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# Innovation and Access to Finance
## *(Capacitatea de inovare și accesul la finanțare)*

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# Innovation and Access to Finance : Theoretical aspects

- **Innovation drivers**
  - Supply-side factors (e.g. FDI) (Romer, 1990; Weitzman, 1998)
  - Demand-side factors (e.g. entrepreneurship) (Schmookler, 1966)
  - Structural factors (e.g. quality of institutions) (Acemoglu and Robinson, 2000)
  - Financial constraints influence innovation capabilities (Hall, 2008; Hottenrott and Peters, 2012)

- **Access to finance**
  - ✓ External finance plays a significant role in firm-level innovation (Ayyagari et al., 2011; Brown et al., 2012; Fernandez, 2017)
  - ✓ Accessibility to finance is not uniformly available in all economies (Hewa et al., 2019; Lee et al., 2015)
  - ✓ Bank financing has the most significant effect on firm-level innovation compared to non-bank financing (Wellalage and Fernandez, 2019)
  - ✓ Most empirical works show that the access to finance enhances innovation activities (long-term horizon, affordable interest rates, etc.)

# Questions, research hypotheses and contributions

## ❖ Questions

- How credit allocation fluctuations influence the innovation capacity (and related inputs/outputs)?
- How the innovation is impacted by positive and negative shocks is credit activity?
- Has the access to finance the same impact on high- or low-level innovation economies?

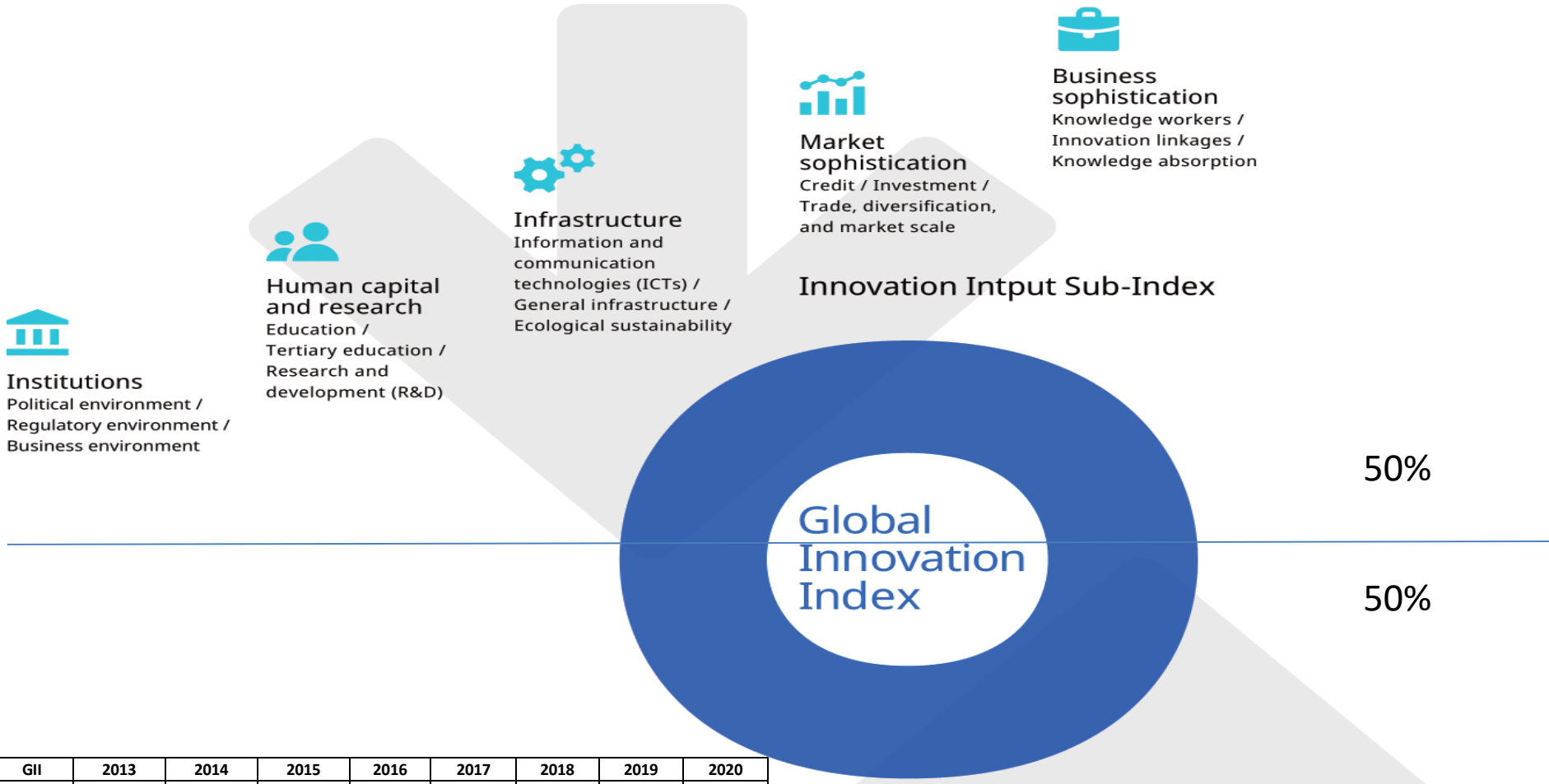
## ❖ Research hypotheses

- H1: The impact of credit activity fluctuations on innovation, can be either positive or negative (depending on the type of innovation – opportunity driven vs necessity driven)
- H2: The response of innovation capacity to credit activity fluctuations is asymmetric, depending on the level of innovation
- H3: The financial shocks have a stronger impact on innovation outputs compared to the innovation inputs

## ❖ Contributions

- Panel data quantile regression for 117 countries, over the period 2013-2020 (WIPO and WB data), bootstrap regression and fixed effect analysis for robustness (Canay, 2011)
- A new approach used for identifying positive and negative shocks in the credit activity (credit to GDP ratio decomposition)

# Global Innovation Index and Sub-Indxes




| GII | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---|---|---|---|---|---|---|---|---|
| MIN | Yemen | Togo | Togo | Yemen | Yemen | Yemen | Yemen | Yemen |
| | 19.3 | 17.6 | 18.4 | 14.6 | 15.6 | 15 | 14.5 | 13.6 |
| MAX | Switzerland | Switzerland | Switzerland | Switzerland | Switzerland | Switzerland | Switzerland | Switzerland |
| | 66.6 | 64.8 | 68.3 | 66.3 | 67.7 | 68.4 | 67.2 | 66.1 |
| Romania | 40.3 | 38.1 | 38.2 | 37.9 | 39.2 | 37.6 | 36.8 | 36 |

Source: Global Innovation Index Database, WIPO, 2022.

# Data and methodology

## ❖ Data

- ➢ Global Innovation Index, Innovation Input Sub-index, Innovation Output Sub-index (WIPO database) – 117 countries with complete data for 2013-2020
- ➢ Credit activity (Domestic credit to private sector- of GDP) (WB database)
- ➢ GDP per capita PPP (international $) in natural log – control
- ➢ 909 observations

## ❖ Methodology

- ➢ Quantile regression panel data models
  - General equation

$$GII_{it} = \alpha_0 + \alpha_1 Credit_{it} + \alpha_2 GDP_{it-1} + \mu_i + \gamma_t + \varepsilon_{it}$$

  - Panel bootstrap regression (Kapetanios, 2008)
  - Fixed effects panel-quantile regression (Canay, 2011) - robustness

- ➢ Credit activity shocks

$Credit_{it}^{+}$ = *IF(*$Credit_{it}$*>AVERAGE(*$Credit_{it-1}$*:*$Credit_{it-4}$*);*$Credit_{it}$*−AVERAGE(*$Credit_{it-1}$*:*$Credit_{it-4}$*);0)*

$Credit_{it}^{-}$ = *IF(*$Credit_{it}$*<AVERAGE(*$Credit_{it-1}$*:*$Credit_{it-4}$*);*$Credit_{it}$*−AVERAGE(*$Credit_{it-1}$*:*$Credit_{it-4}$*);0)*

# Results (1/3)

## ❖ GII and credit activity

➢ Credit activity fluctuations (SD – rolling window t : t-4)

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_SD | 0.0238 | 0.073 | 0.181** | 0.247** | 0.341*** | 0.308*** | 0.226*** | 0.084 | 0.017 | -0.073 |
| GDP | 4.408*** | 5.251*** | 6.645*** | 7.497*** | 7.999*** | 8.270*** | 8.567*** | 8.872*** | 9.149*** | 9.756*** |
| intercept | -16.39*** | -21.53*** | -32.40*** | -38.83*** | -42.18*** | -43.21*** | -43.89*** | -43.67*** | -43.16*** | -43.68*** |

➢ Positive shocks in credit activity

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_PS | -0.092* | -0.056 | -0.070 | -0.094 | -0.035 | -0.075 | -0.044 | 0.016 | -0.045 | -0.036 |
| GDP | 4.885*** | 5.316*** | 6.701*** | 7.705*** | 8.461*** | 8.535*** | 8.824*** | 8.845*** | 9.274*** | 9.735*** |
| intercept | -20.21*** | -21.56*** | -31.98*** | -39.42*** | -45.01*** | -43.86*** | -44.91*** | -42.88*** | -43.99*** | -43.55*** |

➢ Negative shocks in credit activity

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_NS | 0.025* | 0.023 | 0.050 | -0.001 | -0.041 | -0.089** | -0.076** | -0.068** | -0.054** | -0.022 |
| GDP | 4.762*** | 5.360*** | 6.744*** | 7.623*** | 8.424*** | 8.345*** | 8.692*** | 8.798*** | 9.149*** | 9.666*** |
| intercept | -18.88*** | -21.96*** | -32.47*** | -38.95*** | -44.83*** | -42.62*** | -43.71*** | -42.74*** | -43.21*** | -43.14*** |

➢ Hypotheses validation

- ✓ H1 – for middle-level innovation countries, fluctuations in credit activity enhance innovation whereas the negative shocks negatively impact innovation at middle and upper quantiles (mixed findings)
- ✓ H2 – the impact of access to finance on innovation capacity is asymmetric

➢ Robustness checks confirm the results: (i) fixed effects quantile regression, (ii) no. of bootstraps (200 instead of 500)

# Results (2/3)

## ❖ GII inputs and credit activity

### ➢ Credit activity fluctuations (SD – rolling window t : t-4)

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_SD | -0.107 | 0.091 | 0.150** | 0.107* | 0.148** | 0.207*** | 0.129** | -0.050 | -0.061 | -0.001 |
| GDP | 5.688*** | 6.553*** | 7.534*** | 8.007*** | 8.439*** | 8.325*** | 8.590*** | 9.688*** | 10.20*** | 9.704*** |
| intercept | -19.86*** | -26.08*** | -33.13*** | -35.51*** | -38.47*** | -36.33*** | -37.03*** | -43.90*** | -45.49*** | -37.05*** |

### ➢ Positive shocks in credit activity

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_PS | -0.054 | -0.163*** | -0.237*** | -0.192** | -0.090 | -0.029 | 0.024 | -0.002 | 0.022 | -0.000 |
| GDP | 5.525*** | 6.833*** | 7.852*** | 8.331*** | 8.503*** | 8.500** | 8.895*** | 9.525*** | 10.19*** | 9.703*** |
| intercept | -18.52*** | -27.51*** | -34.79*** | -37.57*** | -38.20*** | -36.80*** | -39.13*** | -42.81*** | -45.64 | -37.05*** |

### ➢ Negative shocks in credit activity

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_NS | -0.004 | 0.007 | 0.035 | -0.012 | -0.023*** | -0.038*** | -0.056 | -0.035 | -0.010 | 0.002 |
| GDP | 5.365*** | 6.650*** | 7.674*** | 8.049*** | 8.539*** | 8.423*** | 8.590*** | 9.386*** | 10.18*** | 9.705*** |
| intercept | -17.24*** | -26.60*** | -33.78*** | -35.43*** | -38.87*** | -36.34*** | -36.53*** | -41.79*** | -45.54*** | -37.06*** |

### ➢ Hypotheses validation

- ✓ H1 – for middle-level innovation countries, fluctuations in credit activity enhance innovation inputs
- ✓ H1 - Positive shocks negatively impact innovation at lower quantile whereas the negative shocks negatively impact innovation at middle and upper quantiles (mixed findings)
- ✓ H2 – the impact of access to finance on innovation capacity is asymmetric

### ➢ Robustness checks confirm the results: (i) fixed effects quantile regression, (ii) no. of bootstraps (200 instead of 500)

# Results (3/3)

## ❖ GII outputs and credit activity

➢ Credit activity fluctuations (SD – rolling window t : t-4)

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_SD | 0.091 | 0.117 | 0.0217** | 0.312** | 0.399*** | 0.319*** | 0.279*** | 0.172** | 0.131 | 0.074 |
| GDP | 4.344*** | 5.096*** | 6.168*** | 7.243*** | 7.607*** | 7.506*** | 7.810*** | 8.307*** | 8.815*** | 9.327*** |
| intercept | -25.53*** | -29.03*** | -36.60*** | -44.15*** | -46.13*** | -42.90*** | -43.23*** | -44.98*** | -46.41** | -44.99*** |

➢ Positive shocks in credit activity

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_PS | -0.089 | -0.085 | -0.083 | -0.108 | -0.038 | -0.058 | -0.071 | -0.091 | -0.030 | 0.170 |
| GDP | 4.199*** | 5.198*** | 6.483*** | 7.660*** | 8.222*** | 8.077*** | 8.476*** | 8.729*** | 9.033*** | 9.674*** |
| intercept | -23.74*** | -29.44*** | -38.34*** | -46.61*** | -50.11*** | -46.25*** | -47.77*** | -47.94*** | -47.57*** | -48.21*** |

➢ Negative shocks in credit activity

| quantiles | lower quantiles | | | middle quantiles | | | | upper quantiles | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **0.05** | **0.15** | **0.25** | **0.35** | **0.45** | **0.55** | **0.65** | **0.75** | **0.85** | **0.95** |
| Credit_NS | 0.039* | 0.041 | 0.050 | -0.016 | -0.047 | -0.113** | -0.106*** | -0.087*** | -0.090*** | -0.051** |
| GDP | 4.468*** | 5.184*** | 6.605*** | 7.677*** | 8.140*** | 7.987*** | 8.085*** | 8.589*** | 8.778*** | 9.147*** |
| intercept | -26.16*** | -29.25*** | -39.58*** | -47.15*** | -49.56*** | -46.00*** | -44.85*** | -47.26*** | -45.90*** | -43.47*** |

➢ Hypotheses validation

- ✓ H1 – for middle-level innovation countries, fluctuations in credit activity enhance innovation inputs; negative shocks negatively impact innovation at middle and upper quantiles (mixed findings)
- ✓ H2 – the impact of access to finance on innovation capacity is asymmetric
- ✓ H3 – the impact of credit activity is higher on innovation outputs compared with innovation inputs

➢ Robustness checks confirm the results: (i) fixed effects quantile regression, (ii) no. of bootstraps (200 instead of 500)

# Conclusions

## ❖ Summary of results

- Credit activity volatility positively impact the national innovation capabilities for middle-level innovative countries
- No clear impact of positive shocks in credit activity
- Negative in credit activity shocks have a negative impact on innovation in middle- and upper-level innovative countries
- The negative effect is stronger in the case of innovation outputs compared with innovation inputs

## ❖ Results' interpretation and policy implications

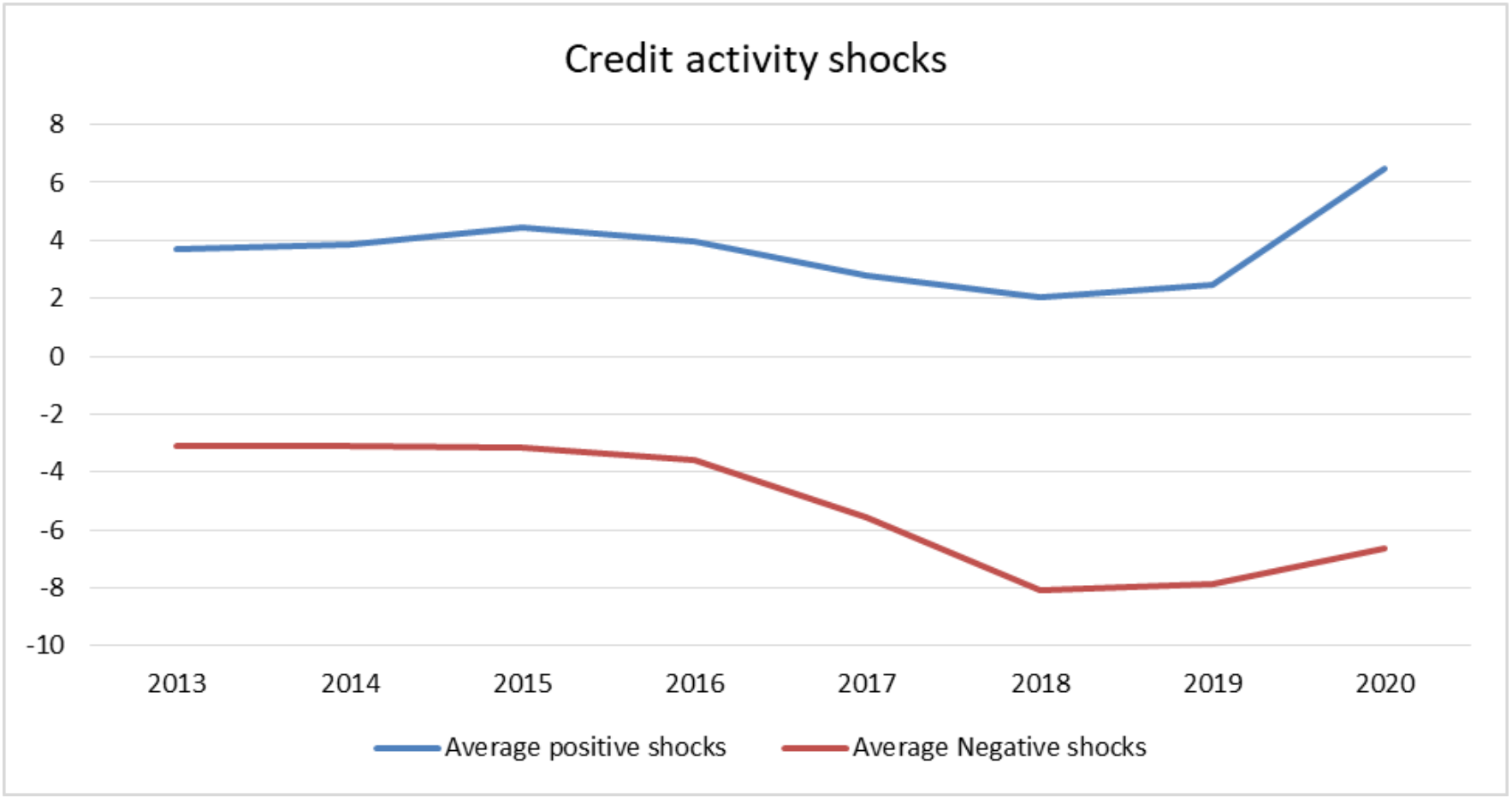
- Credit fluctuations generates an increased uncertainty regarding the access to finance for middle-level innovative countries; in this context, the innovation activities intensify in order to identify new profit sources, to prevent profit decreases in the context of credit tightening, etc.
- No significant effect of the access to finance on innovation in the low-level innovative countries (less developed financial systems, the access to external financing sources is reduced)
- For middle- and upper-level innovative countries it is important to avoid negative shocks in credit activity (a credit crunch negatively impact knowledge and technology outputs, as well as creative inputs).

# Smart Diaspora 2023

**10 - 13 Aprilie 2023, Timișoara**

## Thank you for your attention!

# Appendix A


Credit activity shocks
8
6
4
2
0
-2
-4
-6
-8
-10
2013
2014
2015
2016
2017
2018
2019
2020
Average positive shocks
Average Negative shocks

# Appendix B

## ➢ Summary statistics

| Variables | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| GII | 37.05 | 11.77 | 13.60 | 68.40 |
| GII_IN | 44.32 | 11.95 | 19.90 | 74.20 |
| GII_OUT | 29.77 | 12.45 | 6.400 | 68.60 |
| CREDIT_SD | 4.811 | 5.206 | 0.127 | 56.21 |
| CREDIT_PS | 3.706 | 6.038 | 0.000 | 53.55 |
| CREDIT_NS | -5.156 | 16.47 | -170.3 | 0.000 |
| GDP_CAP | 9.618 | 1.100 | 6.957 | 12.00 |

## ➢ Panel unit root tests

| | Fisher-type panel unit root tests | | | Levin, Lin & Chu |
|---|---|---|---|---|
| Tests | W-stat | ADF | PP | t* |
| GII | 4.922 | 148.9 | 235.7 | -8.236*** |
| GII_IN | -0.035 | 239.4 | 371.3*** | -9.559*** |
| GII_OUT | 4.848 | 169.0 | 282.4** | -2.227** |
| CREDIT_SD | -8.767*** | 442.2*** | 222.8 | -49.37*** |
| CREDIT_PS | -3.206*** | 239.3*** | 167.2 | -10.96*** |
| CREDIT_NS | -3.210*** | 191.2*** | 114.1 | -27.89*** |
| GDP_CAP | 7.946 | 141.3 | 169.1 | -0.730 |