Climate Disasters, Innovation, and Productivity in Africa

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This presentation is based on the personal views of the presenter and does not necessarily represent the views of Cairo University.

Background

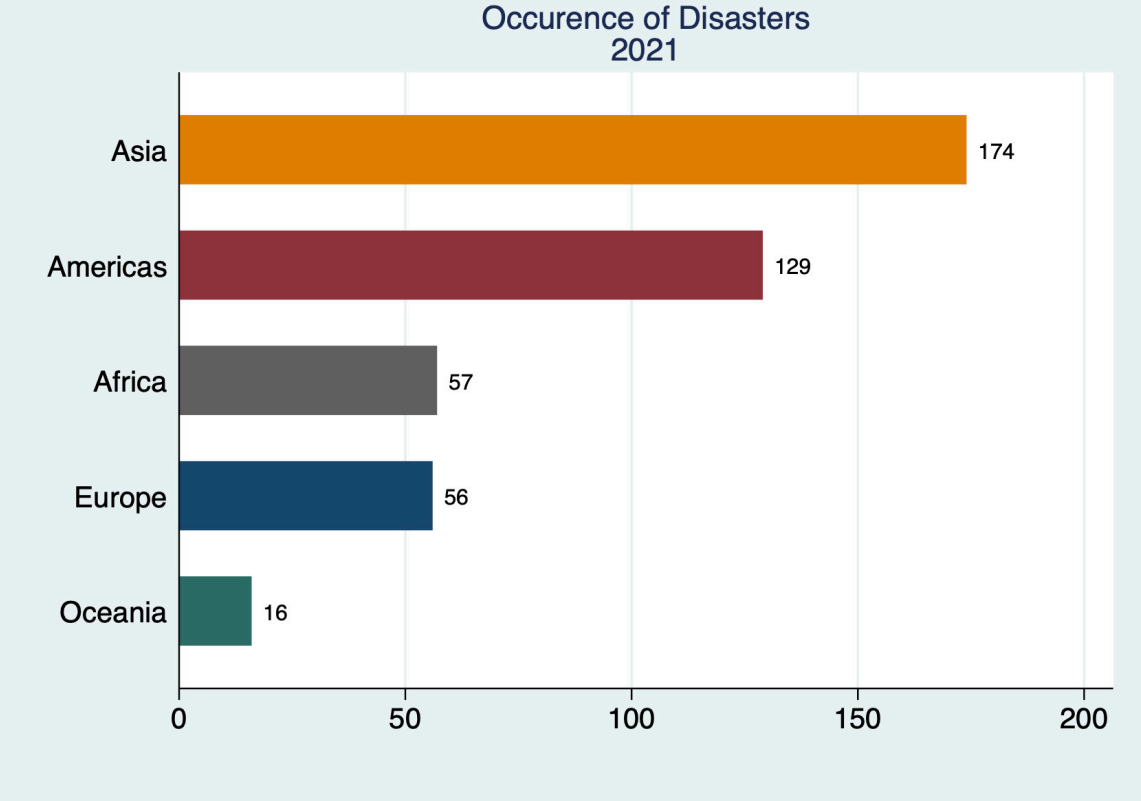
- Africa is the most vulnerable region to climate change effects despite its low contribution to greenhouse gas emissions.
- Evidence on the impact of climate disasters on firm performance in Africa is limited if not inexistent.
- This gap in the literature hampers the design of disaster risk reduction and climate change adaptation strategies for the business sector.

Existing Work

- Evidence on disaster impacts is divided into:
  - Direct impacts: e.g., property losses
  - Indirect economic impacts: e.g., effects on economic growth
- Direct impacts are relatively well understood.
- Evidence on economic growth impacts of natural disasters is more uncertain:
  - Inconclusive: failure to fully account for the differences in disaster types, locations, economic and financial development, institutional quality, time periods, disaster cost definitions, etc.
  - Macro: mostly obtained from highly aggregated macroeconomic data at the country or regional levels

Motivation: Some Worrying Figures!

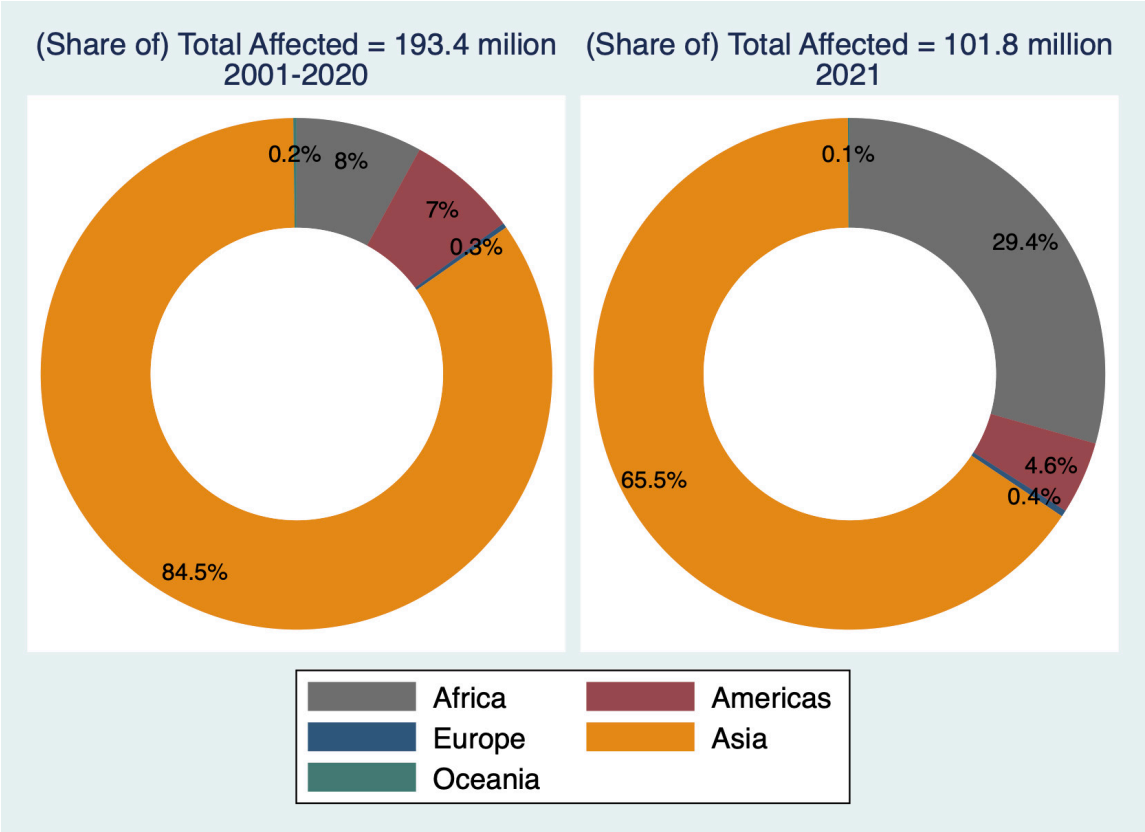
Occurrence of Natural Disasters
2021



Source: Author's calculations based on EM-DAT data.

Motivation: And Even More Worrying!

Share of Total Affected by Natural Disasters
2001-2021



Source: Author's calculations based on EM-DAT data.

This Study

Objectives:

- Estimate the impact of climate disasters on firm-level innovation and productivity in Africa
- Allow for heterogeneous effects of climate disasters over several respects: disaster compound, firm size, etc.

Contribution:

- Conceptually, extend the literature on the determinants of firm-level innovation and productivity to incorporate climate disasters as exogenous shocks
- Methodologically, our estimation strategy of the CDM model attenuates potential endogeneity concerns, especially that arising from OVB, by including a "latent" variable to reflect the effect of unobserved factors underlying the relationships b/w R&D, innovation output, and productivity

Generalized Structural Equation Model

We use the CDM model—developed by Crépon et al. (1998)—to integrate the links between R&D, innovation output, and productivity in a recursive framework.

We extend this framework by including in the three stages of the analysis the effect of climate disasters as exogenous shocks.

1. **R&D spending:**

$$\Pr(RD_i = 1 \mid X_{i,RD}) = \Phi(\alpha_o + \boldsymbol{Z}_{i,RD}\alpha_Z + \alpha_D D_{i,RD} + \boldsymbol{L_i})$$

2. **Innovation output:**

$$\Pr(IO_i = j \mid \kappa, X_{i,IO}) = \Psi(\kappa_{j-1} < \beta_o + \beta_{RD} RD_i + \boldsymbol{Z}_{i,IO}\beta_Z + \beta_D D_{i,IO} + \beta_L \boldsymbol{L_i} + \varepsilon_{i,IO} \leq \kappa_j)$$

3. **Productivity:**

$$P_i = \gamma_o + \gamma_{IO} IO_i + \boldsymbol{Z}_{i,P}\gamma_Z + \gamma_D D_{i,P} + \gamma_L \boldsymbol{L_i} + \varepsilon_{i,P}$$

Data: Description

- **Data sources:**
  - R&D, innovation output, and productivity: microdata from the World Bank Enterprise Survey
  - Climate disasters: the Emergency Events Database (EM-DAT) by the Centre for Research on the Epidemiology of Disasters (CRED)
- **Sample coverage:** 47 African countries
- **Sample size:** 22,547 firms
- **Working sample:** 15,533 firms in the manufacturing sector
- **Time framework:** 2006-2021

Data: Variables

Key explanatory:

Climate disaster

- Occurrence
- Compound disasters
- Affected population

Dependent 1: **R&D** (dummy: spending=1)

- Market share
- Diversification
- Demand pull (export, int'l market)
- Technology push (foreign tech, ICT)
- Credit (gov support, access to finance)

Dependent 2: **Innovation output** (ordinal: process & product innovations)

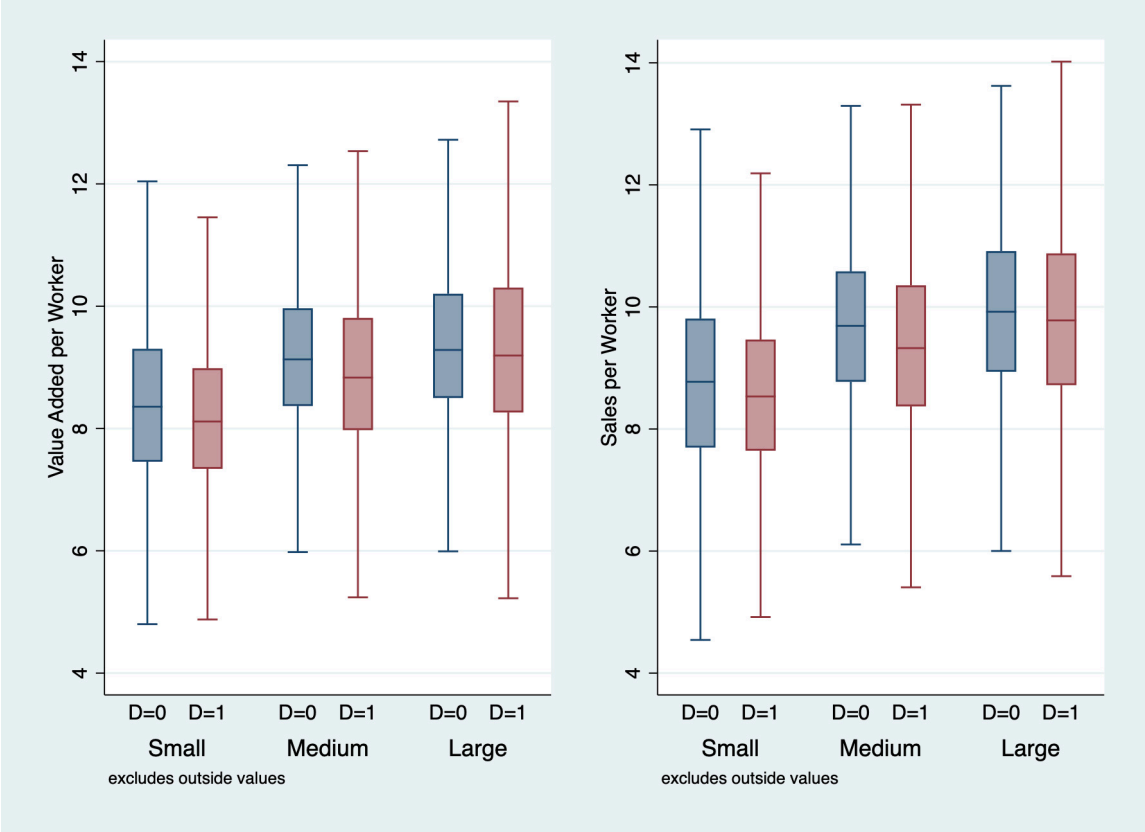
- **R&D**
- Demand pull (export, int'l market)
- Technology push (foreign tech, ICT)

Dependent 3: **Productivity** (value added per worker, sales per worker)

- **Innovation**
- Labor
- Skill composition
- Physical capital
- Energy intensity

Descriptive Analysis

Productivity by Climate Disaster Occurrence by Firm Size
2006-2020



Source: Author's calculations based on Enterprise Survey and EM-DAT data.

Results: GSEM Estimation of the R&D Spending Equation

Dependent Variable: **R&D**

Specification	(1)		(2)		(3)	
Climate disaster						
Occurrence	-0.040	(0.222)				
Compound disasters			0.055	(0.181)		
Affected population					0.078	(6.931)
Labor	0.291***	(0.037)	0.299***	(0.036)	0.298***	(0.039)
Age	-0.027	(0.053)	-0.041	(0.053)	-0.022	(0.057)
Market share						
Monopolistic competition	0.325**	(0.141)	0.372***	(0.140)	0.303**	(0.148)
Oligopoly	0.353***	(0.092)	0.395***	(0.091)	0.299***	(0.098)
Monopoly	-0.208	(0.330)	-0.223	(0.327)	-0.264	(0.357)
Diversification	0.005**	(0.002)	0.005**	(0.002)	0.005**	(0.002)
Demand pull						
Export orientation	0.009***	(0.003)	0.008***	(0.003)	0.011***	(0.003)
International competition	-0.319	(1.148)	-0.328	(1.149)	-0.583	(1.151)
Technology push						
Foreign technology	0.535***	(0.109)	0.564***	(0.109)	0.580***	(0.114)
ICT						
Adoption=1	0.581***	(0.118)	0.592***	(0.116)	0.557***	(0.124)
Adoption=2	0.996***	(0.123)	1.007***	(0.120)	0.989***	(0.128)
Credit						
Public support	0.009*	(0.005)	0.008	(0.005)	0.010*	(0.006)
Access to finance	0.598***	(0.096)	0.587***	(0.095)	0.675***	(0.099)
Latent variable (L)	1.000	(Constr'd)	1.000	(Constr'd)	1.000	(Constr'd)
Constant	-3.274***	(0.654)	-2.802***	(0.275)	-4.669***	(0.630)
Industry dummies	Yes		No		Yes	
Country dummies	Yes		Yes		Yes	
Observations	9,061		9,061		8,625	

Results: GSEM Estimation of the Innovation Output Equation

Dependent Variable: **Innovation Output**

Specification	(1)		(2)		(3)	
Climate disaster						
Occurrence	-0.311***	(0.027)				
Compound disasters			-0.347***	(0.022)		
Affected population					-9.290***	(0.827)
R&D spending	0.642***	(0.039)	0.646***	(0.039)	0.618***	(0.040)
Labor	0.010	(0.007)	0.007	(0.007)	0.006	(0.007)
Age	0.012	(0.010)	0.017*	(0.009)	0.010	(0.010)
Demand pull						
Export orientation	-0.000	(0.000)	-0.000	(0.000)	0.000	(0.001)
International competition	-0.039	(0.039)	-0.035	(0.038)	-0.042	(0.040)
Technology push						
Foreign technology	0.168***	(0.024)	0.168***	(0.024)	0.179***	(0.024)
ICT						
Adoption=1	0.143***	(0.022)	0.140***	(0.022)	0.145***	(0.023)
Adoption=2	0.231***	(0.022)	0.225***	(0.022)	0.237***	(0.023)
Latent variable (L)	-0.092*	(0.050)	-0.091*	(0.050)	-0.137***	(0.052)
Constant	0.818***	(0.079)	0.766***	(0.049)	0.293***	(0.076)
Industry dummies	Yes		No		Yes	
Country dummies	Yes		Yes		Yes	
Observations	9,061		9,061		8,625	

Results: GSEM Estimation of the Productivity Equation

Dependent Variable: **Value Added Per Worker**

Specification	(1)		(2)		(3)	
Climate disaster						
Occurrence	-0.156*	(0.085)				
Compound disasters			-0.175***	(0.064)		
Affected population					-4.414*	(2.591)
Innovation output	0.072**	(0.034)	0.076**	(0.035)	0.084**	(0.038)
Labor	0.093***	(0.017)	0.081***	(0.017)	0.081***	(0.017)
Labor quality	0.001	(0.001)	-0.000	(0.001)	0.000	(0.001)
Age	0.018	(0.025)	0.017	(0.024)	0.015	(0.024)
Capital intensity	0.318***	(0.013)	0.329***	(0.012)	0.318***	(0.013)
Energy intensity	-0.157***	(0.014)	-0.154***	(0.013)	-0.158***	(0.014)
Latent variable (L)	0.217***	(0.063)	0.224***	(0.064)	0.234***	(0.061)
Constant	7.195***	(0.268)	7.254***	(0.197)	7.156***	(0.253)
Industry dummies	Yes		No		Yes	
Country dummies	Yes		Yes		Yes	
Observations	9,061		9,061		8,625	

Results: GSEM Estimation of the Productivity Equation

Dependent Variable: **Sales Per Worker**

Specification	(1)		(2)		(3)	
Climate disaster						
Occurrence	-0.259***	(0.082)				
Compound disasters			-0.227***	(0.063)		
Affected population					-7.580***	(2.527)
Innovation output	0.098***	(0.033)	0.104***	(0.033)	0.110***	(0.036)
Labor	0.107***	(0.016)	0.095***	(0.016)	0.096***	(0.016)
Labor quality	-0.000	(0.001)	-0.001	(0.001)	-0.000	(0.001)
Age	0.010	(0.024)	0.014	(0.024)	0.007	(0.024)
Capital intensity	0.322***	(0.013)	0.337***	(0.013)	0.321***	(0.013)
Energy intensity	-0.184***	(0.012)	-0.182***	(0.012)	-0.185***	(0.012)
Latent variable (L)	0.206***	(0.060)	0.210***	(0.061)	0.225***	(0.058)
Constant	7.769***	(0.275)	7.779***	(0.197)	7.669***	(0.261)
Industry dummies	Yes		No		Yes	
Country dummies	Yes		Yes		Yes	
Observations	9,061		9,061		8,625	

Conclusions

- The occurrence and severity of climate disasters decrease the firm's likelihood of introducing process and product innovations and firm's productivity in Africa.
  - A climate disaster decreases firm productivity by about 16%.
  - A compound disaster decreases firm productivity by about 18%.
- The probability of engaging in R&D for a firm increases with its market share (but not to the extent of a monopoly), diversification, with the demand pull and technology push factors, and access to credit.
- The firm innovation output increases with its R&D spending and with the technology push factors, either directly or indirectly through their effects on R&D.
- Firm productivity increases with a higher innovation output, even when controlling with the skill composition of labor and for physical capital intensity. Energy inefficiency decreases firm productivity.

Thank you.

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