



CALIBRATION OF A DEBT-SERVICE-TO- INCOME LIMIT: EVIDENCE FROM MICRODATA

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Context

- The National Bank of Romania (NBR) introduced amendments to Regulation No. 17/2012, which limits the Debt-Service-to-Income (DSTI) ratio for household loans to 40 percent.
- The proposed changes to the policy were supported by the IMF's Financial Sector Assessment Program (FSAP), and calibration of the limit based on findings of joint IMF-NBR analytical work.
- The presentation and the accompanying paper describe this joint analysis (with Maral Shamloo, Radu Popa and Liviu Voinea).



Background

Why limit household indebtedness?

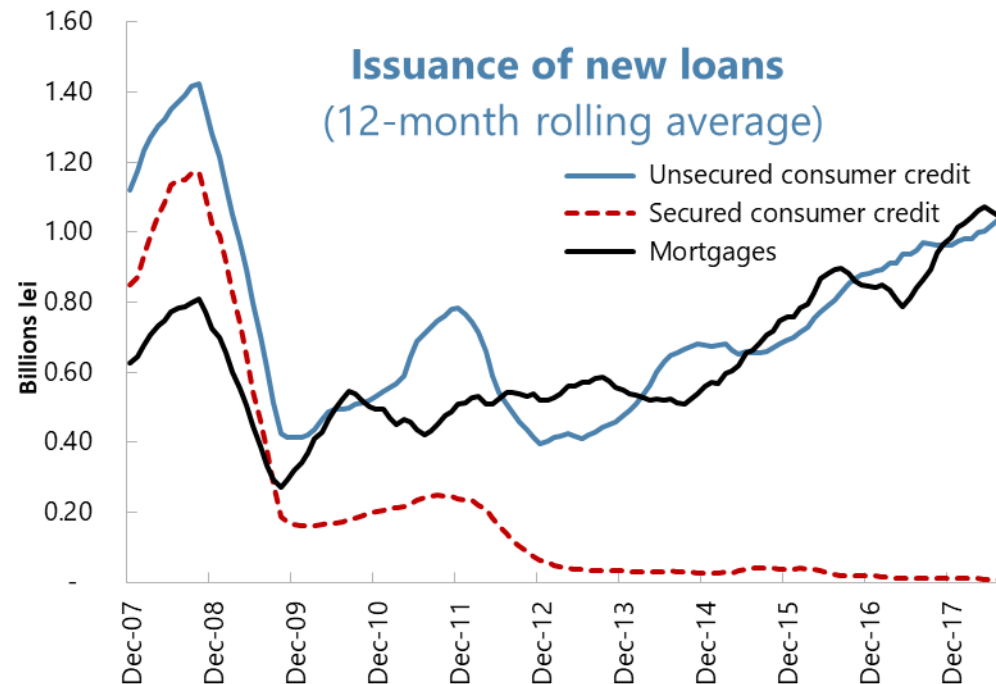
- Risks associated with high household leverage well established (Reinhart and Rogoff (2009); Schularick and Taylor (2012), Jorda et al. (2016)).
- Thus, important to prevent a build-up of vulnerabilities in household balance sheets.
- Sectoral macroprudential tools have proven effective (Claessens et al. (2013), Kuttner and Shim (2016), and IMF (2014)).
 - Demand-side tools improve borrower resilience.
 - DSTIs have a built-in automatic stabilizer, complement LTV.
 - When calibrated prudently, a DSTI limit provides resilience against income and interest rate shocks.
- We provide guidance on how to calibrate one such tool in Romania: a limit on households' DSTI ratio.



Background

Why Now?

- Why now?
 - Household vulnerabilities are rising (again).
 - The flow of mortgages is at a historical high;
 - Flow of unsecured consumer lending has reached levels seen prior to the crisis
- Thus, cyclical position allows (and calls) for building up resilience.





Background

Why this approach?

- Appropriate calibration of borrower-based macroprudential tools central to their effectiveness.
 - Loan-level data is needed for an assessment of the impact:
 - Benefits – from reduction in default probability
 - Costs – from reduction of loan volumes
 - Loan/borrower level data isolates borrower characteristics as opposed to macroeconomic determinants.
- Romania provides a perfect case:
 - Bank-dependent economy.
 - Comprehensive credit register covering all loans to individuals.



Literature

- Despite the benefits of the use of microdata, this literature is still nascent.
- A number of studies rely on household survey data (Fuster and Zafar (2015), Igan and Kang (2011), Gross and Poblacion (2017)).
 - The main drawback of these studies is the lack of true (observed) default data.
- Our work is closest in approach to:
 - Kelly et al. (2015), who use loan-level data from Ireland to show first-time buyers less likely to default.
 - Kukk (2016), who use credit register data from Estonia to confirm higher debt service ratios are associated with a higher probability of arrears.



Overview of results

- The effect of DSTI on probability of default is non-linear:
 - Increases in DSTI become relevant at around 50% (30%) for mortgages (consumer loans).
- Defaults on consumer loans more sensitive to debt-service burden than defaults on mortgage loans:
 - Threshold for DSTI sensitivity is lower for consumer loans.
- Imposing a 40% DSTI limit effective in lowering mortgages PDs:
 - PDs in our sample would drop by 27 %
 - At a cost of reducing credit volume by 11%.
- 40% limit at origination is consistent with some “built-in” room for shocks.

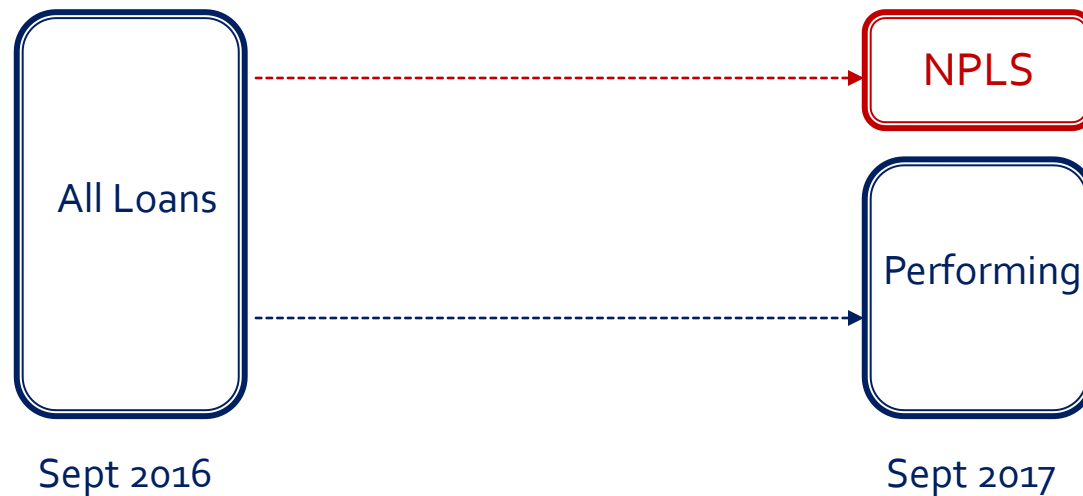


Methodology

PD model

Borrower level PD model

- Consider all household loans as of June 2016.
- “Follow” the same loans as of June 2017.
- Estimate PD as a logit function of loan and borrower characteristics





Data

- Loan data from Central Credit Register and Credit Bureau :
 - More than 350,000 mortgages and more than 2 million consumer loans on balance sheet of banks as of June 2016.
 - Loan and borrower information: loan type, currency, residual maturity, bank and county of residence, borrower age, year of origination, Prima Casa
- Monetary Balance Sheet
 - The interest rate reported by the bank based on loan type.
- Ministry of Public Finance
 - The latest available data on income are wages for the fiscal year of 2016.
- Information consolidated by debtor using the national PIN
- DSTI:
 - Sum of monthly annuity of all loans divided by the monthly income.



Data

- Split the data into two subsamples:

- Mortgage borrowers:
 - 200,598 **borrowers** with a mortgage loans
 - ...30 percent of whom also have a consumer loan.

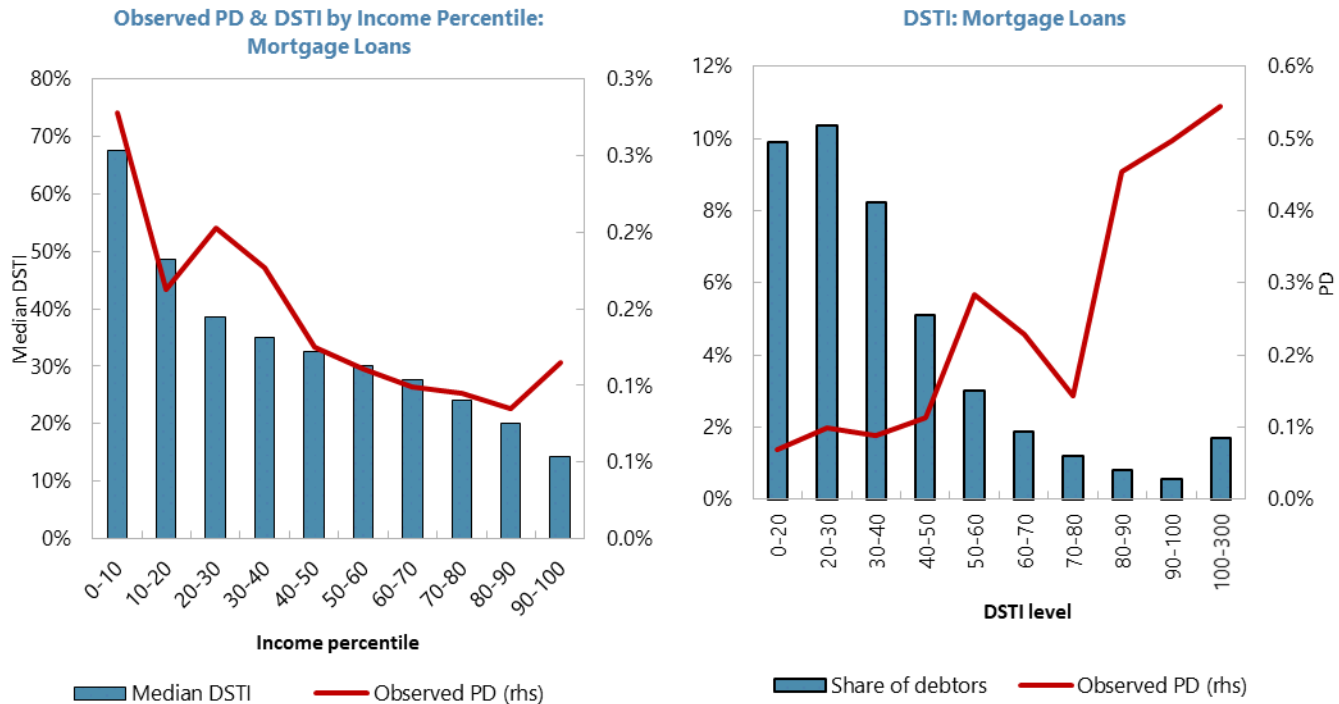
- Consumer-loan borrowers:
 - 467,969 **borrowers** with unsecured consumer loans.
 - ...12 percent of whom have more than 1 consumer loan.

- Note: We conduct the analysis at borrower level, not loan level.



Data: Stylized Facts Mortgage Loans

- Stylized facts on 200,598 borrowers with a mortgage loan

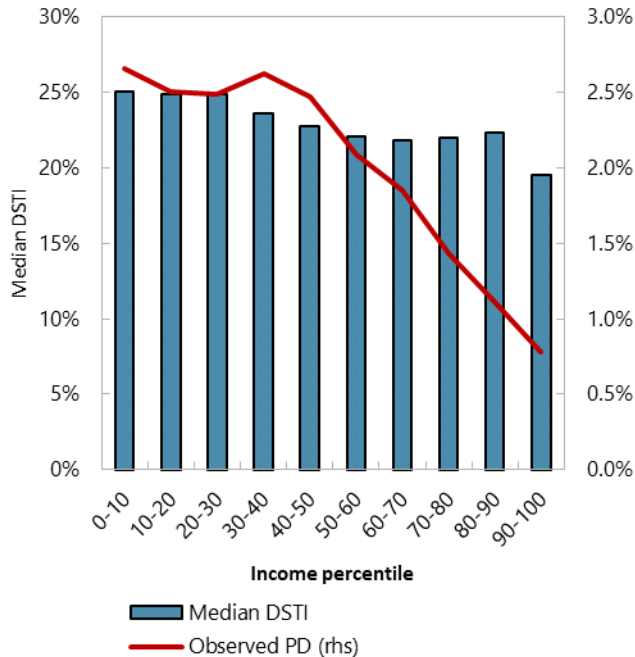




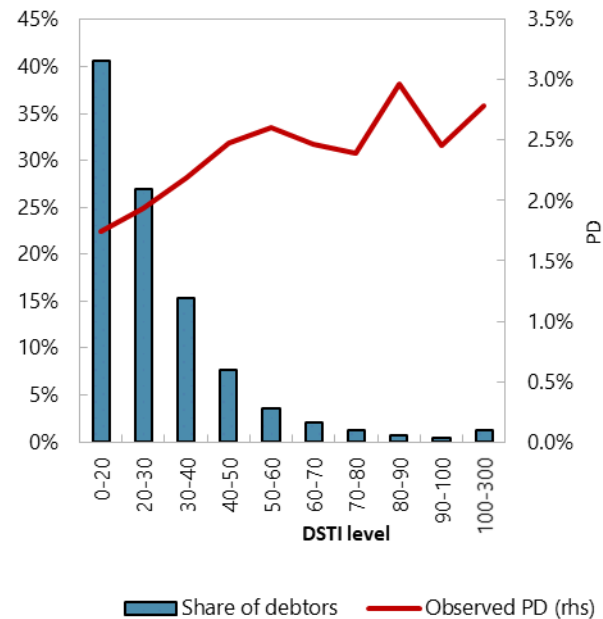
Data: Stylized Facts Consumer Loans

- Stylized facts on 467,969 borrowers with at least a consumer loan.

Observed PD & DSTI by Income Percentile:
Consumer Loans



DSTI: Consumer Loans





Empirical Strategy

PD model Overview

- One-year ahead PD is explained by a number of loan and debtor-level characteristics:

$$y_i = \alpha + \sum_{j=1}^5 \beta^j \cdot d_i^j DSTI_i + \sum_k \delta^k \cdot X_i^k + \varepsilon_i$$

- $y_i = \ln\left(\frac{PD_i}{1-PD_i}\right)$ is the logit transformation of the probability of default.
- $DSTI_i$ is the debt burden associated with loan i ,
- d_i^j is a dummy variable which is 1 if loan i belongs to range j and zero otherwise.
- X_i^k are other characteristics of loan i (currency, LTV, residual maturity, loan size, borrower income and age, and indicators for additional loans, first home mortgages, bank, year or origination and regions).



Empirical Strategy

PD model for mortgages

- For mortgages, we consider 5 ranges:

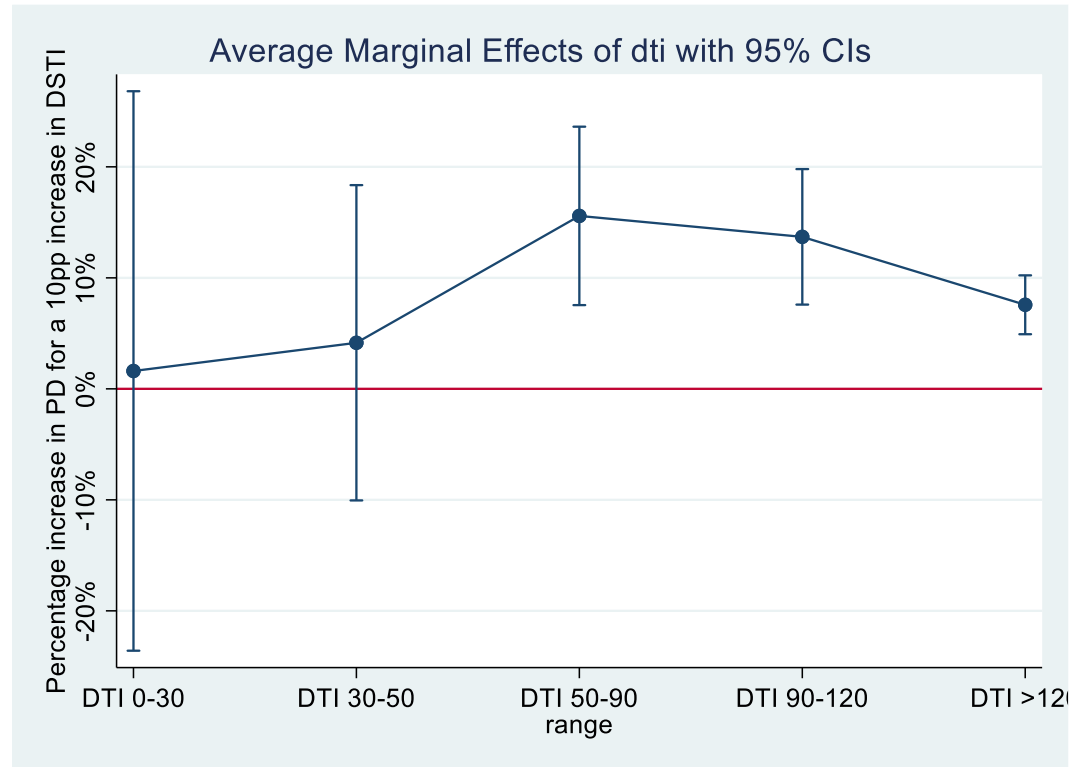
Indicator	DSTI (in percent)	Number of loans	Share of total
Range =1	[0,30)	94,712	47.2%
Range =2	[30,50)	62,430	31.1%
Range =3	[50,90)	32,175	16.0%
Range =4	[90,120)	5,859	2.9%
Range =5	>120	5,422	2.7%
Total		200,598	100%

- As potential other explanatory variables, we consider: Residual maturity, LTV, currency denomination, income, loan size, bank, region and year of origination fixed effects.



Results Mortgages

- Increases in DSTI increase PD if DSTI > 50 percent.
- Robust to a range of specifications.
- Preferred specification includes LTV, loan size, residual maturity, currency denomination and dummies for Prima Casa, bank, year or origination and region as explanatory variables.





Results

Mortgages

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Range1#dti	0.0236	1.316	0.0486	0.0579	-0.160	-0.136	0.161
Range2#dti	0.246	1.011	0.294	0.326	-0.00165	0.0859	0.415
Range3#dti	1.439***	1.878***	1.501***	1.536***	1.253**	1.335**	1.562***
Range4#dti	1.274***	1.875***	1.344***	1.378***	1.156***	1.218***	1.375***
Range5#dti	0.686***		0.747***	0.776***	0.665***	0.696***	0.762***
res_mat	0.0295**	0.0290*	0.0341**	0.0367**	0.0334**	0.0344**	0.0476***
eur	0.611***	0.594***	0.612***	0.608***	0.618***	0.614***	0.185
chf	1.321***	1.300***	1.237***	1.194***	1.222***	1.213***	1.002**
fh	-1.547***	-1.639***	-1.583***	-1.597***	-1.597***	-1.598***	-1.570***
consumer	0.787***	0.666***	0.801***	0.809***	0.851***	0.836***	0.950***
ltv			0.357***	0.552***	0.474***	0.500***	0.510***
Logsize				-0.339**	-0.292*	-0.308*	-0.305*
Income category dummies						Yes	
Other dummies							Yes



Results: Marginal Impact Mortgages

- Marginal impact: percentage increase in PD for a 1 percentage point increase in DSTI.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
range = 1,	0.0235	1.315	0.0485	0.0578	-0.160	-0.136	0.161
range = 2	0.245	1.010	0.294	0.326	-0.00165	0.0858	0.415
range = 3	1.435***	1.874***	1.497***	1.532***	1.250***	1.332***	1.558***
range = 4	1.268***	1.865***	1.338***	1.372***	1.151***	1.213***	1.369***
range = 5	0.681***		0.743***	0.771***	0.661***	0.691***	0.757***
Observations	200,598	191,932	200,598	200,598	200,598	200,598	198,843

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1



Empirical Strategy

PD model for consumer loans

- For consumer loans, we consider 5 ranges:

Indicator	DSTI (in percent)	Number of loans	Share of total
Range =1	[0,20)	190,176	40.6%
Range =2	[20,30)	126,036	26.9%
Range =3	[30,50)	107,571	23.0%
Range =4	[50,70)	26,651	5.7%
Range =5	>70	17,535	3.7%
Total		467,969	

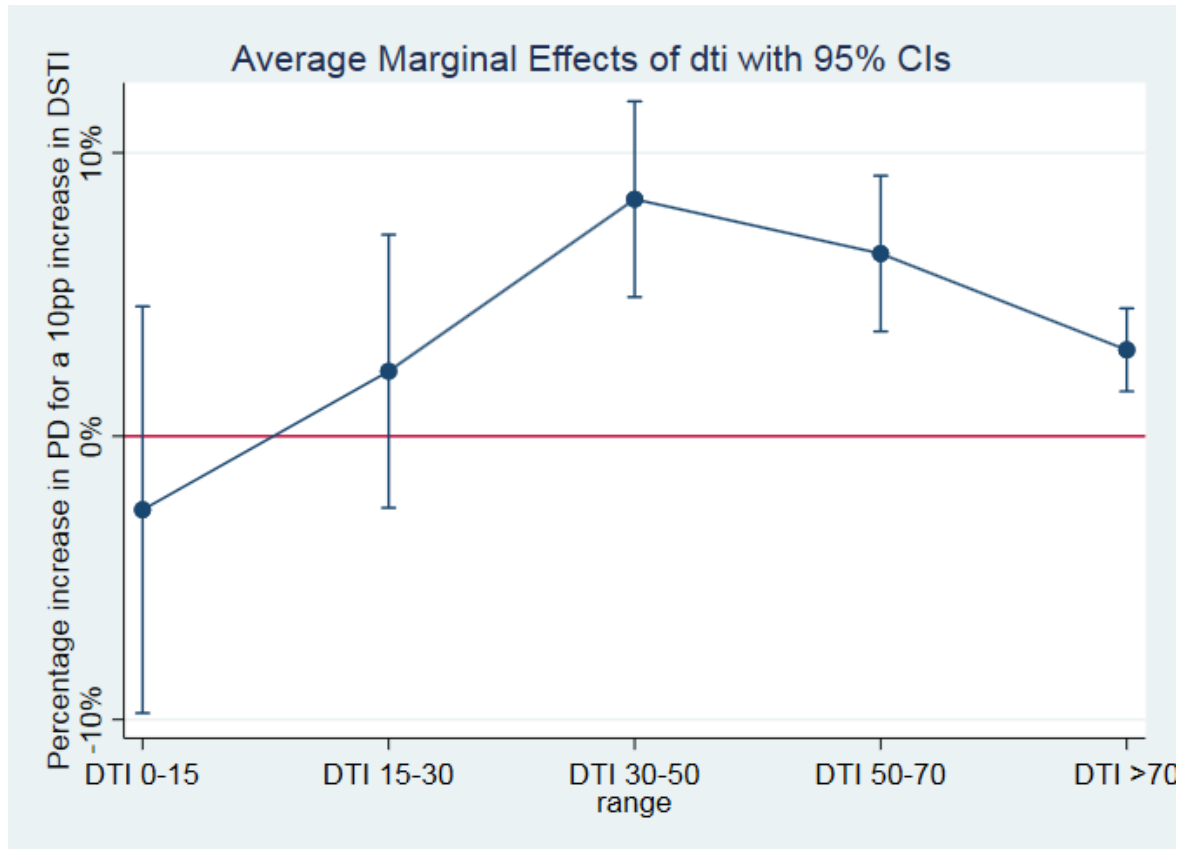
- As potential other explanatory variables, we consider: Borrower age, residual maturity, income, loan size, bank, region and year of origination fixed effects.



Results

Consumer loans

- Increases in DSTI lead to a higher PD if $DSTI > 30$ percent.
- Robust to a range of specifications.
- Preferred specification includes income, loan size, borrower age, residual maturity, and regional, bank and year of origination dummies as explanatory variables.





Results

Consumer Loans

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
range1#dti	0.343	0.535	1.118**	1.418***	0.0349	-0.492	-0.264
range2#dti	0.405	0.815***	1.164***	2.316***	0.832***	0.159	0.234
range3#dti	0.627***	1.091***	1.318***	2.684***	1.487***	0.912***	0.856***
range4#dti	0.538***	0.882***	1.032***	2.224***	1.246***	0.786***	0.661***
range5#dti	0.301***	0.445***	0.766***	1.013***	0.616***	0.363***	0.313***
res_mat	0.212***	0.110***	0.109***	0.304***	0.195***	0.148***	0.285***
age		-0.0440***	-0.0445***	-0.0450***	-0.0450***	-0.0453***	-0.0459***
logsize				-0.572***	-0.262***	-0.117***	-0.0937**
High income					-0.367***		
Low income					0.601***		
Log income						-0.771***	-0.785***
Dummies							Yes
N	467,969	467,969	461,877	467,969	467,969	467,969	467,806



Results: marginal impact Consumer loans

- Marginal impact: percentage increase in PD for a 1 percentage point increase in DSTI.

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
range = 1b,	0.337	0.525	1.098***	1.392***	0.0343	-0.483	-0.260
range = 2	0.397*	0.799***	1.141***	2.271***	0.815***	0.156	0.229
range = 3	0.613***	1.066***	1.288***	2.622***	1.453***	0.891***	0.836***
range = 4	0.525***	0.860***	1.006***	2.168***	1.215***	0.766***	0.645***
range = 5	0.293***	0.434***	0.746***	0.992***	0.601***	0.354***	0.305***
Observations	467,969	467,969	461,877	467,969	467,969	467,969	467,806
Standard errors in parentheses	*** p<0.01, ** p<0.05, * p<0.1						



Counterfactual Mortgages

- We compare our defaults and credit volume with a counterfactual of maximum DSTI of 40 percent in place.
- For every loan in our database that if $DSTI > 40$ percent:
 - DSTI is limited to 40 percent;
 - The size of the loan is adjusted to achieve $DSTI = 40$ percent.
- We then project hypothetical PDs under the new DSTIs and compare them with actual PD rates.



Counterfactual: PDs Mortgages

- For mortgages, DSTI limit implies a 27 percent drop in defaults and a 11 percent drop in total size of credit.
- Highest impact for DSTI from 90 to 120

		Probability of Default (calibrated) -- Mortgages		
		Actual	40 percent limit	Percentage change
Range 1 DSTI <30	Mean	0.32%	0.32%	0%
	Median	0.19%	0.19%	
Range 2 DSTI: [30,50)	Mean	0.35%	0.35%	1%
	Median	0.19%	0.20%	
Range 4 DSTI: [50,90)	Mean	0.90%	0.44%	-51%
	Median	0.49%	0.24%	
Range 4 DSTI: [90,120)	Mean	1.51%	0.58%	-62%
	Median	0.91%	0.34%	
Range 5 DSTI>120	Mean	2.10%	0.84%	-60%
	Median	1.50%	0.68%	
Total	Mean	0.50%	0.37%	-27%
	Median	0.25%	0.21%	



Counterfactual: PDs Mortgages

- The reduction of PD is highest for lowest income category.

Probability of Default -- Mortgages				
Income Category		Actual	40 percent limit	Percentage change
1: below average	Mean	0.70%	0.42%	-41%
	Median	0.36%	0.22%	-38%
2: [avg., 2*average]	Mean	0.42%	0.34%	-19%
	Median	0.21%	0.19%	-9%
3: above 2*average	Mean	0.39%	0.35%	-9%
	Median	0.22%	0.22%	-2%
Total	Mean	0.50%	0.37%	-27%
	Median	0.25%	0.21%	-18%



Counterfactual: Loan Volumes Mortgages

- The reduction of loan volumes is highest for high DSTI loans.

		Credit Volume (bn of Lei) -- Mortgages		
		Actual	40 percent limit	Percentage change
Range 1:DSTI <30	Total Credit	15.5	15.5	0%
Range 2:DSTI: [30,50)	Total Credit	10.2	9.8	-4%
Range 4:DSTI: [50,90)	Total Credit	5.2	3.3	-36%
Range 4:DSTI: [90,120)	Total Credit	0.9	0.4	-61%
Range 5: DSTI>120	Total Credit	0.9	0.2	-75%
Total	Total Credit	32.7	29.2	-11%



Counterfactual: Loan Volumes Mortgages

- ... as a result of which, low income borrowers see the highest drop in loan volumes.

		Credit Volume (bn of Lei) -- Mortgages		
Income Category		Actual	40 percent limit	Percentage change
1: below average	Total Credit	10.4	7.9	-24%
2: [avg., 2*average]	Total Credit	12.6	11.8	-6%
3: above 2*average	Total Credit	9.7	9.4	-3%
Total	Total Credit	32.7	29.2	-11%



Caveats

- Impact on could be exaggerated somewhat due to:
 - Unobserved joint borrower information in our dataset
 - Improved underwriting standards: forward looking impact less than backward looking.
 - Undeclared income
- Our dataset does not fully capture impact on consumer loans as only 17 percent of such loans have $DSTI > 40$ percent.
 - But, loans from non-bank lenders not included.
 - Real impact may be larger.



Amended Regulation No. 17/2012

- October 2018 amendment to NBR Regulation No. 17/2012, sets maximum household indebtedness such that DSTI does not exceed:
 - 40 percent of the net income for leu-denominated loans;
 - 20 percent for foreign currency loans.

- Two exemptions:
 - Ceiling is 45 percent for first-time buyers;
 - Exemption for 15 percent of flow (other examples: UK, NZ, Portugal)

- The regulation applies to banks and NBFIs alike.



Policy Proposal

- The amendments level the playing field between bank and non-bank lenders
- Simple methodology for calculation of maximum loan level
 - No explicit shocks to calculate “stress” DSTI as ceiling incorporates reasonable shocks
- Transparent: the limit is explicit and not bank-dependent
- Safeguard low-income earners



Analysis supports the new regulation

- Our analysis supports the design of the amended regulation:
 - 40 percent limit allows some room for shocks before reaching the critical DSTI of 50 percent.
 - First-time buyers benefit from a higher limit on DSTI
 - FX loans have a lower limit consistent with their higher PD all else equal.



Stressed DSTIs

Impact on DSTI and PD

- What shock would take a borrower from DSTI 40 percent to 50 percent, which is the critical level (for mortgages)?

		Lei Loan	FX loan
Original Maturity (months)	n	360	
Original interest rate (annual)	r	4%	
Original DSTI		40%	20%

	Domestic Loan			FX Loan	
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
Interest Rate shock	2.0%	0.0%	1.5%	0.0%	1.5%
Income Shock	0.0%	20.0%	5.0%	0.0%	5.0%
FX shocks	0.0%	0.0%	0.0%	60.0%	30.0%
Modified DSTI	50.2%	50.0%	50.1%	32.0%	32.5%



Conclusion

- Our analysis suggests that the new NBR regulation limiting household DSTI to 40 will lead to a decrease in PDs and improve asset quality of financial institutions going forward.
 - Mortgage PDs become sensitive to increases in DSTI at debt-service levels around 50 percent.
 - By limiting the DSTI to 40 percent, the regulation builds in some buffer before borrowers reach this critical level.
- For consumer loans, sensitivity of PD to changes in DSTI occurs at a lower level.
 - By including non-bank lenders, the regulation captures high debt-service loans extended by these lenders.