# Damaged Collateral and Firm-Level Finance: Evidence from Russia's War in Ukraine

Solomiya Shpak[1,4,5] John S. Earle[1,2] Scott Gehlbach[3] Mariia Panga[1]

[1]George Mason University
[2]IZA Institute of Labor Economics
[3]University of Chicago
[4]Kyiv School of Economics
[5]National Bank of Ukraine

June 6, 2023

## Introduction

- Russia's full-scale invasion has caused not only large loss of life, injuries, and humanitarian crises, but also enormous economic damage.
- Compared with 2014, major financial reforms have made Ukrainian banks much healthier.
- But damage to collateral threatens financial stability.

# Damage caused by Russia's war in Ukraine

## Research question and approach

How much has Russia's war in Ukraine damaged the collateral of Ukrainian firms, and how much collateral damage has that caused the Ukrainian financial system at the firm level?

Using detailed microdata on corporate loans and borrowers in Ukraine Feb-Nov 2022, we measure:

- Change in collateral value since the full-scale invasion
- Variation in collateral damage with location and condition
- Firm-level outcomes:
  - Change in default rate
  - Bank estimate of default probability
  - Ability to obtain new loans
  - Amount of new loans

# Preview of Results

- War damages collateral
  - Extent of damage likely understated, as losses not yet fully recognized
- Damage to collateral raises firm defaults
  - 10-percent reduction in collateral value raises default rates and banks' assessment of firms' probability of default by approximately eight and four percentage points, respectively
- Reduced collateral value lowers ability to borrow
  - 10-percent reduction in collateral value lowers the probability of getting any new loan by nearly eight percentage points and decreases new lending by over two percentage points
- Implies reduced investment and lower future economic growth

# Outline

- Overview of banking sector in Ukraine
- Related literature
- Data and sample description
- Empirical strategy
- Results and discussion

# Overview of Banking Sector in Ukraine

- Before 2014: little control over loans to related parties and business groups, high share of loans in foreign currency
- 2014: annexation of Crimea, military conflict in Donetsk and Luhansk
- 2014–2019: NBU gains independence and institutional capacity
  - Basel principles on credit risk assessment, related party lending, and exposure concentration
  - More than 100 banks (over half) exit due to lack of equity, nontransparent ownership structure, money laundering, bank fraud etc.
  - Banking recovery, increase in corporate lending, fall in borrowing costs
- 2022: NBU reacted to invasion with package of policy changes:
  - relaxed assessment of credit risk
  - stopped requirement for automatic default after 90 days
  - stopped collateral review
- Real losses not yet fully recognized, will continue to increase

# Related literature

- The collateral channel
  - Theory: Barro (1976) collateral decline raises defaults
  - Important role in Great Depression (Fisher 1933, Bernanke 1983)
  - Empirical papers focus on real estate:
    - Gan (2007): 1989 land price shock in Japan lowers investment, borrowing
    - Chaney et al. (2012): real estate value raises investment in U.S.
    - Wu et al. (2015): similar result for China
- Collateral damage from war: research focuses on trade losses
  - Glick and Taylor (2009): country panel 1870-1997
  - Korovkin and Makarin (2022): Ukraine-Russia 2014
- Costs of Russia's war in Ukraine
  - Direct damages to physical infrastructure of Ukraine reached $147.5 billion ("Russia Will Pay," April 2023)
  - Cost of reconstruction and recovery in Ukraine has grown to $411 billion (World Bank, 2023)
- This paper: How war damages the collateral posted by firms, and how this damage affects defaults and ability to borrow

# Data

- Supervisory loan-level data (loan data)
- Data from firm-level financial statements
- Survey of banks on damage to collateral (survey data)
- List of raions directly affected by the invasion

# Loan and borrower data

- Loan Data
  - Monthly administrative data reported by banks to the National Bank of Ukraine for all loans above UAH 2 mln (USD 54K as of Jan. 2023)
  - Covers 96 percent of total loan amount in the Ukrainian banking system.
  - Information on exposure at default
  - Collateral asset type and value (liquidity-adjusted fair market value)
  - Actual default and bank's assessment of probability of default
- Data from financial statements
  - location of the borrower's registration (raion)
  - borrower industry

# Survey of banks on collateral damage

- Survey of banks as of July 1, 2022
- Information on up to 100 largest borrowers from 66 banks
- For each bank-borrower and collateral type pair:
  - collateral location (raion)
  - collateral condition
    - ⋆ destroyed
    - ⋆ damaged
    - ⋆ loss of control
    - ⋆ no information
    - ⋆ no damage
  - collateral asset type (residential/commercial real estate, transportation, equipment, integrated property)

# Identifying affected raions

- We identify a raion as affected if it meets at least one of the following requirements:
  - a raion was indicated in the Order 75 of the Ministry of Reintegration of the Temporarily Occupied Territories of Ukraine "On approval of the list of territorial communities which are located in the area of fighting, under temporary occupation, or encirclement (blockade)" since April 25, 2022, and thereafter
  - raions temporarily occupied and then liberated prior to April 25, 2022
- A raion is "affected" if at least one territorial community within it was the area of fighting, under temporary occupation, or blockade
- Annexed Crimea is excluded due to the absence of any data since 2014
- Caveat: the value of collateral in "unaffected" raions can be indirectly reduced by the war and directly damaged by missile attacks

# Classification of raions affected by Russia's invasion
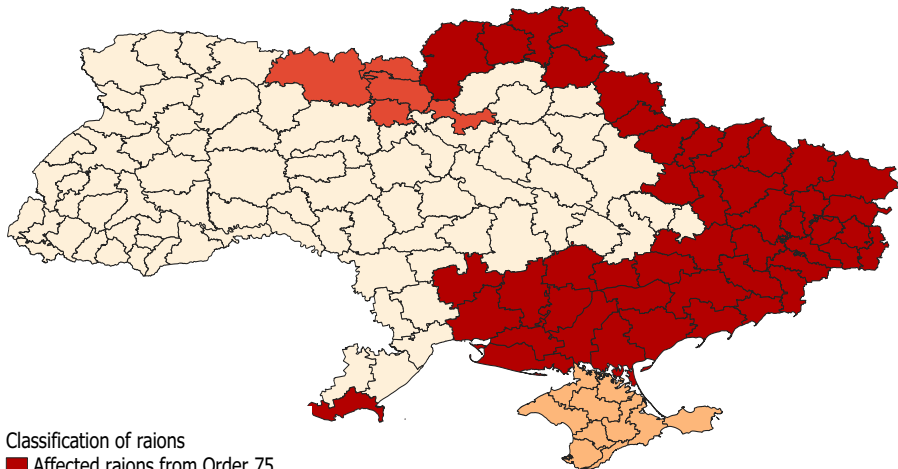


Classification of raions
- ■ Affected raions from Order 75
- ■ Affected raions not from Order 75
- ■ Annexed Crimea
- □ Other raions

# Sample and Data Construction

- Restrict survey data to corporate borrowers only
- For each bank-borrower-collateral asset, create two variables:
  - *Affected collateral* if any part of collateral asset located in affected raion
  - Collateral condition variables (*damaged, destroyed, loss of control, no information*)
- Merge with financial statements data to identify 2-digit industry and location of borrower registration
  - *Affected borrower* if borrower is registered in affected raion
- Merge with loan data by bank-borrower-collateral asset type as of February and November, 2022
  - Use loan data to calculate firm-level outcomes

# Firm-level outcomes

- Default
  - ▶ PD=1 if borrower defaulted as of November 1, 2022
- Change in bank's estimation of future default probability
  - ▶ Difference between PD as of November 2022 and PD as of February 2022
- New loans

    New loans= 1 if borrower had at least one new loan between February and November
- Share of new loans
  - ▶ Ratio of sum of new loans between March and November (and still outstanding as of November) to sum of all loans in February 2022

# Change in Probability of Default by Raion, Feb-Nov 2022



Change in PD
- Not in sample
- -0.2 - 0
- 0 - 0.1
- 0.1 - 0.2
- 0.2 - 0.3
- 0.3 - 0.4
- > 0.4
- NA
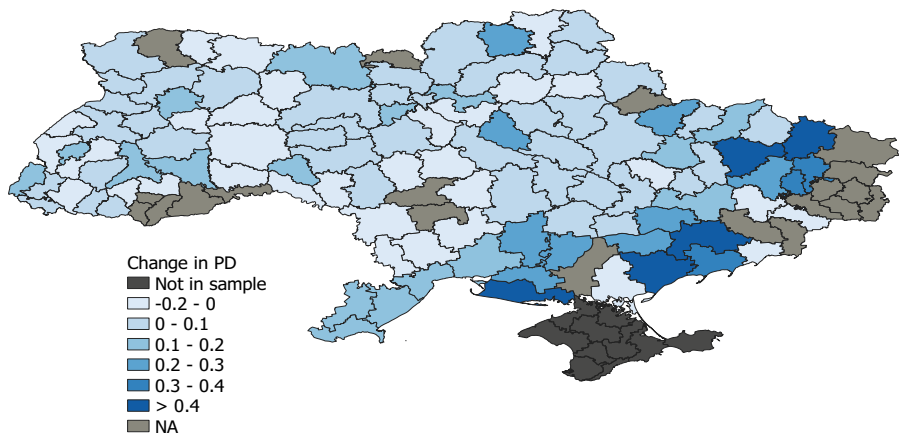
# New loans issued after February 24, 2022



New loans
- Not in sample
- 0 - 0.05
- 0.05 - 0.15
- 0.15 - 0.3
- 0.3 - 0.45
- > 0.45
- NA
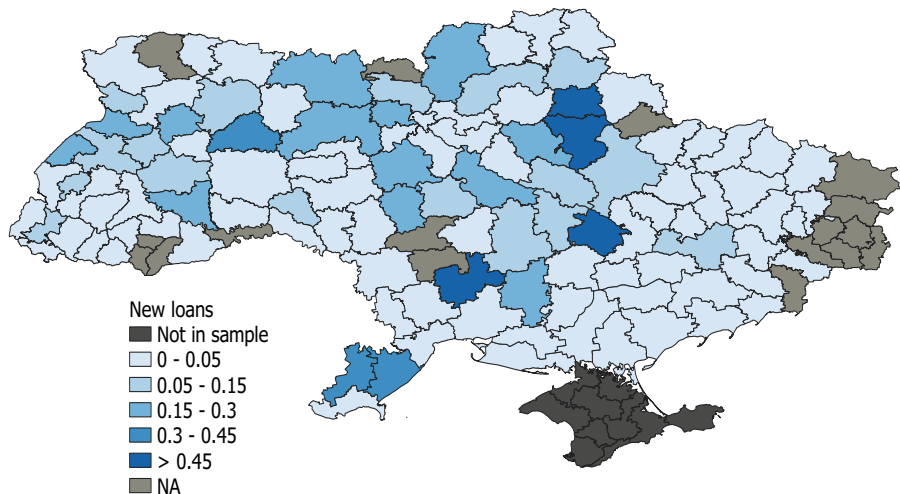
# Main Determinant of Interest

Change in collateral-loan ratio from Feb $(t-1)$ to Nov 2022 $(t)$

$$ColChange_{clib} = \frac{ColSum_{clibt}/LoanSum_{libt} - ColSum_{clibt-1}/LoanSum_{libt-1}}{ColSum_{clibt}/LoanSum_{libt}}$$

- $ColSum_{clibt}$ ($ColSum_{clibt-1}$) is value of collateral asset $c$ of loan $l$ for borrower $i$ in bank $b$ as of November (February)
- $LoanSum_{clibt}$ ($LoanSum_{clibt-1}$) is outstanding amount of loan $l$ for borrower $i$ in bank $b$ as of November (February)
- Use "CVK" = value of collateral asset adjusted for liquidity according to prescribed coefficients by collateral type

# Identification and Measurement Problems

- Firms that experience negative shocks to the value of collateral may also be more likely to suffer from other effects of the war (loss of production capacity, personnel, and market demand)

- Change in collateral value is likely measured with error due to difficult in collateral assessment under war conditions

- Defaults measured with error due to policy change dropping requirement for default after 90 days nonpayment

- Probability of default measured with error as banks face difficulty assessing effects of war

- Banks might generally be less likely to lend to firms in less safe regions (e.g., close to Donetsk and Luhansk oblasts, and to annexed Crimea), whether their collateral was damaged or not

- If firm's bank has a loan portfolio with a heavy weight towards firms damaged by the war, then the bank may be less likely to extend future loans

# Our approach

- Condition on various observed and unobserved characteristics, including borrower and collateral presence in an affected raion and fixed effects for bank, borrower's industry, and "macro" region
- Use IV approach, where we exploit plausibly (and conditionally) exogenous variation in collateral value induced by any damage to collateral
- Robustness: exclude assets used in production (equipment and integrated property)

# Estimating Equation

$$Y_{clib} = \beta * ColChange_{clib} + \gamma * ColAffected_{cib} + \omega * BorrAffected_{ib}$$
$$+ \theta_b + \sum_j \alpha_j D_{ij} + \sum_r \gamma_r D_{ir} + \epsilon_{clib} \quad (1)$$

- $Y_{clib}$ represents one of four outcome variables: *Default*, *PDChange*, *NewLoan*, or *ShareNewLoans*
- $ColChange_{clib}$ is change in collateral value for collateral asset $c$ of loan $l$ for borrower $i$ in the bank $b$
- $ColAffected_{cib} = 1$ if any part of the collateral asset is located in an affected raion
- $BorrAffected_{ib} = 1$ if borrower is registered in affected raion
- $\theta_b$ = bank FE, $\alpha_j$ = 2-digit industry FE, $\gamma_r$ = macro-region FE
- Instrument $ColChange_{clib}$ with dummies for damaged, destroyed, no information, loss of control

# Outcomes by Collateral Condition

| Collateral condition | Default | PD change | New loans | Share new loans | Collateral change | N |
|---|---|---|---|---|---|---|
| All collateral assets | 0.14 | 0.09 | 0.19 | 0.14 | -0.01 | 5667 |
| Any damage | 0.34 | 0.21 | 0.15 | 0.09 | -0.26 | 476 |
| No damage | 0.12 | 0.09 | 0.20 | 0.15 | 0.02 | 5161 |
| Missing | 0.00 | 0.02 | 0.08 | 0.01 | 0.04 | 30 |

Notes: Columns 1 through 4 report mean values of Default, PD change, New loans, and Share of new loans where the unit of observation is bank-borrower. Column 5 reports the mean of ratio of collateral-loan ratios where the unit of observation is borrower-loan-collateral asset. Any damage=1 if any of collateral asset was damaged, destroyed, have lost control or there is no information about the condition of this collateral asset. PD change = change in probability of default from February to November 2022. Default = 1 if borrower defaulted as of November 2022. Share new loans = ratio of new loans initiated between March and November (and outstanding as of November) relative to all loans in February. New loans = 1 if borrower had at least one new loan between February and November. Collateral change is change in collateral-loan ratio between February and November.

# Collateral Condition and Collateral Location

| Collateral condition | Collateral in affected raions | Collateral in other raions |
|---|---|---|
| Damaged | 66 | 29 |
| Destroyed | 9 | 0 |
| Loss of control | 330 | 1 |
| No information | 117 | 7 |
| Not damaged/destroyed/lost | 1,287 | 3,874 |
| Missing condition | 15 | 15 |

Notes: One collateral asset can have several collateral conditions. Out of 95 damaged collateral assets, 69 experienced loss of control; there is no information on 3 others. Out of 9 destroyed collateral assets, 5 experienced loss of control. Out of 124 assets with no information, 3 are damaged and 52 experienced loss of control.

# Outcomes by Collateral/Borrower Location

| | Default | PD change | New loans | Share new loans | Collateral change | N |
|---|---|---|---|---|---|---|
| Borrower in affected raion | 0.16 | 0.16 | 0.17 | 0.11 | -0.04 | 1,170 |
| Borrower not in affected raion | 0.14 | 0.08 | 0.20 | 0.15 | 0.01 | 4,497 |
| Collateral in affected raion | 0.17 | 0.14 | 0.19 | 0.13 | -0.06 | 1,741 |
| Collateral not in affected raion | 0.13 | 0.08 | 0.20 | 0.15 | 0.02 | 3,926 |
| State loan program | 0.00 | 0.05 | 0.89 | 0.60 | 0.14 | 823 |
| No state loan program | 0.15 | 0.10 | 0.13 | 0.10 | -0.03 | 4,844 |

Notes: Columns 1 through 4 report mean values of Default, PD change, New loans and Share of new loans, where the unit of observation is bank-borrower. Column 5 reports the mean of change in collateral-loan ratio between February and November, where the unit of observation is borrower-loan-collateral asset.

# Change in Collateral Loan Ratio and Collateral Condition

|                              | (1)       | (2)       | (3)       | (4)       | (5)       | (6)       |
|------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| Any damage                   | -0.277*** | -0.294*** | -0.318*** | -0.318*** | -0.287*** | -0.289*** |
|                              | (0.076)   | (0.090)   | (0.098)   | (0.094)   | (0.097)   | (0.098)   |
| Collateral in affected raion |           |           |           |           | -0.061**  | -0.053    |
|                              |           |           |           |           | (0.028)   | (0.035)   |
| Borrower in affected raion   |           |           |           |           |           | -0.015    |
|                              |           |           |           |           |           | (0.050)   |
| Bank FE                      |           | ✓         | ✓         | ✓         | ✓         | ✓         |
| Industry FE                  |           |           | ✓         | ✓         | ✓         | ✓         |
| Macro-region FE              |           |           |           | ✓         | ✓         | ✓         |
| Observations                 | 5,667     | 5,667     | 5,499     | 5,499     | 5,499     | 5,499     |
| R-squared                    | 0.047     | 0.101     | 0.140     | 0.144     | 0.148     | 0.148     |

Notes: The table shows the results of OLS regression with change in collateral-loan ratio between February and November as dependent variable. The unit of observation is bank-borrower-loan-collateral asset. *Any damage* takes on the value of 1 if any of collateral asset was damaged, destroyed, experienced loss of control, or had missing information about its condition. In parentheses, heteroskedasticity-robust standard errors that correct for correlation of error terms at the borrower level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

# Change in Collateral Loan Ratio and Collateral Condition

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| Damaged | -0.054 | 0.011 | -0.003 | -0.007 | 0.005 | 0.002 |
| | (0.075) | (0.071) | (0.055) | (0.054) | (0.056) | (0.055) |
| Destroyed | -0.127** | -0.015 | 0.034 | 0.031 | 0.034 | 0.032 |
| | (0.051) | (0.057) | (0.071) | (0.073) | (0.073) | (0.071) |
| No information | 0.133 | 0.175* | 0.175* | 0.171* | 0.181* | 0.180* |
| | (0.111) | (0.105) | (0.097) | (0.096) | (0.094) | (0.094) |
| Loss of control | -0.390*** | -0.440*** | -0.499*** | -0.499*** | -0.472*** | -0.472*** |
| | (0.076) | (0.090) | (0.098) | (0.097) | (0.100) | (0.100) |
| Collateral in affected raion | | | | | -0.048* | -0.040 |
| | | | | | (0.026) | (0.029) |
| Borrower in affected raion | | | | | | -0.014 |
| | | | | | | (0.043) |
| Bank FE | | ✓ | ✓ | ✓ | ✓ | ✓ |
| Industry FE | | | ✓ | ✓ | ✓ | ✓ |
| Macro-region FE | | | | ✓ | ✓ | ✓ |
| Observations | 5,667 | 5,667 | 5,499 | 5,499 | 5,499 | 5,499 |
| R-squared | 0.065 | 0.127 | 0.169 | 0.172 | 0.174 | 0.174 |

Notes: Table shows the results of OLS regression with the change in collateral-loan ratio between February and November as the dependent variable. The unit of observation is bank-borrower- loan-collateral asset. In parentheses, heteroskedasticity-robust standard errors that correct for correlation of error terms at borrower level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

# Default and Probability of Default

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | Default | | Change in default probability | |
| | OLS | IV | OLS | IV |
| Change in collateral-loan ratio | -0.130** | -0.798*** | -0.031 | -0.425** |
| | (0.058) | (0.230) | (0.043) | (0.191) |
| Collateral in affected raion | 0.027 | -0.058 | 0.004 | -0.046 |
| | (0.034) | (0.042) | (0.031) | (0.037) |
| Borrower in affected raion | 0.061 | 0.066 | 0.130** | 0.134** |
| | (0.047) | (0.048) | (0.054) | (0.060) |
| Bank FE | ✓ | ✓ | ✓ | ✓ |
| Industry FE | ✓ | ✓ | ✓ | ✓ |
| Macro-region FE | ✓ | ✓ | ✓ | ✓ |
| Observations | 5,499 | 5,499 | 5,499 | 5,499 |
| Mean dep. variable | 0.122 | 0.122 | 0.121 | 0.121 |

Notes: Dependent variable is default as of November 2022 (columns 1–2) and change in default probability between February and November 2022 (columns 3–4). The unit of observation is bank-borrower-loan-collateral asset. First-stage $F$-stats is 13.51. In parentheses, heteroskedasticity-robust standard errors that correct for correlation of error terms at borrower level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

# New Loans and Share of New Loans

|  | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
|  | New loans | | Share of new loans | |
|  | OLS | IV | OLS | IV |
| Change in collateral-loan ratio | 0.219*** | 0.769*** | 0.001 | 0.244*** |
|  | (0.047) | (0.166) | (0.049) | (0.061) |
| Collateral in affected raion | 0.058 | 0.129** | -0.003 | 0.028 |
|  | (0.048) | (0.054) | (0.046) | (0.043) |
| Borrower in affected raion | -0.093 | -0.094 | -0.052 | -0.051 |
|  | (0.082) | (0.080) | (0.038) | (0.038) |
| Bank FE | ✓ | ✓ | ✓ | ✓ |
| Industry FE | ✓ | ✓ | ✓ | ✓ |
| Macro-region FE | ✓ | ✓ | ✓ | ✓ |
| Observations | 5,499 | 5,499 | 5,499 | 5,499 |
| Mean dep. variable | 0.284 | 0.284 | 0.121 | 0.121 |

Notes: In columns 1 and 2, dep. variable is indicator that takes a value of one if borrower obtained a new loan between Feb. and Nov. 2022. In columns 3 and 4, dep. variable is new loans obtained between Feb. and Nov. 2022 as share of all outstanding loans as of Feb. 2022. The unit of obs. is bank-borrower-loan-collateral asset. First-stage $F$-stat is 13.51. In parentheses, heteroskedasticity-robust se that correct for correlation of error terms at borrower level. Sign. levels: * $p < 0.10$, **

# Defaults: Excluding Production Assets

|  | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
|  | Default | | Change in default probability | |
|  | OLS | IV | OLS | IV |
| Change in collateral-loan ratio | -0.120* | -0.904*** | -0.023 | -0.511** |
|  | (0.055) | (0.256) | (0.042) | (0.214) |
| Collateral in affected raion | 0.032 | -0.066 | 0.022 | -0.039 |
|  | (0.035) | (0.048) | (0.034) | (0.041) |
| Borrower in affected raion | 0.064 | 0.079 | 0.124** | 0.134* |
|  | (0.049) | (0.059) | (0.062) | (0.073) |
| Bank FE | ✓ | ✓ | ✓ | ✓ |
| Industry FE | ✓ | ✓ | ✓ | ✓ |
| Macro-region FE | ✓ | ✓ | ✓ | ✓ |
| Observations | 3,913 | 3,913 | 3,913 | 3,913 |
| Mean dep. variable | 0.128 | 0.128 | 0.128 | 0.128 |

Notes: Dependent variable is default as of November 2022 (columns 1–2) and change in default probability between February and November 2022 (columns 3–4). The unit of observation is bank-borrower-loan-collateral asset. First stage F-stats is 13.48. In parentheses, heteroskedasticity-robust standard errors that correct for correlation of error terms at borrower level. Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

# New Loans: Excluding Production Assets

|                               | (1)        | (2)        | (3)        | (4)        |
|-------------------------------|------------|------------|------------|------------|
|                               | New loans  |            | Share of new loans |    |
|                               | OLS        | IV         | OLS        | IV         |
| Change in collateral-loan ratio | 0.210***   | 0.814***   | 0.000      | 0.278***   |
|                               | (0.053)    | (0.211)    | (0.050)    | (0.080)    |
| Collateral in affected raion  | 0.086      | 0.162**    | 0.021      | 0.057      |
|                               | (0.057)    | (0.065)    | (0.052)    | (0.050)    |
| Borrower in affected raion    | -0.100     | -0.110     | -0.054     | -0.057     |
|                               | (0.092)    | (0.088)    | (0.042)    | (0.043)    |
| Bank FE                       | ✓          | ✓          | ✓          | ✓          |
| Industry FE                   | ✓          | ✓          | ✓          | ✓          |
| Macro-region FE               | ✓          | ✓          | ✓          | ✓          |
| Observations                  | 3,913      | 3,913      | 3,913      | 3,913      |
| Mean dep. variable            | 0.291      | 0.291      | 0.121      | 0.121      |

Notes:In columns 1 and 2, dep. variable takes a value of one if borrower obtained a new loan between Feb. and Nov. 2022. In columns 3 and 4, dep. variable is new loans obtained between Feb. and Nov. 2022 as share of all outstanding loans as of Feb. 2022. The unit of obs. is bank-borrower-loan-collateral asset. Heteroskedasticity-robust s.e. correct for correlation of error terms at borrower level. Signif. levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

# Summary and Conclusions

We analyze almost real-time microdata on loans, borrowers, and collateral in Ukraine to assess the effects of war in 2022

- War damages collateral
  - ▶ Extent of damage likely understated, as losses not yet fully recognized
- Damage to collateral raises firm defaults
  - ▶ 10-percent reduction in collateral value raises default rates and banks' assessment of firms' probability of default by approximately eight and four percentage points, respectively
- Reduced collateral value lowers ability to borrow
  - ▶ 10-percent reduction in collateral value lowers the probability of getting any new loan by nearly eight percentage points and decreases new lending by over two percentage points
- Implies reduced investment and lower future economic growth

# Limitations and Future Research

- Caveats
  - ▶ Short time period
  - ▶ July survey linked to November outcomes
  - ▶ Measurement error in collateral value $\implies$ downward bias
  - ▶ Measurement error in defaults $\implies$ noisy estimation
- Future plans
  - ▶ Add firm balance sheet data for 2022
  - ▶ Update with improved collateral value (assuming assessment improves over time)
  - ▶ Use new information on all collateral location (not just from survey)
  - ▶ Investigate consequences for bank portfolios and financial stability

# Thank you for your attention!