Climate and Energy Finance Group (CEFGroup)

University of Otago Te Whare Wānanga o Otāgo New Zealand

Business School Te Kura Pakihi

Expand or Avoid?
Microfinance Credit Risk and Climate Vulnerability

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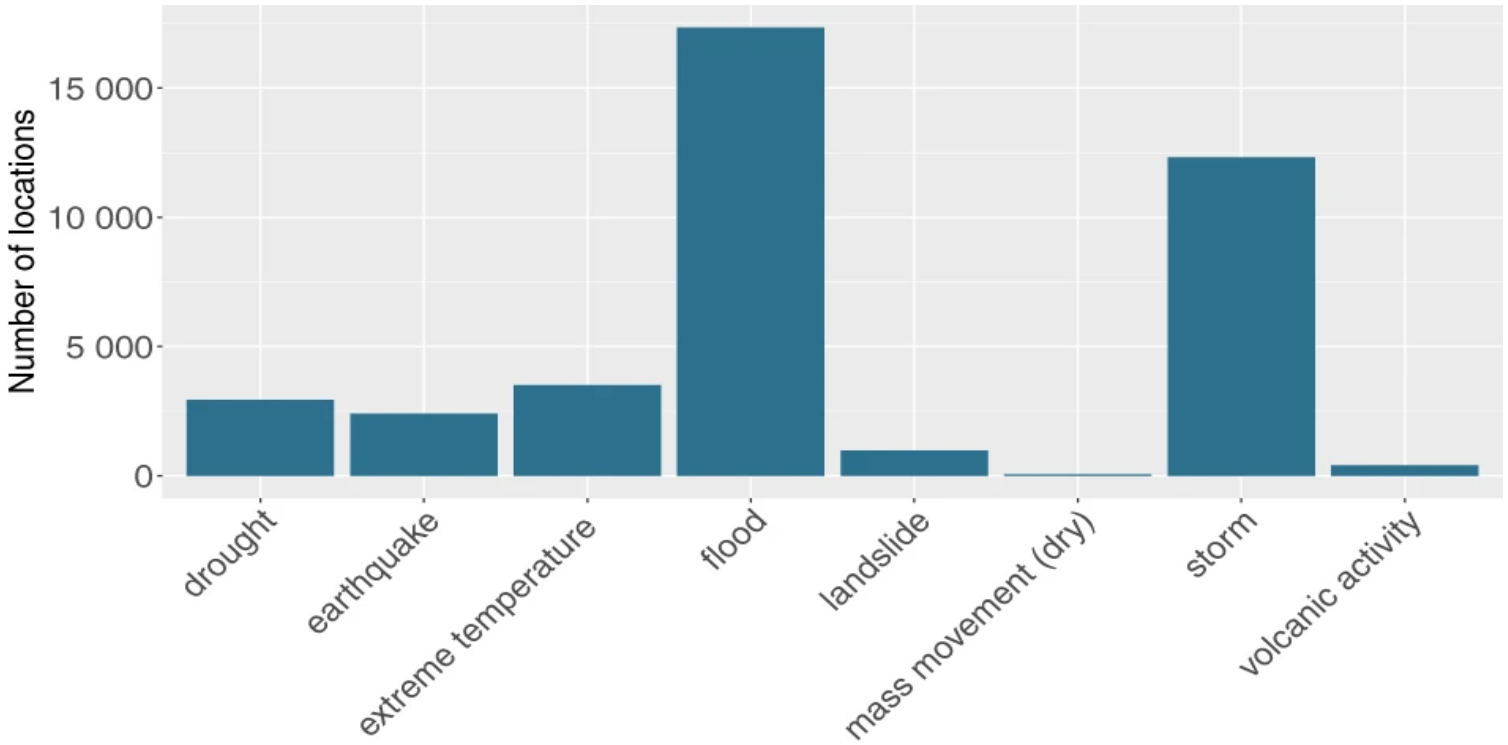
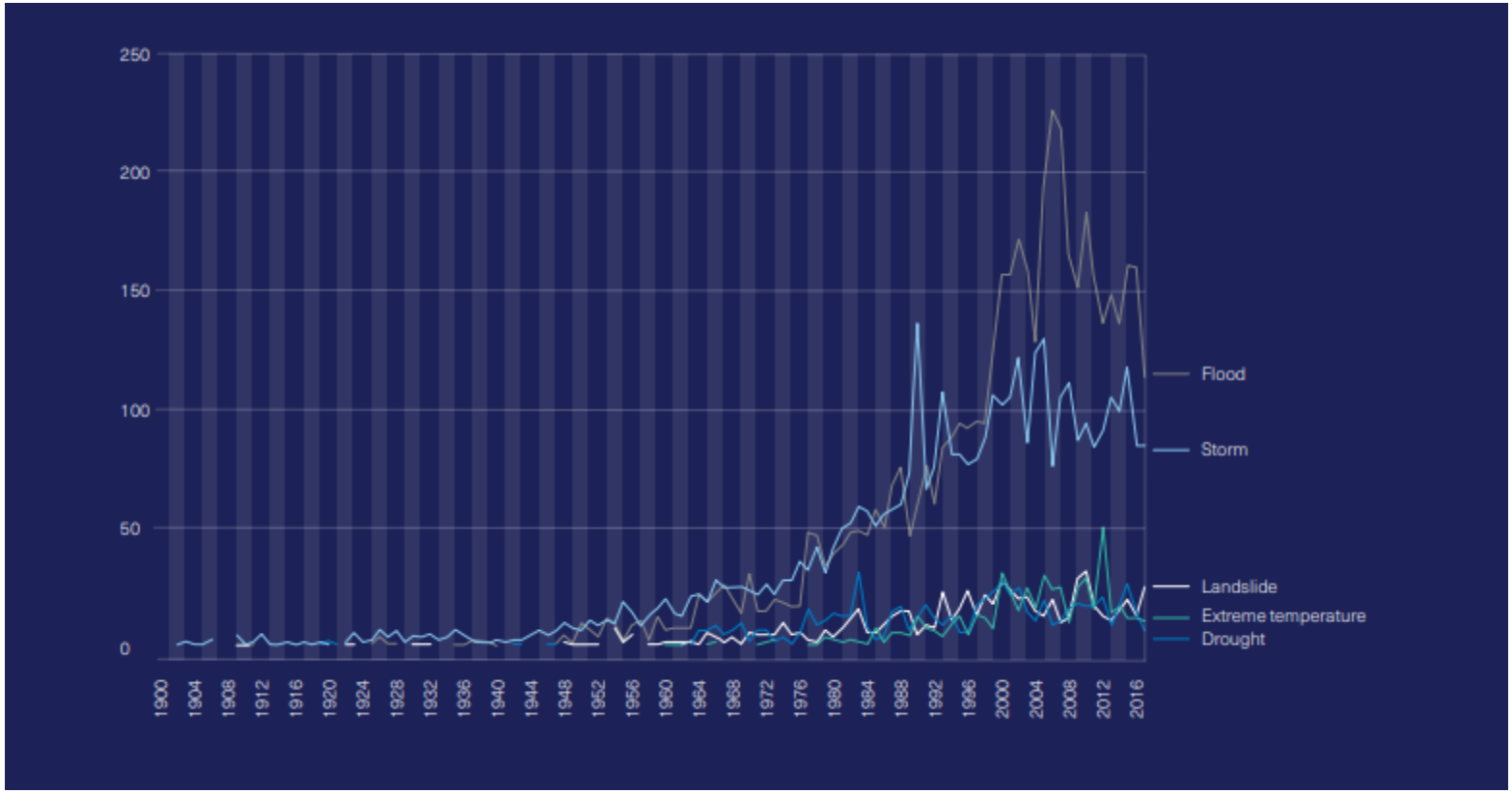
Number of anthropogenic climate change events
1960 – 2018



Source: Rosvold and Buhaug (2021)

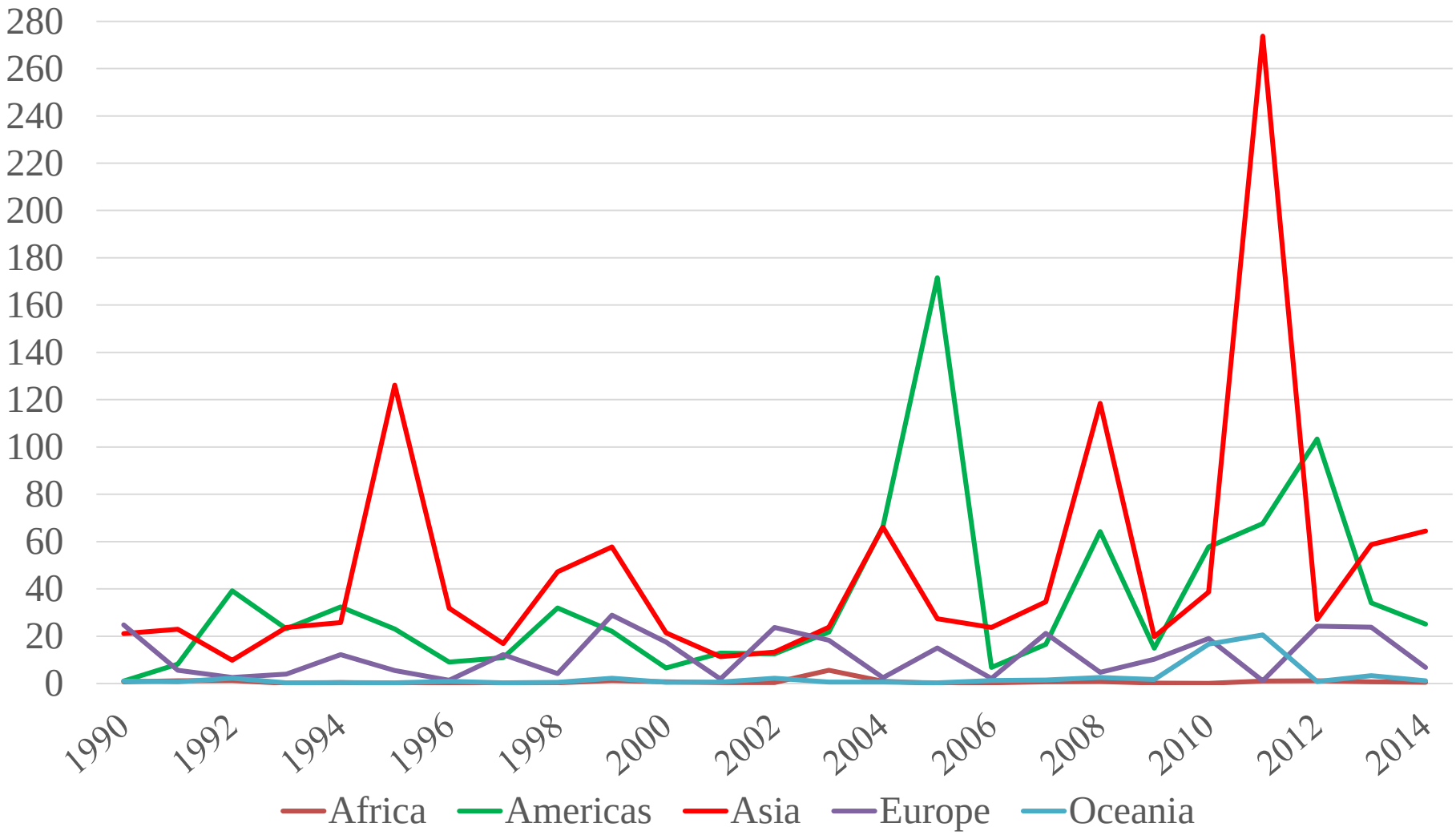
Number of weather-related catastrophes
1900 – 2017



Source: Buhr et al. (2018)

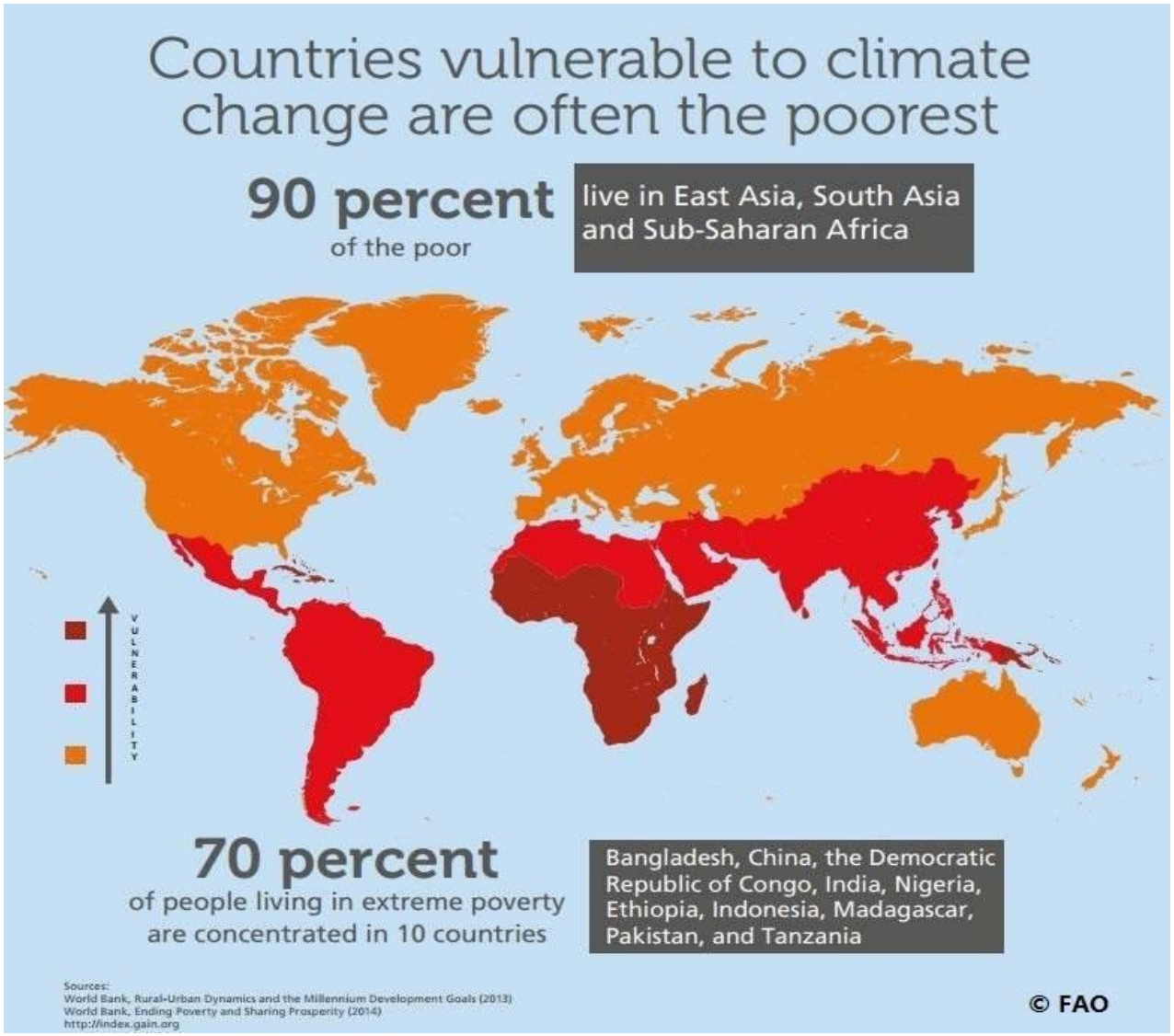
Economic Damage of Disasters (U$b)

1990 – 2014

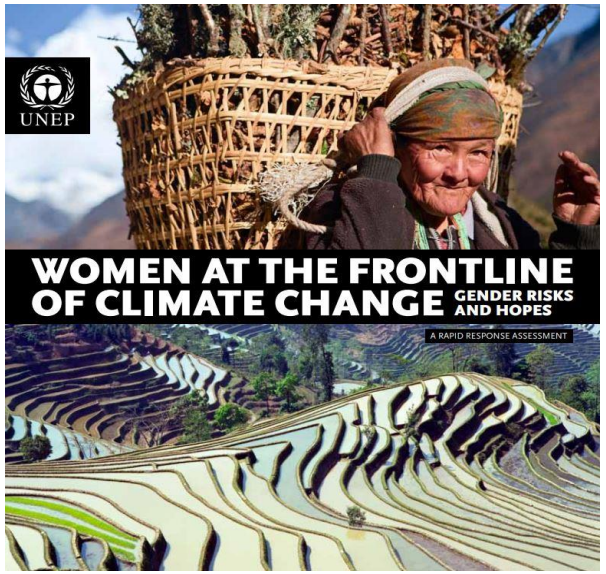


Source: Nguyen, Diaz-Rainey, Roberts, and Le, (2021)

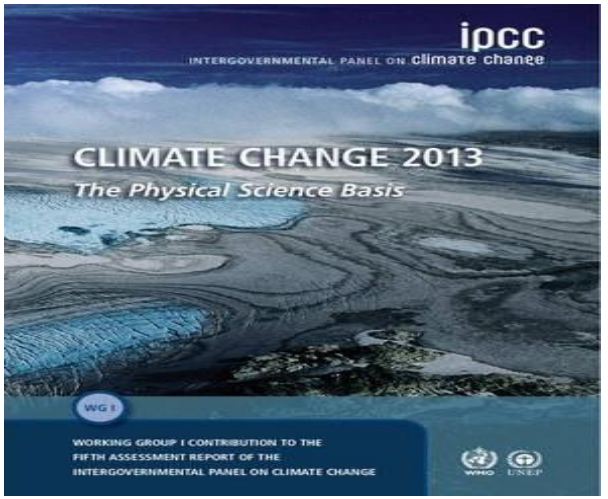
Most Climate Vulnerable Regions



Source: FAO (2017)



Source: UNEP (2011)

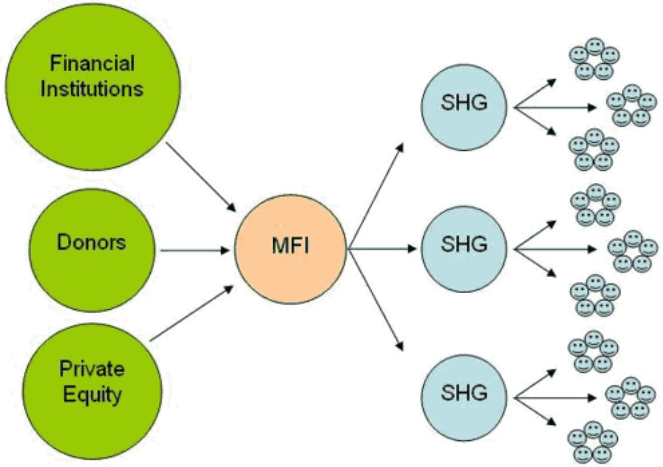


Source: IPCC (2013)

Research Background – cont.

Unique characteristics of MFI's operations:

- Poor, precisely to women (*Grameen's women borrower* **>96%**).
- Collateral free loan –relatively small scale.
- Group lending –an innovative lending approach.
- **Remote engagement** –geographically, and mostly in rural locations.
- Create social impact –alleviate poverty, promote wellbeing of the poor.



MFI's Geographic Expansion in Bangladesh

Source: Microcredit Regulatory Authority (2020)

Research Motivation

UNIVERSITY of OTAGO
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The initial alarm rang by the **UNEP Financial Initiatives** (2001) on *"banking in the wake of large-scale natural catastrophes"*.

Academics started looking into the issues in **banking research**;

Natural disasters: default risk, (Collier et al., 2011; Collier & Skees, 2012), stability (Klomp, 2014), non-performing assets (Noth & Schuwer, 2018), deposit withdrawal (Brei et al., 2019), Nguyen, Diaz-Rainey, Roberts, and Le, (2020).

Climate risk: bank leverage (Dafermos et al., 2018), bank lending (Faiella & Natoli, 2019), financial risk (Caselli & Figueira, 2020).

Klomp (2018) suggested that natural disaster have **positive impact** on overall **microfinance risk**.

Research Motivation – cont.

Geographic diversification-bank risk relationship is driven by two key theories.

- **Portfolio theory** suggests bank's geographic diversification may reduce variation in earning, **which lower its risk**, and enhance efficiency through economies of scale (Bandelj, 2016; Chu et al., 2020; Goetz et al., 2013; 2016).

- **Agency theory** suggests bank's geographic expansion may **increase agency costs** to monitor larger territory, lower loan quality and elevate fragility (Berger & Ofek, 1995; Denis et al., 1997; Deng & Elyasiani, 2008; Fang & Lelyveld, 2014; Liang & Rhoades, 1988).

The empirical evidences of **these views have yielded mixed results**.

Research Questions and Hypotheses

Q1: How does climate vulnerability affect credit risk in microfinance?
H1: Climate vulnerability is associated with an increase in microfinance credit risk.

Q2: How does geographic expansion impact on credit risk in microfinance?
H2a. Geographic expansion is associated with an increase in microfinance credit risk.
H2b. Geographic expansion is associated with a decrease in microfinance credit risk.

Q3: How does climate vulnerability moderate the geographic diversification-credit risk relationship?
H3: Climate vulnerability moderates the consequences of geographic expansion on microfinance credit risk.

Contributions

Q1: How does climate vulnerability affect credit risk in microfinance?
The findings are addition to the *Klomp (2018)* study, but from the climate vulnerability aspect, as well as and a cross-country panel evidence which confirm single country findings by *Möllmann et al., (2020)* and *Pelka et al., (2015)*.

Q2. How does geographic diversification impact on credit risk in microfinance?
There are handful of studies analysed the geographic diversification-microfinance risk relationship, except *Zamore et al. (2019)*.

Geographic expansion-microfinance profitability relationship, i.e. Alimukhamedova et al., (2016) and Chikalipah (2019).

Q3: How does climate vulnerability moderate the geographic diversification-credit risk relationship?
To the best of our knowledge, we present the initial systematic evidences of how climate vulnerability moderate the consequence of geographic diversification on microfinance credit risk.
This adds to claims by *Johnson et al. (2019)*, and *Khan and Rabbani (2015)* on MFIs are less accessible in climate prone area.

Data and Sample

Data:
Unbalanced sample of 2,591 MFIs from 119 countries for the period of 1999-2019.

MFI-related data –**Microfinance Information eXchange**.
Governance Index –**Kaufmann *et al.* (2010).**
Macroeconomic data –**World Development Indicators**.

Climate-related data:
- Notre Dame Global Adaptation Index **(ND-GAIN)** –Notre Dame Environmental Change Initiative, University of Notre Dame (Kling et al., 2018; 2021).

- Emergency Events Database (**EM-DAT**), Centre for Research on the Epidemiology of Disasters (CRED), Université Catholique de Louvain (Nguyen et al., 2020; Noy, 2009).

Estimation Method

Dynamic Panel Model

$$Risk_{ijt} = \gamma_i + \delta_t + \mu Risk_{ijt-1} + \beta_k MFI^k_{ijt} + \beta_m MACRO^m_{jt} + \emptyset CVUL_{jt} + \varepsilon_{ijt}$$

System-GMM estimator to deal with:

- Presence of fixed effect (γ_i) and lagged dependent variable ($Risk_{ijt-1}$).
- Endogenous variables (simultaneity with $Risk_{ijt-1}$): MFI^k_{ijt} ; e.g. GEX.

*Durbin- Wu- Hausman (DWH) test for endogeneity.

Validity tests:

AR(2) test for the second-order autocorrelation.

Hansen J-statistics test the over-identification test and instruments validity.

Difference-in-Hansen tests validity of each subset of instruments.

Estimation Method – cont.

$$Risk_{ijt} = \gamma_i + \delta_t + \mu Risk_{ijt-1} + \beta_k MFI^k_{ijt} + \beta_m MACRO^m_{jt} + \emptyset CVUL_{jt} + \varepsilon_{ijt}$$

Credit Risk

LLP = Loan-loss provisions

PaR30 = Portfolio at risk <30 days

WOR = Write-off ratio

CCR = Composite credit risk (PaR30+WOR)

zCCR = Z-score of CCR

MFI-level variables

GEX = Number of branches

SIZE = Log of total assets

EC = Equity capital

GROUP = Group lending method

OWNERSHIP = Shareholder owned

MATURE = >8yrs older MFIs

INCDIV = Income diversification

Macroeconomic variables

WGI = World governance index

GDP_c = GDP per capita

GDP_g = GDP growth rate

Climate vulnerability measure

Notre Dame Global Adaptation Index

DAMAGE = Total economic loss caused by all disasters each year to the country prior year GDP (%)

Summary Statistics

Variables	N	Mean	Std. Dev.	Min	Max
Dependent variables					
LLP	12,770	7.64	388.22	-141.95	44,525.34
PaR30	15,042	7.35	15.20	0.00	711.43
WOR	3,454	2.48	23.48	-12.68	2,571.14
CCR	12,397	9.53	26.87	-2.86	2571.14
zCCR	3,454	0.00	1.00	-0.46	95.35
Independent variables					
CVUL	14,935	42.77	6.42	27.04	67.70
GEX	12,528	49.04	188.01	1.00	5,000.00
IVE	12,436	-68.50	1046.32	-30235.10	7204.41
IVES	11,504	7.09	491.64	-7604.41	12759.10
DAMAGE	9,936	17.40	2.781452	8.01	23.03
IDE	8,268	1058.50	3948.021	8.01	62,842.90
MFI-level controls					
SIZE	14,602	15.53	2.28	1.95	29.00
EC	14,581	0.34	1.21	-18.35	156.12
IND	3,409	-1,583.24	9064.14	-78,864.77	0.98
GROUP	15,042	0.11	0.32	0.00	1.00
SHO	13,938	0.46	0.50	0.00	1.00
MATURE	4,693	0.66	0.48	0.00	1.00
Country-level controls					
IQI	13,146	-3.30	2.63	-12.62	9.21
GDPc	15,000	7.192.87	6,283.11	630.68	62,526.94
GDPg	14,946	5.08	3.74	-46.08	54.16
CRISIS	15,042	0.14	0.35	0.00	1.00
Regional dummies					
AFRICA	15,031	0.28	0.45	0.00	1.00
EAP	15,031	0.16	0.37	0.00	1.00
EECA	15,031	0.17	0.38	0.00	1.00
LAC	15,031	0.20	0.40	0.00	1.00
MENA	15,031	0.03	0.16	0.00	1.00
SA	15,031	0.16	0.37	0.00	1.00

Study variables:

PaR30: Portfolio at risk <30 days
LLP: Loan-loss provisions
CCR: Composite credit risk
Z-score: Z-score of CCR
WOR: Write-off ratio

CVUL: Climate vulnerability
GEX: Geographic expansion
IVE: Interaction (CVUL*GEX)
IVES: Interaction (CVUL*GEX*SHO)
DAMAGE: The ratio of the total economic loss to the country prior year GDP
IDE: Interaction (DAMAGE*GEX)

SIZE: Natural log of total assets
EC: Equity capital
IND: Income diversification
GROUP: Group lending method
SHO: Shareholder firm
MATURE: >8yrs older MFIs

IQI: Institutional quality index
GDP_{CAPITA}: GDP per capita
GDP_{GROWTH} : GDP growth rate
CRISIS: Financial crisis 2007-2009

REGION (Africa, East-Asia and Pacific, Latin America and Caribbean, Middle-east and North Africa, and South Asia)

Results – Dynamic Models

	(1)	(2)	(3)	(4)	(5)
	LLP	PaR30	WOR	CCR	zCCR
Lagged dep. (y_{t-1})	0.081***	0.485***	0.569***	0.337***	0.337***
	(0.006)	(0.022)	(0.018)	(0.024)	(0.024)
CVUL	0.533***	0.081	0.064	0.360	0.013
	(0.090)	(0.157)	(0.065)	(0.188)	(0.007)
GEX	0.044***	0.014***	-0.001	0.036***	0.001***
	(0.006)	(0.002)	(0.003)	(0.007)	(0.000)
IVE	-0.001***	-0.000***	-0.000	-0.001***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control variables	YES	YES	YES	YES	YES
Fixed effects *i*, *t*	YES	YES	YES	YES	YES
Number of MFIs	626	632	576	615	615
Number of IV	138	139	137	139	139
AR(2) test (p-value)	0.704	0.290	0.294	0.349	0.349
Hansen-J test (p-value)	0.302	0.752	0.530	0.887	0.887
Difference-in-Hansen (p-value)	0.440	0.626	0.828	0.481	0.481

Results – Ownership Effects

	(1)	(1)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Panel A: Shareholder-owned MFI					**Panel B: Non-shareholder-owned MFI**				
	LLP	PaR30	WOR	CCR	zCCR	LLP	PaR30	WOR	CCR	zCCR
Lagged dep. (y_{t-1})	0.357***	0.653***	0.522***	0.546***	0.546***	0.011	0.711***	0.527***	0.503***	0.503***
	(0.066)	(0.041)	(0.057)	(0.128)	(0.128)	(0.008)	(0.050)	(0.023)	(0.133)	(0.133)
CVUL	-0.201	0.329	-0.199	0.429	0.016	1.139***	-1.308***	0.373*	0.170	0.006
	(0.164)	(0.247)	(0.166)	(0.842)	(0.031)	(0.336)	(0.436)	(0.196)	(1.010)	(0.038)
GEX	-0.024***	-0.044***	-0.028	0.069	0.003	0.015*	-0.021	0.012**	-0.019	-0.001
	(0.005)	(0.003)	(0.017)	(0.074)	(0.003)	(0.009)	(0.015)	(0.005)	(0.015)	(0.001)
IVE	0.001***	0.001***	0.001	-0.001	-0.000	-0.000	0.001	-0.000**	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control variables	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Fixed effects i, t	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Number of MFIs	339	352	321	342	342	309	304	277	287	287
Number of IV	74	74	74	74	74	74	74	74	74	74
AR(2) test (p-value)	0.164	0.303	0.637	0.343	0.343	0.232	0.356	0.259	0.872	0.872
Hansen test (p-value)	0.731	0.447	0.454	0.260	0.260	0.980	0.665	0.859	0.374	0.374
Difference-in-Hansen (p-value)	0.768	0.337	0.446	0.171	0.171	0.851	0.566	0.772	0.258	0.258
Wald Chi^2 (p-value)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Results – Ownership Effects – cont.

	(1)	(2)	(3)	(4)	(5)
	LLP	PaR30	WOR	CCR	zCCR
Lagged dep. (y_{t-1})	0.066***	0.495***	0.560***	0.337***	0.337***
	(0.007)	(0.021)	(0.017)	(0.023)	(0.023)
CVUL	-0.073**	0.184*	-0.111***	-0.124	-0.005
	(0.029)	(0.095)	(0.041)	(0.182)	(0.007)
GEX	-0.009***	0.013***	-0.000	-0.011	-0.000
	(0.002)	(0.002)	(0.004)	(0.008)	(0.000)
IVE	0.000***	-0.000***	-0.000	0.000**	0.000**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
IVES	-0.000***	-0.000	0.000	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Control variables	YES	YES	YES	YES	YES
Fixed effects *i*, *t*	YES	YES	YES	YES	YES
Number of MFIs	626	632	576	615	615
Number of IV	136	137	135	137	137
AR(2) test (p-value)	0.773	0.287	0.305	0.355	0.355
Hansen-J test (p-value)	0.225	0.677	0.500	0.676	0.676
Difference-in-Hansen (p-value)	0.421	0.565	0.789	0.360	0.360

Robustness Tests – cont.

	(1)	(2)	(3)
	LLP	PaR30	WOR
Lagged dep. (y_{t-1})	0.055	0.286***	0.433***
	(0.033)	(0.016)	(0.020)
DAMAGE	0.273***	0.135***	0.233***
	(0.022)	(0.029)	(0.015)
GEX	0.001	0.005***	0.002***
	(0.001)	(0.001)	(0.001)
IDE	-0.070***	-0.040***	-0.002***
	(0.000)	(0.000)	(0.000)
Control variables	YES	YES	YES
Fixed effects *i*, *t*	YES	YES	YES
Number of MFIs	268	277	242
Number of IV	122	123	118
AR(2) test (p-value)	0.311	0.356	0.318
Hansen test (p-value)	0.774	0.867	0.734
Difference-in-Hansen (p-value)	0.792	0.760	0.306

Conclusion

WHAT: Empirical analysis on the effects of climate vulnerability and geographic expansion on credit risk of microfinance loan portfolio.

Key findings:
(i) Climate vulnerability and geographic expansion **increase credit risk** in MFI loan portfolio.

(ii) The **risk is more pronounced** for non-shareholder-owned MFIs compared to shareholder-owned MFIs.

(iii) In addition, we report evidence that **climate vulnerability moderates** the consequences of geographic expansion on microfinance credit risk.

These evidences are **in-line** with the propositions of **agency theory**.

Policy implication: The key policy implication of this study is, MFI should include the **climate risk and exposure** of a specific MFI to exogenous climatic shocks in their risk assessment and expansion strategy.

THANK YOU!

Expand or Avoid?
Microfinance Credit Risk and Climate Vulnerability

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