower defaults, and the property taken over and auctioned by the bank fails to recover the outstanding loan amount, the borrower may not only lose their property in an extreme case, but they will still owe the bank a major amount.

I considered it important to check in international literature which market was used for a basis, since the assumptions for empirical studies or the premise for modelling might be different, which would lead to different conclusions. American authors focus their research on strategic default, which says the client could but would not pay due to high deficiency (negative equity). Negative equity is the outcome of the loan value exceeding property value. LTV ratios are more emphatic with these models, as the analysis is focused on willingness to pay.

An interesting empirical finding is that contrary to the basic idea, borrowers are typically willing to pay their mortgages even if equity is negative. According to a paper on the topic most frequently cited (*Bhutta–Dokko–Shan*, 2010), 80% of default occurred when payment difficulties and negative equity were both present. Half of the borrowers opted for strategic default when property prices were reduced by almost 50%. Several explanations were offered why borrowers con-

tinued to pay with negative equity. Bhutta, Dokko and Shan 2010 say the reason why making payments is still worth even if the loan value exceeds collateral can be explained by the complex tax rules, since mortgage payments reduce one's taxable base for personal income tax. According to other explanations, the stigma, the high transactional expenses of moving and eviction, or poor debtor rating by credit institutions due to reputational damage can be the reason for seemingly illogical mortgage payments. This is also supported by the findings of *Guiso, Sapienza and Zingales* (2013), who analysed the probability of strategic default with the help of questionnaires. They included features unrelated to financial issues, such as gender, ethnic minority or even political attitude and views on banks as explanatory variables, all of which proved significant.

Finally, *Deng, Quigley, and Van Order* (2000) compiled a real option model based on pricing. According to the model, instalments are a kind of option fee assuming property prices will rise again. Continuing repayment is worth to a borrower, otherwise – if they stop payments and the bank repossesses their house – the process is irreversible, they will have no more chance to possess, or sell and make early repayment if the real estate market recovers.

There is no walk-away-right in Hungary, so we have to take this into account if studies allow strategic default options. It should be noted that in the event of negative equity further collection is not binary and is subject to many other factors, for instance, the time of the eviction, or the type of mortgage right enforcement, i.e., whether the creditor can only seize the collateral via court proceedings or in another way, typically via a notary public (*Enoch et al.*, 2013). Hungarian decision makers should consider that in some western countries you can take out insurance for such a case, i.e., if a borrower is still in debt after their property has been foreclosed and auctioned, the insurer will cover the difference. Such insurance contracts are termed gap insurance.

Another important issue in credit agreements is whether the loan interest is fixed or variable. Although it may seem a clear definition, the meaning of fixed and variable rate loans may differ by banks or by countries. In English language studies one can find fixed-rate mortgage (FRM), where the interest rate is fixed till maturity; and there is adjustable-rate mortgage (ARM), where interest rate is defined as the sum of a certain reference rate and loan premium or spread. Reference rates are reviewed from time to time as stipulated in the contract, and the interest payable is calculated according to the outstanding principal until the next review date. Pursuant to MNB regulations, credit institutions in Hungary may deem a mortgage loan product to be fixed rate if the interest period of the reference rate is 5 years or longer. The Central Bank paid special attention to the comparison of fixed and variable rate mortgage loans in their 2017 *Financial Stability Report*. The authors said, "...fixed-rate loans, however, provide longer-term safety for debtors.

The price for this is the higher interest rate upon borrowing in the case of a rising yield curve. However, if the interest rate difference between variable-rate and fixed-rate products contains only the effect of the expected interest rate path, the cost of the two products is offset during the interest rate period as a whole” (*Financial Stability Report*, November 2017). Nevertheless, the interest of fixed-rate loans adjusted by the inter-bank rate of the relevant maturity or by interest swap was higher in Hungarian banks. According to the credit institutions, the reason for that was to offset the loss incurred on the early termination of the interest rate swaps used to hedge fixed-term loans in the event of early repayment.

Partly to reduce the risk of interest rate increase, the National Bank of Hungary set up the Certified Consumer-Friendly Housing Loan classification system. In addition, two more unconventional instruments, i.e., 5 and 10-year monetary policy IRS facilities and a mortgage bond purchase programme were introduced in January 2018 to mitigate risks. Additionally, to mitigating “long-term interest risk”, the Central Bank support interest rate fixation since “the probability of interest rate increase is higher on a few years’ timescale than of their further reduction” (MNB, 2017).

In this paper, fix (hereinafter: FRM) means loans with fixed rates until the end of term and variable (hereinafter: ARM) means loans with interest rates re-priced monthly or in every 3 months in line with the relevant reference rate. In US studies, where there is a walk-away-right, another central issue is how interest fixing affects default. Contrary to the Financial Stability Report, Campbell 2013 argued that the initial and expected future instalments of ARM loans are lower on the US market than those of FRM ones, since there is a historical rise of yield curves. The empirically higher rate of default of ARM loans is explained by saying that lower initial instalments can be alluring for people who expect high income increase, so they plan to purchase a property that is expensive compared to their current income level. So, in many cases, ARM borrowers commit themselves to stretched instalments pushing the limits of their current incomes. On the other hand, FRM borrowers are characterised by risk avoidance, maximising loan amounts is less typical for them. This supports a statement in the Stability Report, „variable-rate is often coupled with lower incomes, higher amount of loan and longer maturity, which indicates that financially stretched households are more urged to choose the variable rate because of the interest rate spread” (MNB, 2017).

Fuster and Willen (2017) made a step further, arguing that not only initial instalments are lower, but ARM loans are more advantageous in a crisis, since – due to monetary stimulus – central banks reduce interest rates, so instalments may also be reduced significantly. Empirical data show that the state of the economy positively correlates with interest rate levels. So, reference rates decline in a recession, so the instalments of ARM loans are reduced, while the central bank increases

interest rates in economic recovery. This increases instalments, but debtors in a favourable economic environment can either take out a replacement loan or sell their property as the real estate market expands and prepay their loan with the increased instalment. On the opposite, instalments are fixed for FRM loans, so borrowers do not enjoy the benefits of reduced interest rates, but they are not affected by increasing rates either.

However, the lessons of the 2008 crisis showed that most borrowers indebted in FRM had no possibility to swap their loans for ones with more favourable rates although reference rates declined. Overall, the set of monetary instruments lose their effectiveness. Still, it is underlined that ARM can be even more unfavourable in certain situations, for instance, in stagflation. Campbell and Cocco (2015) came to a similar conclusion based on their simulation model, where the default probability and interest margins of ARM and FRM loans were analysed. The above three papers studied the US market. Both empirical research and modelling might have come up with different findings in the case of a small open country having its own currency. In such a country an economic crisis can bring about a currency crisis, as it happened in Hungary after 2008.

Overall, it can be stated that the exposure to nominal interest levels of variable-rate loans is cash-flow risk as well, which is borne better by a financial enterprise than a natural person. If interest is fixed, bearing the risk of real interest is a kind of discounting risk affecting net present value. A change in the net present value of a loan appears in the asset position, so it will not affect a client's liquidity position even if interests increase in real terms, but financial institutions must manage net present value risk, as the effect of revaluation impact equity. Another problem is that in the case of APR the risk from interest change is not quantified, so loans with shorter interest periods look disproportionately favourable, as it is presented by Berlinger (2019) in his study.

5 DEBT CAP INDICATORS IN INTERNATIONAL LITERATURE

I carried out systematic search in Scopus of Elsevier, one of the largest academic publishing houses of the world, setting the filtering criteria in Table 4 using combinations of the following words to search in key words, titles, and abstracts.

Table 4
Search words in Scopus

	AND		
	Mortgage Housing loan	Default Delinquency Foreclosure	LTV Loan to Value PTI Payment to Income DTI Debt to Income MTI LTI Loan to Income DSCR DSTI
OR			

The search engine produced 102 studies for the combinations. Reading the abstracts, 21 relevant papers remained. Their major findings are presented in table format.

The first column in the Table includes authors' names and date of publication.

The second column presents the data, i.e., the data of which country were analysed, when and how many observations were made. They help place the study in context and identify any potential limitations. In the third column the process applied is presented. For econometric models, their explanatory power and the definition of dependent variables is also presented. In most models the probability of default was modelled, while default may vary by countries and periods. Default in most models was set after 90 days of non-payment of instalments. In the fourth column the ratios are presented with their impact on default, or – for economic models – according to their part played in the models.

Next, I analysed other explanatory variables of econometric models. This partly helps understand the gradient of ratios exercised on default, and partly is a starting point for modellers to select the relevant studies.

Finally, I summed up the major findings and the conclusions made by the authors from the given studies. The short abstracts are not sufficient to learn the whole content, they focus on the description of the part played by the ratios in the models.

Table 5

Impact of LTV, PTI and LTI rates on default probability

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Linn and Lyons (2020)	Data of 2.3 million mortgage loans collected by European Data Warehouse. The loans were disbursed 1991 to 2013 in Ireland, Portugal, the United Kingdom, the Netherlands, and Spain.	Econometric model – logit model, where default is a dependent variable. Five different models covering all the countries with different explanatory variables are presented. Pseudo-R ² : (0.225 – 0.245)	Rates not divided by 100.	% Δ Unemployment rate *** (+)
			LTV*** at disbursement (6.27Th-06 – 7.16Th-06)	Country dummies ***
			LTV*/*** at disbursement (–1.28e-05 – –1.04e-05)	Other loan dummy *** (+)
			PTI*** at disbursement (0.00426 – 0.00740)	Current interest rate *** (+)
			Current ¹⁷ LTV*** (0.000225 – 0.000295)	Remaining term ***(+)
				Dummies linked to work income.
				Year dummy ¹⁸
				Loan type dummy ²
				Interest type dummy ²

Findings

„Double trigger” theory verified by research; negative income shock and negative equity together explain default. In addition, different institutional systems in different countries, particularly foreclosure, highly define the impact of different variables on default.

¹⁵ Since studies used different scales, I separately indicated if they are 0-100 (not divided by 100) or 0-1 (divided by 100).

¹⁶ Given gradient or gradients are indicated, I used consensual indication of significance level; * 10 % significance level, ** 5 % significance level, *** 1 % significance level.

¹⁷ Current: value at time of default for defaulted loans; last observation for performing loans

¹⁸ Significance level or sign not indicated.

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Chamboko and Bravo (2020)	383,770 mortgage loan contracts from the United States in Q12009-Q32016 made available monthly by Fannie Mae	Markov-chain type, discrete periodical multi-state model. Seven categories: In the period analysed: performing, late paying, defaulting, refinanced, early repayment, foreclosed by credit institution, sold by buyer and short sale. Explanatory variables included variables linked to disbursement and loan performance. Regression coefficients related to default are presented here.	Rates not divided by 100:	Loan purpose (dummy) ^{***} Property type (dummy) ^{***} Distribution channel (dummy) ^{***} Borrowers' score (credit score) ^{***} (-)
			PTI ^{***} at disbursement (0.0214)	No of borrowers ^{***} (-)
			LTV ^{***} at disbursement: (0.000462)	Co-debtor's credit score ^{***} (-) Maturity at disbursement ^{***} (+) Remaining term ^{***} (+) Principal at disbursement ^{***} (+)
Findings				
The behaviour of a full credit cohort was empirically studied in the model. Few temporary matrix-type studies were done on retail lending since researchers' access to databases of such detail is limited. 88.4% of clients were transferred from "performing" category to another cohort at least once in the period studied. The highest proportion (71.4%) made early repayment. Early repayment was mainly typical of high score clients. 16.9% of all clients were late payers at least once, but their 70.6% recovered and only 27.1% defaulted. However, even three quarter of defaulters recovered, and continued to pay their loans. The authors state that in a recession modelling only late payment and default are not sufficient to understand the processes, especially in the case of mortgage loans.				
Allen, Grieder, Peterson and Roberts (2020)	Canadian data collected from questionnaires February 2005 to October 2008, 170,167 observations.	Modelling progressively stringent debt cap regulations via microsimulation models.	LTV stringency measures mitigate effect of interest shock on debtors in vulnerable income position better than debt cap regulations targeting income.	
			Findings	
Tightening of LTV and PTI at disbursement on first home buyers in Canada was studied in the model. According to the model, LTV rates had a higher impact on demand by first home buyers, both in terms of number of loans and the loan amount drawn, as well as on the reduction of default probability. It is an advantage of micro-simulation models, that they could study the interactions of economic policy effects and non-linear consumers' response, for which dynamic stochastic equilibrium models are less suitable.				

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
<i>Adzis, Lim, Yeok and Saha (2020)</i>	Database of largest Malaysian credit institute, data of 47,158 borrowers of mortgage loans in 2016	Econometric model – logit model, where default rate is dependent variable. One model is presented; it is separately run by genders. Pseudo-R ² : 0,1858	Rates divided by 100: PTI at disbursement: not significant LTV*** at disbursement: (1,2065)	Time since disbursement ***(-) Interest at disbursement ***(+) Remaining term ***(+) Approved loan amount ***(+) Guarantor***(-) Gender (male/female)*** Ethnic dummies Province dummies
Findings				
As far as the authors are aware, it is the first study modelling mortgage loan defaults from the internal database of a credit institutions in a developing country.				
<i>Kim, Cho, and Ryu (2018)</i>	Data from several large banks in South Korea, mortgage loans disbursed March 2004 to December 2009. Monthly data taken till August 2010. 225,809 loan contracts	Cox-regression /proportional hazard regression. One main and several partial models analysed by regions, periods, and loan purpose. 225 809 observations The main model is presented. -2LogL: 11 398.19	Rates not divided by 100: Current LTV***: (0.03682) Current PTI***: (0.02286)	Spread between initial loan interest and current loan interest ***(+) Algorithm of initial loan amount ***(+) Debtor's initial credit rating (Highest: 1)***(+)
Findings				
PTI is significant in the aggregated model, but based on survival models by loan purpose, even PTI at 10% significance level can be discarded in the case of mortgage not for own housing; the authors found the effect of PTI rate less robust on defaulting than that of LTV rate. Further, they state the rate of ARM and FRM loans and the rate of FRM early repayment is a good proxy to assess the material position of households, since FRM debtors in trouble opted for early repayment or "bullet or IO" type ARM loans.				

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Kelly and O'Toole (2018)	Mortgage loans disbursed in the United Kingdom 1987 to 2014; data of subsidiaries of three Irish banks. 106,326 data observed and used	Econometric model, time series logit-model, where default means 90+ days of non-payment. Several regression models have been run for different variables. Model presented includes all effects, 67,094 observations. Pseudo-R ² : 0,082	Rates not divided by 100: LTV*** at disbursement: (0.0007) DSR*** at disbursement: (-0.0122) ΔDSR ¹⁹ (till reporting date)***: (-0.0001) ΔLTV (till reporting date)***: (0.0009)	Time since disbursement ***(+) Variable interest (dummy)**(+) Several loans (dummy)***(+) Disbursed amount ***(+) Maturity **(-) Only interest payment (dummy)***(+)
	Findings			
	The authors studied the impact of tightening debt cap regulations (DSR and LTV) on Buy-to-Let loans. According to their results, the “double trigger” phenomenon is present, i.e., both own funds at disbursement and the income rate are significant. According to the Spline model, default probability starts to increase steeply above 75% LTV and below 1,5 DSR rate.			
Greenwald (2018)	US market 2000 to 2014. Mortgage-related figures from Fannie Mae Single Family Dataset.	Macroeconomic model, general equilibrium model in framework system, particular attention to monetary transmission channel.	PTI is more effective macroprudential regulation than LTV rates. PTI liberalisation greatly contributes to stronger cycles both as direct and indirect effect.	
	Findings			
	The author studied the effect of LTV and PTI limits on credit risk, and the reasons for early repayment. Monetary policy can stabilise inflation by more effective mortgage market transmission channels. It also has a major impact on the dynamism of lending. Because of monetary policy, PTI regulations are effective instruments to smooth out cycles.			

Greenwald (2018)

¹⁹ Debt service ratio (DSR): lease fee at time of disbursement compared to instalment

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
<i>Berkovec, Canner, Haiman and Gabriel (2018)</i>	Almost 220,000 mortgage loans disbursed in the US 1987 to 1989	Econometric model, different logit regression for 3 disbursement years	<p>Rates divided by 100:</p> <p>LTV*** at disbursement: (3.8381 - 6.1806)</p> <p>PTI at disbursement (as banded category variable): not significant 0</p>	<p>Refinanced (dummy)** (+)</p> <p>Condominium (dummy)** (+)</p> <p>Maturity below 30 years (dummy)*** (-)</p> <p>Hirschman-Herfindahl index for credit offer *** (-)</p> <p>Category variables related to marital status (dummy) partly***</p> <p>Liquid assets***(-)</p> <p>Income***(-)</p> <p>Rate of income not from salary ***(+)</p> <p>Afro American (dummy)*** (+)</p> <p>Other category variables related to property location (dummy)***</p>
Findings				
<p>The study was initially made in in 1997, but it was republished in 2007 in a book. Based on 1971 Becker article, it studied discrimination linked to mortgage lending. Accordingly, citizens belonging to different ethnic minorities can only have access to more expensive loans. The data do not support this; however, ethnic category variables did have a significant effect on default probability.</p>				
<i>Adelino, Schoar and Severino (2018)</i>	US data, from surveys by the American Community Survey, Home Mortgage Disclosure Act, Federal Housing Finance Agency	Descriptive statistics, comparison, and summary of literature	<p>LTV at disbursement did not change significantly during a boom or a crisis.</p> <p>There were reliable data to calculate Value-to-Income rate; it increased significantly, most in higher income categories, during a boom</p>	
Findings				
<p>In the pre-crisis period creditors started to disburse higher and higher amounts, so that LTV rates did not change significantly. In contrast, lending was reduced in the recession. As a result of counter-cyclical banking lending policy, low-income households were displaced from the housing market when real estate prices were historically low. The VTI rate could predict overheating of the economy.</p>				

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
<i>Mamonov and Benbunan-Fich</i> (2016)	Monthly data from the US mortgage market January 2000 to March 2014, Fannie Mae database, almost 21.7 million mortgage loan contracts	Authors compared six different models on the same base: logistical regression, decision tree, random forests, „boosted“ decision tree, support vector machine (VSM) and neural net (ANN). Authors analysed probability of late payment.	LTV (unclear if it is at disbursement or current): (+) PTI (unclear if it is at disbursement or current): (+)	Borrower's credit score (-) Loan purpose Interest rate (+) Loan amount taken (+)
	Findings			
<i>Demanyuk and Loutskina</i> (2016)	In all models the LTV and PTI rates proved to be the best predictors in addition to debtor rating. Of the models studied, ANN proved to be the best performer, but it still gave incorrect results estimating the highest number of defaulting clients. It is because such predictive models cannot predict / consider exogenous shocks even in the case of complex and expansive databases.			
	Two databases used; one is of loans disbursed 1999-2006, the other is from 2005-2006. 1,373,098 transactions observed.	Econometric model. Several topics analysed, contribution by Mortgage Company from lending boost to backtesting probability of default with single institutions. Default definition: non-payment for 60+ days. Seven different models for probability of default, in six cases controlled for bank data, model no 7 is introduced here. Pseudo-R ² : 0,17	Rates not divided by 100: LTV**at disbursement (0.001) LTV***at disbursement (0.79)	MC category variable (dummy)***(+) Low credit rating ***(+) Property appraisal 2 years later ***(-) Initial interest rate ***(+) ARM (dummy)***(+) Early repayment fine (dummy)***(+) Interest instalment only loans (dummy)***(+) First-home loan (dummy)***(-) Full documentation (dummy)*** (-) Securitization (dummy)*** (-)
Findings				
The authors studied the expansion of a shadow banking system and deficient regulatory environment in connection with the 2007/2008 mortgage loan crisis in the US. While BHCs (Bank Holding Companies) were strictly regulated, MCs (Mortgage Companies) were exempt from it. BHCs were exempt from equity and other banking regulations by selling through MCs. As they could lend to clients riskier-than-average, one can study the effect of neglecting certain debt cap regulations on default. Compared to BHCs, MCs disbursed loans of higher LTV rates to poor-rating clients and had to face higher rates of default.				

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Campbell and Cocco (2015)	US data for macroeconomic figures and regulations, 1970-2012.	Microeconomic model with heterogeneous agents modelling different interest types (ARM, FRM, ARM with teaser). Linear algebraic equations solved with iteration rather than using formulae, fixed points calculated. Model built on strategy default option.	For primary assumption, 90% LTV rate was taken, with 4.5% for LTI. Default rate significantly increased above 90% LTV. After disbursement, P/TI rate was analysed in the model. Default of variable-rate loans (ARM) was affected by LTI rate, while for fixed-rate loans LTV rate was more important. Initial LTV has negative correlation to mortgage loan margins in the model. This may be because, as competition increases, loan margins decline but the risk policy of banks also become more lenient.	
Findings				
The model analysed the impact of variable, fixed interests and non-annuity loans on default in different economic cycles. It states that the instalments of ARM loans are lower in a recession because of the decline of reference rates, still, default is higher, because the income of those borrowers correlates with economic cycles more and they are willing to undertake stretched instalment burdens. While LTI rates increase insolvency for a loan, LTV increases the risk of default, so decision makers should consider the combination of the two.				

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Dean and Quintin (2015)	Survey of Consumer Finance questionnaire data for 1997, 2007 and 2010 used to model the US mortgage market.	Microeconomic model, US mortgage market modelled with people of heterogeneous age and income. Analysed the effect of different housing market and income shocks on probability of default.	Higher LTV concentration can be seen among younger borrowers and in lower asset categories. As lending is boosted, high LTV rates can be seen with higher-than-average loan amounts. This can be partly explained as agents had no other investment opportunity into the model. It is possible if there were alternative investment opportunities, borrowers with higher assets would have opted for higher LTV. In terms of income related indicators, the model's results are often in contrast to empirical data but the LTV grows jointly with the loan amount.	
Findings				
Different age clients with different own funds were modelled for default because of different income and property market shocks. The authors believe the change of lending practices in 1999 to 2006 and the increasing leverage for mortgage loans explain 60% of increased default. If high LTV rate loans played a part when housing prices suddenly crashed, the effect is even more significant. The LTV boom was partly because the state propagated providing the population with homes by different state entities and programmes, which led to relaxed regulations.				

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Géte and Reher (2015)		Two-period mortgage market microeconomic model assuming heterogeneous agents, modelling probability of default emphatic. Endogenous variables are loan interest, upper limit of loan amount, type of housing (owned/rented), rate of LTV, LTI, intensive margin of credit and presence on credit market (might have supply and demand grounds)	An optimal LTV rate is essential in the model. Maximum rate depends on the creditor's financing expenses (increase), foreclosure rate (increase), and optimal rental and ownership rates on the housing market. If the creditor's financing expenses are low, breakeven point occurs at higher LTV (and LTI) rates with lower interest rates.	
		Findings		
		Although the reduction of LTV rates can mitigate default risk, optimal LTV regulations must include some procyclical elements, because on a booming real estate market properties become inaccessible for many people due to high own funds requirement. But aiding home buying in certain cases is desirable economically for the population. It is especially true if income proportionate rental fees increase high. If monetary policy is lenient through reducing creditors' financing expenses, LTV and LTI rates are increased, spread is reduced, stretch borrowers' ability to pay high LTI, and in this way default probability and losses are increased.		
Carlos, Hatchondo, Martinez, and Sánchez (2015)	Model parameters: 2001 Survey of Consumer Finances (US market)	Microeconomic model of housing market processes, modelling default in focus where housing prices and agents' income are hit by idiosyncratic shock	In the event of negative equity, strong regulations of foreclosure („recourse mortgage”), and lower regulatory LTV limits can produce higher home buying with lower default probability, which are the two most important expectations for mortgage regulations. In the model, the decline in demand for housing is negligible at 80% LTV limit, while probability of default is significantly reduced.	
		Findings		
		In addition to recourse mortgage, the authors studied the effect of LTV limitations after the 2008 financial crisis. After default, if collateral is insufficient, a stricter foreclosure policy can mitigate default. On the one hand, according to the model, agents may respond by increasing LTV rates (securing extra spending income in the event of foreclosure), which, on the other hand, increases default probability.		

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Balás, Banai and Hosszú (2015)	August 2013 questionnaire by the National Bank of Hungary, 1000 households (1322 loan contracts including 341 housing loans)	Three models analysed, a logit model for the whole period, a logit model for 2004-2008 disbursements, and a linear regression. Default ratio is the dependent variable; it shows probability of client in arrears for 90+ days from disbursement to date of sample taking. Betas of logit model for the whole period are described in columns of table	Rates divided by 100: Current PTI***: (0.76) Current PTI*** from other loan: (0.24)	Rate of breadwinners in household ***(-) Denominated in hard currency **(+) Instalment per earner ***(+) Expenses on top of instalment **(+) Loan via mediator***(+)
			Findings	
			In terms of PTI regulations, it is important that the same PTI requirements can be too strict for HUF denominated loans and too lenient for FX denominated ones. PTI should be handled differentially in terms of income levels. As for mortgage loans, the model stated FX loans were riskier and sales via agents resulted in higher default probability.	
Oyedokun, Adewusi and Bello, (2015)	Nigerian mortgage market, Primary Mortgage Institutions, data of 305 randomly selected people.	Econometric model, logistic regression based. Pseudo-R ² : 0.15	Rates divided by 100: Current LTV: not significant Current PTI***: (1.484)	Gender*** (male dummy) (+)
			Findings	
			Since few of the high number of variables were significant, social-cultural effects did not vary among the different groups of people, which was in the focus of the study. The authors emphasise that more accurate estimations can be made from a larger database. However, having access to full databases for modelling purposes is a big challenge for researchers in developing countries.	

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Corbae and Quintin (2015)	Data adjusted to the US mortgage market, model focusing on increase of leverage ratio in 1999-2006 and its impact on default.	Microeconomic model of status of mortgage market. Model assumes housing prices and lease fees are fixed, but mortgage rates are subject to demand and supply, so the market is balanced. Heterogenous households decide on default with housing market shocks affecting agents' income.	Rates linked to age: Youth (below 35) are characterised by low own funds and high LTV. No clear connection with LTI.	
			Loan amounts and rates: LTI grows as loan amounts grow, but no clear connection with LTV. In a boom high LTV rates are typical for higher-than-average loan amounts.	
			Income reduction and rates: According to model, LTI and quantity of high LTV rates decline as incomes decline.	
			Findings	
			The growing LTV effect in 1999-2006 contributed to the surge of default after 2008 in about 60%. LTV rates may have been increased because the US government promoted home buying and different government agencies eased different lending restrictions, so loans were granted with more favourable conditions.	

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Yilmazer, Babiartz and Kiss (2012)	180 county-level aggregated data of two US states - Indiana and Ohio; data taken in 2000, 2006 and 2008.	<p>Econometric model, OLS regression for foreclosure. 12 models are presented, 6 different models were set out, but the dependent variable (foreclosure rate) was estimated using two different databases.</p> <p>Since no information criteria were given, the two highest R² results are presented.</p> <p>R² values of the 12 models are between 0.336 and 0.695. R² from two different databases: 0.693 and 0.695</p>	PTI or LTI not significant.	<p>Other state*</p> <p>Loan rate covered by federal programme (FHA) ** (+)</p> <p>Positive interest margin ** (+)</p> <p>Rate of rejected loans ** (-)</p> <p>No of houses***(+)</p>
Findings				
According to the paper, the rate of rejected loans and interest spread have the most important effect on mortgage defaults. Instead, the income, LTI and PTI rates were not enough to filter out bad debtors. The authors call attention to the limitations of the study, for instance, there is no control on housing price changes or unemployment rate. Also, aggregated data are less suitable for such analysis than granulated figures.				
Lin, Lee and Chen (2011)	38,814 mortgage loan contracts, data of a Taiwan credit institution, January 2003 to December 2006.	<p>Econometric model, logit model for 4 regression models. New variables are introduced in model no 2; sample taking is reduced in models no 3 and 4 to have identical number of performers and non-performers (485 pc). Results of model no 2 are presented.</p> <p>Pseudo-R²: 0,307</p>	<p>Rates not divided by 100:</p> <p>Current LTV***: (0.013)</p> <p>Modified current PTI^{18***}: (0.009)</p>	<p>Gender (dummy variable)***: (male +)</p> <p>Educational level (scale variable)** (-)</p> <p>Job position (scale variable, higher value, higher hierarchy level)**(-)</p> <p>Contracted loan amount ***(-)</p> <p>Loan purpose (category variable)**</p> <p>Location related category variables **</p> <p>Confidence index*(-)</p> <p>GDP growth*(+)</p>
Findings				
Using 12 independent variables, the loan portfolio of a Taiwan commercial bank was reviewed. It was found that, in addition to borrowers' characteristics, the location of properties and the macroeconomic environment influence default.				

Authors	Data	Process	Variables studied and findings ¹⁵	Other significant variables (in econometric papers) ¹⁶
Tam, Hui and Zheng (2010)	Time series data of the mortgage market 1998–2007 by monthly questionnaires collected and made available by the Hong Kong Monetary Authority.	Econometric model, auto-regressive model on aggregated figures to estimate probability of default. Since model includes rate of default from previous period, R ² is high. Pseudo-R ² : 0.99777	Rates not divided by 100:	Default rate of previous period ***(+)
			Current LTV rate***: (0.00128)	Gross loan portfolio ***(+)
			Change of current PTI rate***: (0.0049)	Hang Seng Index (real estate price index)***(-)
			Findings	
The default probability of mortgage loans in Hong Kong was analysed using an autoregression model. The HKMA introduced 50% PTI regulations, still, the changes in PTI continue to influence default.				

There is consensus in international literature that the “double trigger” phenomenon is present in retail mortgage lending, i.e., the presence of both own funds and solvency indicators (PTI and LTI) matter. Studying LTV is exciting on its own. Institutional environment including foreclosure options influence optimum size. Most studies, which tried to identify an effective regulatory limit found over 80% significant increase of default probability. *Harrison, Noordewier, Yavas* (2004) studied if defaulting debtors had high LTV. According to their econometric model, if default expenses are higher, good debtors are willing to choose higher LTV because of a kind of self-selection and sign value. However, if default expenses are moderate, risky clients will choose high LTV rates.

On the contrary, the picture is far from being uniform in terms of solvency rates (LTI and PTI). In the case of PTI, the rate of instalment to income is a better approach to assess solvency, but PTI rates at disbursement and current PTI rates need to be separated. The current PTI situation clearly defines the solvency of a household; it is significant in most models. However, the correlation between PTI at disbursement and solvency is not so clear. PTI at disbursement was significant for default estimation in three cases (Linn and Lyons, 2020; Chamboko and Bravo, 2020; and Kelly and O’Toole, 2018), but it was not significant at 10% in three other studies (Demyanyk and Loutskina, 2016; Berkovec, Canner, Hannan and Gabriel, 2018; and Yilmazer, Babiarz and Kiss, 2012), while it was omitted from the final econometric model in several cases. In economic models, such as Campbell and Cocco (2015) or Gete and Reher (2015), the LTI rate is typically analysed at disbursement for loan contracts, because one must use extra assumptions for the loan in case of PTI.

6 IMPACT OF PTI REGULATIONS ON MAXIMUM LOAN AMOUNT

For annuity loans the instalment (P) can be calculated by the following formula, where (R) is effective interest, (PV – present value) is the loan amount disbursed and (n) is maturity:

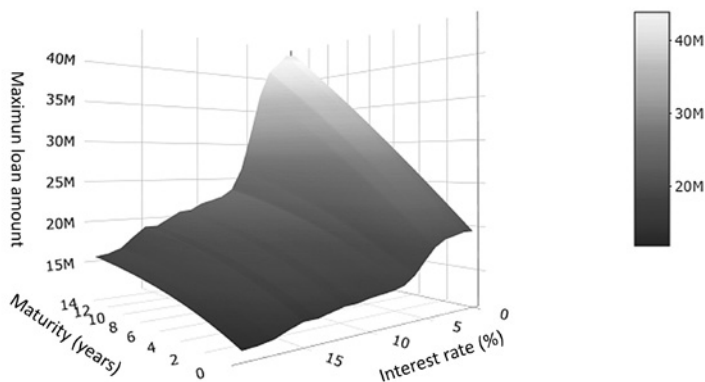
$$P = \frac{(PV * R)}{1 - \left[\frac{1}{1+R} \right]^n}.$$

So, the instalment depends on the interest rate, maturity, loan type and the loan amount drawn. Those were significant recurring variables in default modelling. The formula shows that the loan amount can be increased if contractual interest rate is lower, or if maturity is prolonged.

According to the Central Statistical Office (KSH), the net average salary of full-time employees excluding benefits was HUF 334,238 in Budapest in Q4 2020. As an example of calculation, I studied the difference among loan amounts granted in the event of a (rounded) HUF 350,000 net salary with different maturities and interest rates pursuant to the current MNB regulations

Figure 1

Maximum loan amount granted with net income of HUF 350,000 and 50% PTI compared to maturity and interest rate.



Note: see in table format in the *Annex*.

Provided there are no progressive PTI regulations, and the debt cap regulation is effective, a client can increase their loan amount granted if they take out the loan with longer maturity or at a lower interest rate. Under normal market conditions, variable interest rates result in lower loan interest. It is possible that the high proportion of variable-rate loans discussed in the 2017 November Financial Stability Report was the result of the PTI regulations, since borrowers could maximise their loan amounts in that way. This corresponds to conclusions in international literature, as modelled by Fuster and Willen (2017) and Campbell and Cocco (2015), as well as to empirical observations, as expressed in the Report „financially stretched households are urged more to choose variable rates” (MNB, 2017).

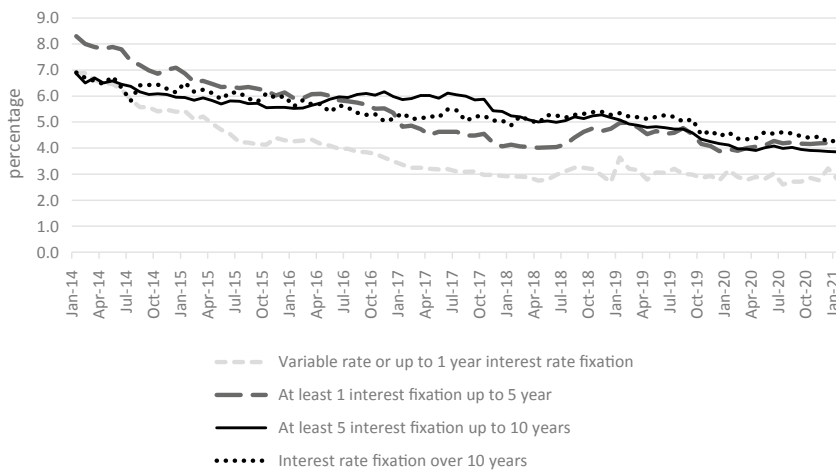
MNB drove clients towards fixed-rate loans following the introduction of progressive PTI rules by interest periods from 01 October 2018. It, in fact, decided instead of the debtors to opt for more expensive financing to reduce nominal interest rate risk. The picture is even more colourful, as MNB provided the banking sector with long-term interest swaps and bought covered bonds reducing long-

term interest rates in that way, which also reduced loan interest rates fixed for a longer period (MNB, 2017).

According to MNB statistical data, the difference between variable rates and rates fixed for over 10 years was 160 bps from January 2014 to January 2021, and 156 bps between fixed rates for at least 5 but not more than 10 years pursuant to unconventional monetary measures. As the product range was varied, for instance, several credit institutions had no fixed rates for over 10 years (MNB, 2017), I selected rate fixing for at least 5 but not more than 10 years for reference.

Figure 2

Average annualised interest rates of HUF loans granted to households and those of HUF deposits placed by them (weighted with contracted amount)



Source: <https://www.mnb.hu/letoltes/huo9o2-lakossagi-huf.xls>

There are no regulatory limitations on maturity, banks can even grant 30-year loans as qualified consumer-friendly loans. The length of maturity, however, has a negative effect on default and proved significant in all econometric models where it was included, partly because many negative events can occur during a longer period, such as divorce, death, or job loss. Further, in terms of annuity loans, interest repayment is higher, and principal is lower at the beginning, so if maturity is long, the outstanding principal will not be reduced materially during the first years. For 30-year loans with 10-year interest periods instalments will be adjusted twice because of changes in reference rates.

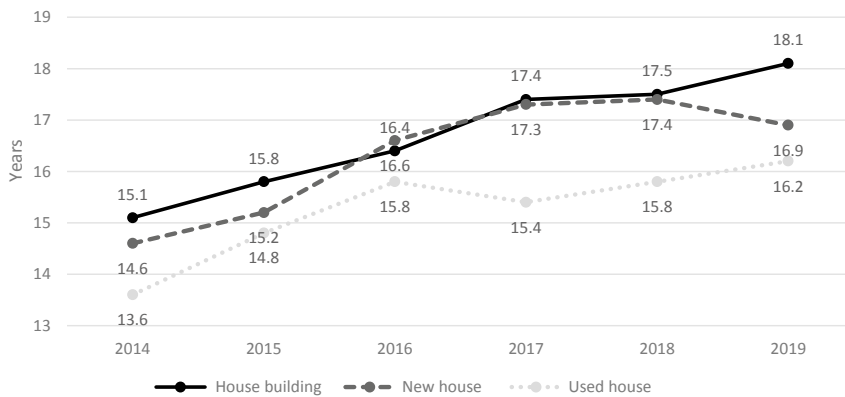
An example: the average annualised interest rate of variable-rate housing loans was 3.11% in July 2017, while it was 6.05% of loans with rates fixed for not more

than 10 years. Provided there are progressive PTI regulations for adjustments, the maturity of a HUF 25-million loan is 14 years and 11 months with HUF 350,000 net income and 50% PTI. As opposed, the maturity of loans with at least 5 but not more than 10 years of rate fixing will be 21 years and 2 months *ceteris paribus*. The example shows that a shorter interest period was a good choice not only because of more favourable financing, but rate fixing might have increased contractual maturity significantly because of the PTI regulations.

In terms of annuity loans, prolongation of maturity also means that principal is repaid at a lower rate. For instance, assuming a 25-million 20-year annuity loan at 6.05% interest, 84.7% of the principal part of the loan will still be outstanding 5 years later and 64.3% of it 10 years later. In case of 30-year maturity, the relevant figures will be 92.9% 5 years later and 83.4% 10 years later. So, although rate fixing seems to be good hedging strategy against interest rate risk, in the case of a 30-year loan with 10-year rate fixing over 80% of the loan amount will be exposed to interest rate risk even if repayments are prudent.

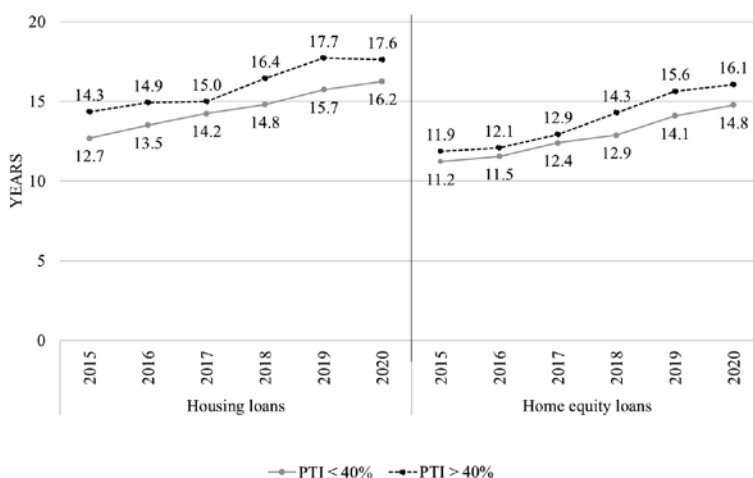
In this paper, I do not argue that rate fixing is less favourable than variable rate loans from a financial aspect, but I want to warn readers that it might be accompanied with negative impacts not in focus previously. One of the conclusions is the higher initial instalments and the expected lower net present value (higher loan repayment) by the debtor, which is supported by international research. As far as I know, studies in Hungary have not compared fixed and variable rate loan types from the aspect of financial rate of return. A shift to variable rate loans was possible, in addition to better initial terms, because of adaptation to PTI regulations, i.e., maximising loan amounts, since it was particularly typical of loans with stretched instalments, as seen in the November 2017 Financial Stability Report.

Because of the formula of annuity loans, prolongation of maturity is the next means of adaptation to maximise the loan amount. Fáykiss et al 2018 concluded in 2018 regarding debt cap regulations that prolongation of maturity “is not typical at present” as debt cap regulations were implemented, but statistics by KSH indicate their increasing relevance.

Figure 3**Average maturity of housing loans in the average of disbursing institutions**

Source: https://www.ksh.hu/docs/hun/xstadat/xstadat_eves/i_zrhoib.html

The phenomenon was reviewed in the 2020 *Macprudential Report*, which found that the effectiveness of PTI limitations was accompanied by the increase of maturity. Average maturity exceeded 17 years by mid-2020. In the Report, maturities with PTI rates of below and above 40% were separately presented.

Figure 4**Evolution of average maturities by PTI values for housing loans and home equity loans**

Source: <https://www.mnb.hu/letoltes/a-jelentes-abrai-2.xlsx>

The *Figure 4* shows a kind of adaptation attitude by debtors; as PTI regulations become effective, debtors respond by prolonging maturity. Although average maturity is still lower than European regulatory limits, 30-year loans have appeared on the market. If PTI regulations prevail, new debt cap regulations can be expected as maturities get longer. According to studies by Linn and Lyons (2020) and Chamboko and Bravo (2020), where PTI at disbursement proved to be significant, maturities positively correlated with default risk. Thus, if the models are accepted to be robust, the increase of maturity caused by PTI regulations may increase default risk.

Another adverse effect is that loan amounts granted are not only subject to income but also to interest level. As one can see in the quantitative example, clients can achieve major excess credit in the event of a small interest adjustment. On the one hand, one can argue that monetary policy and its instruments will be even more effective, as the reduction of interest rates can result in higher-amount loans granted pursuant to the PTI regulations. On the other hand, modelling and considering this additional impact is beyond the framework of standard monetary policy. In the event of undesired effects (such as, over-indebtedness compared to income because of interest rate reduction) the future modification of debt cap regulations can be envisaged, as it did happen in connection with the differentiation by interest periods introduced on 01 October 2018 and the change of income brackets in July 2019.

Considering the above, I propose the introduction of LTI regulations instead of PTI at disbursement. The current PTI rate for loan maturity continues to be a good proxy variable for banks to monitor their clients. However, a LTI limitation would result in loan amounts granted to be independent of the current interest rate level; so, the legal maximum could be calculated and planned in direct proportion to income by potential borrowers. As in the case of LTI the maximum loan amount is given, selecting maturity is up to the individual borrower. They can opt for high instalments for shorter maturity, or they can prefer less stretched instalments for longer maturity. In terms of loan pricing, it is also a question of preference if a borrower opts for more favourable interest rates regarding expected value, or a scheme more protected from interest risk in nominal terms. PTI analysis continues to be a good proxy variable to monitor credit risk, but I believe its value at disbursement is less suitable to assess creditworthiness compared to LTI.

7 SUMMARY

In this paper I reviewed debt cap regulations in Hungary and in Europe as well as in international literature. Reviewing European examples one can state the Hungarian debt cap regulations are among the most complex and most complicated macroprudential intervention measures. Using them the National Bank of Hungary do not only want to regulate the portfolio composition of banks but intend to drive clients towards the schemes deemed desirable, which means HUF loans with long interest periods in the case of housing loans. Although in terms of FX lending both empirical experience and the theory support higher risk, the impact of rate fixing on credit risk is not unambiguous in international literature.

Hungarian LTV regulations correspond to European practice and the approximately 80% maximum value recommended by models in international literature. Conversely, opinions on PTI regulations differ in international literature. While current PTI seems to be a good indicator to predict default, PTI at disbursement is not significant in certain cases, in addition, it can have undesired incentives. An example for that is the excessive spread of variable rates and preference for longer maturity if clients want to increase their loan amounts. To eliminate that, the National Bank of Hungary allow lower PTI rates subject to interest periods, which means clients can be granted loans at higher initial interest rates. At the same time, the increase of maturity remains an open issue, which can have an adverse effect on default. Because of prolonged maturity, 5 and 10-year fixed-rate loans continue to be exposed to risk resulting from interest rate change even if the risk is lower. In addition, interest rate levels influence maximum loan amounts, so maximum loan amounts granted can change significantly even during a shorter period. As opposed to this, an LTI-based limitation can be calculated easily, so clients can plan loan amounts better, which will not depend on maturity or interest rate level.

Appendix

Figure 10: Maximum loan amount available for HUF 350,000 net salary with different maturities and interest rates pursuant to the current 50% PTL regulations

350000	Maturity	Effective interest rate									
		10	9	8	7	6	5	4	3	2,5	2
5		8 236 440	8 430 340	8 630 726	8 837 849	9 051 973	9 273 374	9 502 337	9 739 163	9 860 621	9 984 162
6		9 446 366	9 708 449	9 981 041	10 264 528	10 559 415	10 866 236	11 185 551	11 517 950	11 689 248	11 864 051
7		10 541 417	10 876 944	11 227 871	11 595 025	11 979 282	12 381 571	12 802 874	13 244 231	13 472 773	13 706 747
8		11 532 760	11 945 227	12 379 145	12 835 825	13 316 663	13 823 152	14 356 883	14 919 556	15 212 307	15 512 985
9		12 430 137	12 921 892	13 442 187	13 992 974	14 576 349	15 194 569	15 850 058	16 545 428	16 908 937	17 283 486
10		13 242 454	13 814 796	14 423 759	15 072 112	15 762 854	16 499 236	17 284 781	18 123 307	18 563 719	19 018 958
11		13 977 773	14 631 124	15 330 105	16 078 498	16 880 430	17 740 403	18 663 338	19 654 610	20 177 687	20 720 093
12		14 643 392	15 377 441	16 166 990	17 017 038	17 933 080	18 921 161	19 987 930	21 140 712	21 751 847	22 387 572
13		15 245 920	16 059 753	16 939 737	17 892 304	18 924 577	20 044 448	21 260 669	22 582 947	23 287 180	24 022 060
14		15 791 335	16 683 549	17 653 262	18 708 563	19 858 473	21 113 064	22 483 584	23 982 610	24 784 645	25 624 209
15		16 285 052	17 253 847	18 312 104	19 469 793	20 738 115	22 129 667	23 658 626	25 340 958	26 245 176	27 194 660
16		16 731 970	17 775 235	18 920 452	20 179 703	21 566 654	23 096 791	24 787 669	26 659 209	27 669 683	28 734 039
17		17 136 526	18 251 907	19 482 178	20 841 753	22 347 060	24 016 844	25 872 514	27 938 548	29 059 054	30 242 961
18		17 502 736	18 687 700	20 000 854	21 459 170	23 082 128	24 892 116	26 914 891	29 180 124	30 414 158	31 722 030
19		17 834 233	19 086 118	20 479 780	22 034 963	23 774 493	25 724 787	27 916 462	30 385 051	31 735 838	33 171 835
20		18 134 308	19 450 367	20 922 001	22 571 939	24 426 635	26 516 930	28 878 825	31 554 410	33 024 919	34 592 956
21		18 405 940	19 783 377	21 330 331	23 072 713	25 040 891	27 270 518	29 803 515	32 689 252	34 282 205	35 985 960
22		18 651 825	20 087 828	21 707 367	23 539 726	25 619 462	27 987 428	30 692 006	33 790 596	35 508 481	37 351 403
23		18 874 403	20 366 169	22 055 508	23 975 256	26 164 421	28 669 444	31 545 716	34 859 430	36 704 511	38 689 831
24		19 075 883	20 620 638	22 376 968	24 381 423	26 677 721	29 318 266	32 366 006	35 896 714	37 871 041	40 001 779
25		19 258 265	20 853 284	22 673 791	24 760 208	27 161 201	29 935 508	33 154 185	36 903 379	39 008 799	41 287 769

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