

# Cooling the Mortgage Loan Market: The effect of Borrower-Based Limits on New Mortgage Lending

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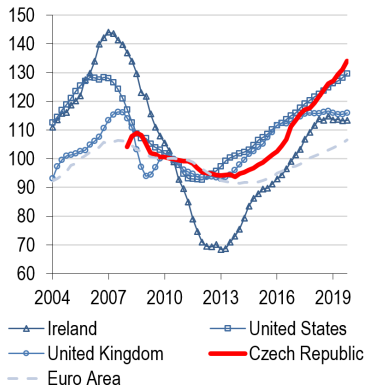
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# Introduction and motivation

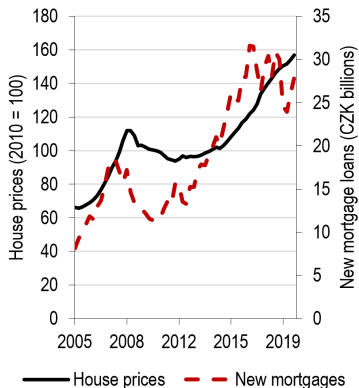
- **Rapid growth of housing loans and house prices** reinforce each other, leading to a build-up of systemic risk (Favara & Imbs, 2015; Justiniano *et al.*, 2019).
- **Macroprudential policy** is meant to weaken the feedback loop between credit and house prices and **reduce the vulnerability** of bank mortgage portfolios.
  - ▶ Borrower-based measures have been particularly favoured, having been adopted by more than 60 countries since 1990 (Alam *et al.*, 2019).
- We examine the effects of three **borrower-based measures** on mortgage lending in the Czech Republic, adopted in 2017 and 2018.
  - ▶ We combine **loan-level data** with borrower, bank and region-level information.
  - ▶ We use machine learning method of causal forest to estimate **causal effect**.
- **Our contribution:**
  - ▶ Comparison of the effects of using value-based (LTV) limit separately and jointly with income-based (DTI, DSTI) limits.
  - ▶ Exploration of heterogeneity in the transmission of the regulation.

# The Property Cycle and House Prices

(A) House Prices: International Comparison



(B) The Property Cycle in the Czech Republic



- Soft landing after the GFC, no major increases in non-performing mortgage loans or funding dry-ups.
- This allowed mortgage lending to grow and property prices to bounce back soon after the GFC and to grow rapidly between 2015 and 2017.

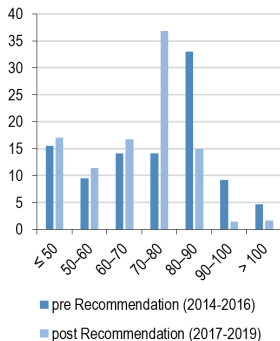
# The Czech Residential Mortgage Market and Regulatory Measures During 2015–2018

Announced	Effective (A)	Hard caps (B)	Soft limits
16 June 2015	16 June 2015	LTV 100%	10% (LTV 90–100%)
14 June 2016	1 October 2016	LTV 95%	10% (LTV 85–95%)
14 June 2016	1 April 2017	LTV 90%	15% (LTV 80–90%)
12 June 2018	1 October 2018	LTV 90% DTI 9; DSTI 45%	5% (debt limits) 15% (LTV 80–90%)

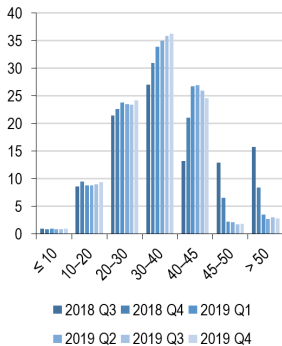
- We focus on the effects of setting the 90% LTV limit and the introduction of income-based DTI and DSTI limits that followed.
- Interesting policy setup to evaluate – value-based vs. income-based limits.

# Recommended Limits: Fulfilment and Loan Distribution

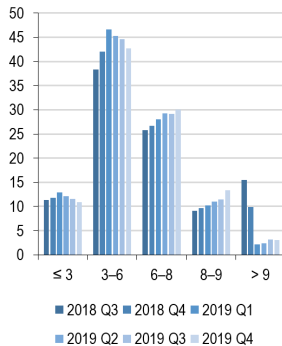
## LTV



## DSTI



## DTI



- Banks affected by the Recommendation were **compliant** with the limits.
- Following setting of the LTV limits, the share of loans with LTVs above 80% fell significantly.
  - ▶ Some **regulatory arbitrage**? 35% of loans had valued exactly equal to the LTV limit.

# Data

- Main source: semi-annual **loan-level** survey: newly granted or refinanced mortgage loans from 2016 to the end of June 2019 (7 rounds of surveys).
  - ▶ Mandatory for all banks engaged in mortgage business
  - ▶ Anonymous individual data
- The survey contains following information:
  - ▶ Mortgage characteristics (e.g. size, collateral value, mortgage for rent or not, maturity, ZIP code, etc.).
  - ▶ Client characteristics (e.g. age, debt level, etc.).
  - ▶ Bank characteristics (e.g. regulatory distance from the limit, market share, etc.).
  - ▶ Loan characteristics are expanded with variables related to the regulatory recommendation (distance to the limit, days until Q-end).
- ZIP codes used to enrich the data with spatial characteristics (GDP, unempl., house prices).
- We work with 81,844 reported mortgage loans.
  - ▶ Substantial data cleaning, we start with 25 banks (91% of total assets of the sector).
  - ▶ After the mop-up, we cover 11 banks (83% of total assets).

# Identification Strategy (1/2)

- We assume the sequential changes in the loan distribution can be causally attributed to the introduction of recommended limits.
- The quasi-natural experiment that we evaluate has the following design:
  - ▶ Assign loans to the control group and two treatment groups.
  - ▶ The **control group** captures mortgages under the first Recommendation (no tightening of credit standards).
  - ▶ Two **treatment groups** (mortgages under LTV 90% and LTV-DTI-DSTI).
  - ▶ Loan-by-loan matching procedure.
- We estimate **causal effect** by comparing the differences between the control and treatment groups.
  - ▶ **Matching method** to reduce sampling bias.
  - ▶ **Regression trees and random forest algorithm** to search for treatment variation/heterogeneity over high-dimensional functions of covariates.

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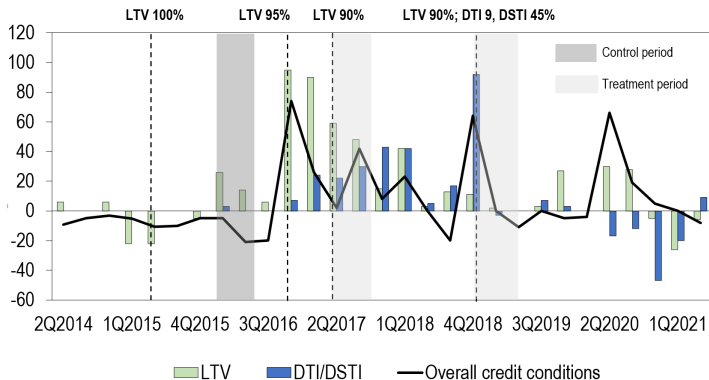
	Treatment			Control		
	minDate	maxDate	N	minDate	maxDate	N
LTV	1/6/2017	31/12/2017	37,019	1/1/2016	14/6/2016	28,104
LTV-DTI-DSTI	1/10/2018	14/6/2019	16,721	1/1/2016	14/6/2016	28,104

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**Note:** minDate/maxDate denotes the minimum/maximum date of when the mortgage was granted to be included in the control or treatment group. N denotes the number of mortgages.

# Insights from the BLS and the Time Assignment of Control and Treatment Periods



- Data prior 2015Q4 not included due to low quality (first rounds of the survey).
- The cutoff date of June 14, 2016 is chosen to account for the front-loading that probably happened after the intended 95% LTV limit was announced.



# Estimation Methodology (Athey & Imbens, 2016)

- Each unit (in our case, a newly granted loan) has two potential outcomes based on a binary treatment:
  - ▶  $Y_i(W_i = 1)$  is the outcome if the unit had been treated
  - ▶  $Y_i(W_i = 0)$  is the the outcome had the unit not been treated
  - ▶ The causal (treatment) effect of a Recommendation on the  $i$ -th loan could be estimated as a simple difference between the potential outcomes
- We estimate the average treatment effect (ATE) as follows:

$$ATE = E[Y_i(W_i = 1) - Y_i(W_i = 0)] \quad (1)$$

we gradually consider size of **mortgage loan**, **value of pledged real estate** and **distance to average interest rate** as our left-hand side variables.

- Estimated ATEs show the change of the given variable due to the Recommendation.

# Effects on Loans Size and Collateral Value

	LTV	LTV-DTI-DSTI
<b>A) Size of mortgage loan</b>		
Average Treatment Effect (ATE)	<b>-18,973</b> (-33,104; -4,841)	<b>-342,290</b> (-378,988; -305,593)
Heterogeneous Treatment Effect (HTE)	<b>7,278</b> (-17,162; 31,718)	<b>364,051</b> (295,636; 432,466)
No. of observations	65,123	44,825
<b>B) Value of pledged property</b>		
Average Treatment Effect (ATE)	<b>223,331</b> (127,309; 319,353)	43,024 (-881; 86,930)
Heterogeneous Treatment Effect (HTE)	<b>214,721</b> (63,781; 365,660)	<b>161,291</b> (33,541; 289,041)
No. of observations	65,123	44,825

- After LTV limit, average loan size dropped by approximately 1.2%, while collateral value increased by 8.5%.
- After the DTI/DSTI limits, average loan size dropped by more than 20%.
  - ▶ Income-based limits may have provided for "belt-and-braces" incentives that left little room for arbitrage by both borrowers and banks.

# The Treatment Effects on Mortgage Loan Rates

	LTV	LTV-DTI-DSTI
Average Treatment Effect (ATE)	<b>0.179</b> (0.067; 0.291)	<b>0.339</b> (0.220; 0.458)
Heterogeneous Treatment Effect (HTE)	-0.046 (-0.264, 0.172)	0.119 (-0.065, 0.303)
No. of observations	65,123	44,825

- In general, one would expect a negative effect of BBMs on bank lending rates (rationing out riskier borrowers, improving the quality of the mortgage portfolio).
- The Czech case is special given the use of both, hard and soft limit
  - ▶ Banks have the option of providing a certain proportion of total loans with higher prudential ratios in the current quarter (15% in the case of LTV and 5% in the case of income-based limits).
- Estimates show that banks increased risk premiums on mortgage loans with high prudential ratios.

# Exposing Heterogeneous Treatment Effects

- We further estimate the conditional average treatment effect (CATE):

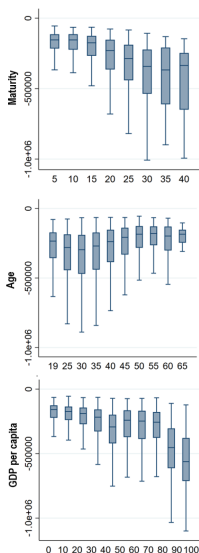
$$\tau(x) = E[Y_i(W_i = 1) - Y_i(W_i = 0) | X_i = x] \quad (2)$$

which calculates the treatment effect for a sub-population with different characteristics, e.g. age, mortgage maturity, etc.

- We formally test for differences in average ATEs between the 30% of mortgages with the highest and lowest value of a given factor ("HTE test")
- The HTE test signals significant heterogeneous treatment effects of:
  - 1 DTI-DSTI on mortgage size,
  - 2 LTV and DTI-DSTI on collateral value.

# CATEs on Mortgage Size (DTI/DSTI Introduction)

- Higher treatment effect stemming from varying maturity of the new mortgages.
  - ▶ Longer maturity used to effectively lower the debt service.
  - ▶ Not possible for maturity exceeding 30y (hard limit).
- Higher treatment effect for mortgages with the youngest main borrower (up to 36y)
  - ▶ CNB now imposes weaker rules for younger borrowers (effective since 1 August 2021).
- "Richer" regions saw higher reduction of loan volumes following the treatment
  - ▶ Improvement of equity in access to mortgages across regions with different levels of prosperity.



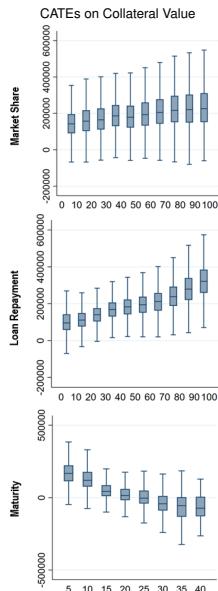
# CATEs on the Value of Pledged Property

## ● After LTV limit:

- ▶ Loans from banks with the greatest market share were issued with a significantly higher collateral value
- ▶ The collateral value increased more for loans with the highest loan repayments
  - ★ Lending into a booming property market?
  - ★ Increased efforts by banks to assign a high value to pledged property at the higher end of the market?

## ● After DTI-DSTI limits:

- ▶ The 30% of loans with the shortest maturity (roughly below 10 years) experienced positive treatment effect
  - ★ Could afford to buy property at a higher price (wealthier clients).
- ▶ The collateral value decreased for the 30% of loans with higher maturity
  - ★ Poorer clients?, had to purchase (and pledge) a cheaper property.



# Conclusions and Policy Implications

- We estimated that the recommended LTV limits reduced the average loan size and increased interest rate on new loans.
- LTV limits also caused collateral value to increase.
  - ▶ More pronounced for banks with higher market power.
- Additional DTI-DSTI limits provided for a belt-and-braces incentives for banks and borrowers that were harder to escape.
  - ▶ Income-based limits decreased loan volume much more than a standalone LTV limit (about 20 times larger treatment).
  - ▶ The mortgage rate increased substantially more than after the recommended LTV limits (0.34 versus 0.18 percentage points).
- Application of DTI-DSTI limits was rather heterogeneous in its impact.
- The combination of income-based and LTV limits has been much more effective in cooling the residential mortgage loan market than using LTV limit alone.

# New Paper Coming Soon - Effects of Easing of Borrower-Based Measures

- We analyze the biggest easing of BBMs (worldwide) – in spite of the pandemic, the CNB has eased the LTV limit and abolished DTI and DSTI limits
- Notable difference in propagation of easing of value-based (LTV) and income-based (DTI, DSTI) limits
  - ▶ LTV-constrained borrowers act in line with a liquidity preference
  - ▶ DTI/DSTI-constrained borrowers act in line with a financial accelerator
- Significant heterogeneity of transmission
  - ▶ LTV more binding for first-time home buyers, younger borrowers, and borrowers from poorer counties
  - ▶ DTI/DSTI more binding for clients from richer counties and second+ mortgages



# Thank you for your attention!

Comments are welcomed and much appreciated.

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# Back-up Slides

# Robustness Check 1

- We separate the effect of treatment across constrained and unconstrained loan groups
  - ▶ We assess whether the loan was more likely to be treated based on LTV score (DSTI not available during control period, cannot be hand-crafted)
  - ▶ Constrained loans are those with LTV equal or higher than 80%
  - ▶ We split the baseline dataset into two separated subsets, one consists of the constrained loans and the other of the unconstrained loans.
  - ▶ We run the same models again separately for each of the subset and analyse differences in results.

# ATEs of LTV Limit for Constrained and Unconstrained Mortgages

	Constrained	Unconstrained
ATE for size of mortgage loan	-13,441.8 (-39,270.9; 12,387.5)	-7,978.9 (-19,736.6; 3,778.6)
No. Of observations	23,874	41,249
ATE for value of pledged real estate	<b>281,640.5</b> (189,568.2; 373,712.8)	-27,213.4 (-154,298.6; 99,871.8)
No. of observations	23,874	41,249
ATE for distance to average rate	<b>0.196</b> (0.083; 0.309)	0.109 (-0.043; 0.261)
No. of observations	23,874	41,249

*Note:* 95% confidence interval in parenthesis, significant estimates are highlighted in bold.

- The collateral increased following the implementation of LTV limit for constrained mortgages
- ...as well as interest rates

# ATEs of Income-Based Limits for Constrained and Unconstrained Mortgages

	Constrained	Unconstrained
ATE for size of mortgage loan	<b>-231,118.2</b>	<b>-259,693.5</b>
	(-301,237.9; -160,998.5)	(-292,057.9; -227,329.2)
No. Of observations	17,076	27,749
ATE for value of pledged real estate	-54,786.4	<b>283,526.1</b>
	(-148,465.9; 38,893.3)	(115,779.5; 451,272.7)
No. of observations	17,076	27,749
ATE for distance to average rate	<b>0.360</b>	<b>0.281</b>
	(0.230; 0.490)	(0.117; 0.445)
No. of observations	17,076	27,749

*Note:* 95% confidence interval in parenthesis, significant estimates are highlighted in bold.

- The collateral channel is not longer operational in case of introducing LTV limits side-by-side with income-based limits
- Due to the existence of the soft limit, interest rates are found to increase more for constrained mortgages

## Robustness Check 2

- To account for any time-specific endogeneity, we calculate distance to average loan size and collateral value (indicator value for given loan minus average at a given month in the given region)
- Estimates are largely compliant with our baseline

	LTV	TOTAL
<b>A) Distance to average mortgage loan size</b>		
Average Treatment Effect (ATE)	<b>-84,220.3</b> (-108,223.5; -60,218.9)	<b>-326,697.2</b> (-361,484.6; -291,909.8)
No. of observations	65,123	44,825
<b>B) Distance to average value of pledged real estate</b>		
Average Treatment Effect (ATE)	<b>172,483.8</b> (63,209.7; 281,758.9)	131,652.464 (-15,274.1; 278,579.9)
No. of observations	65,123	44,825

*Note:* 95% confidence interval in parenthesis, significant estimates are highlighted in bold.

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