



How Climate Change is Shaping Global FDI Flows

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AUSTRALIAN TRADE AND INVESTMENT COMMISSION

"conversation about the weather is the last refuge of the unimaginative"

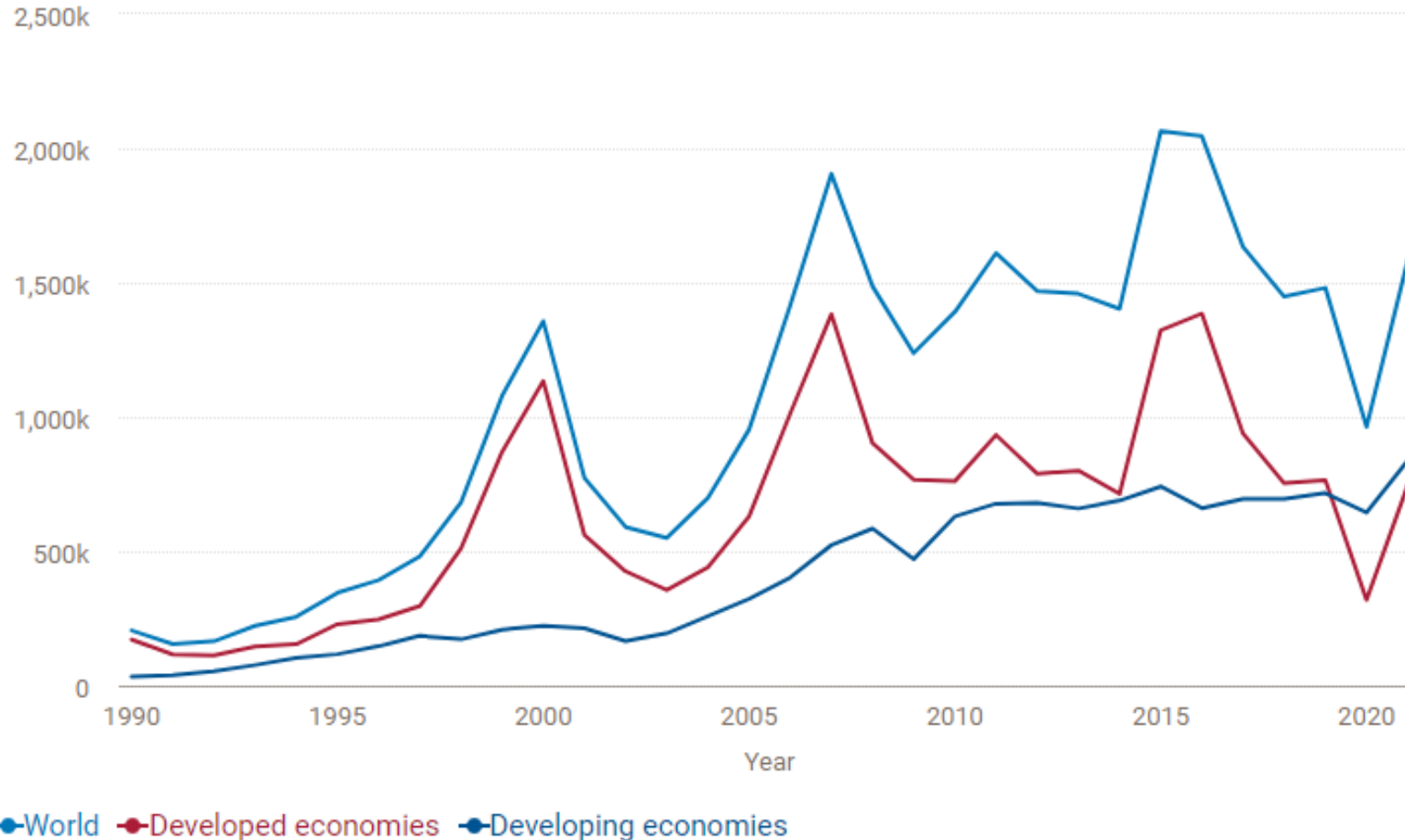
Introduction

Climate change and FDI

FDI as a tool for economic development

Global FDI flows by economic status 1990-2021

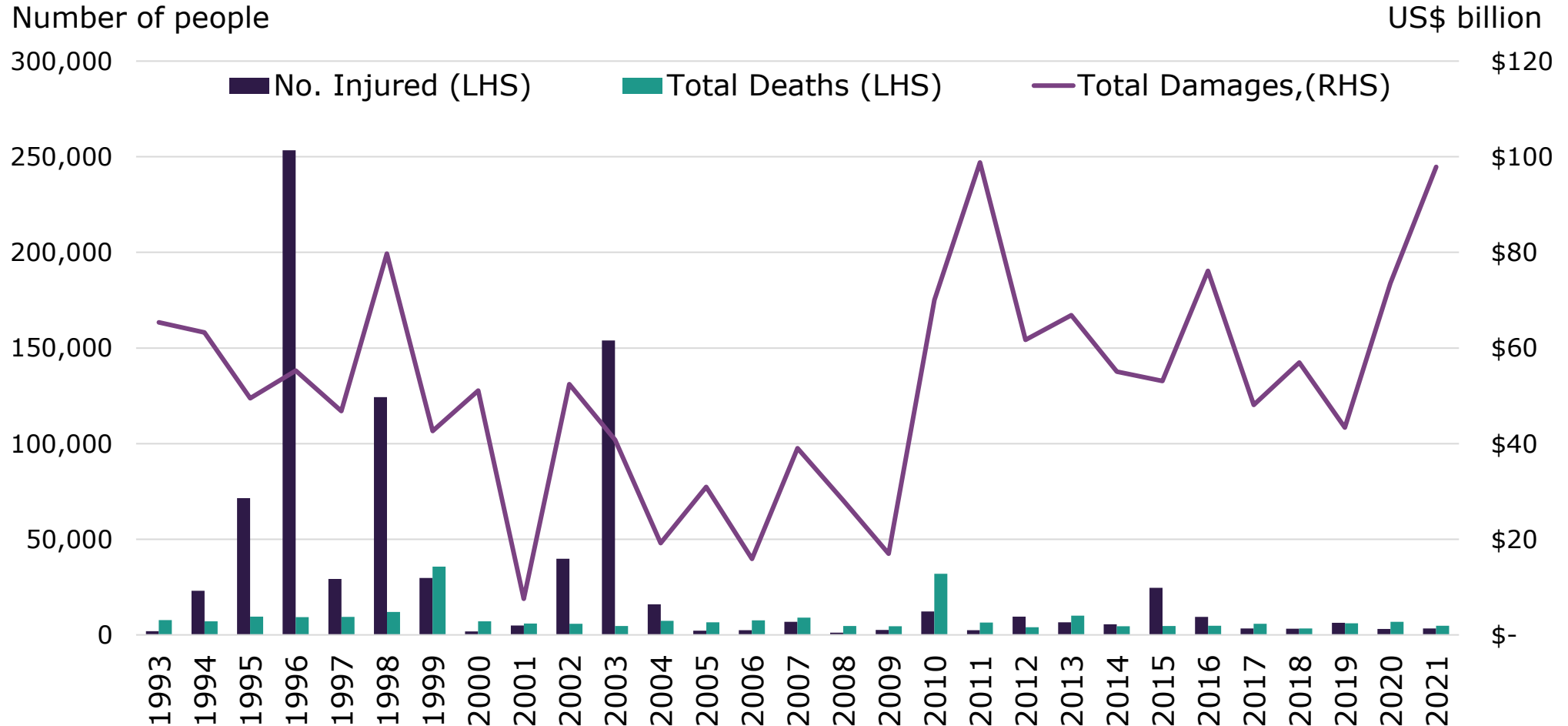
US\$ million



Source: UNCTAD World Investment Report 2022

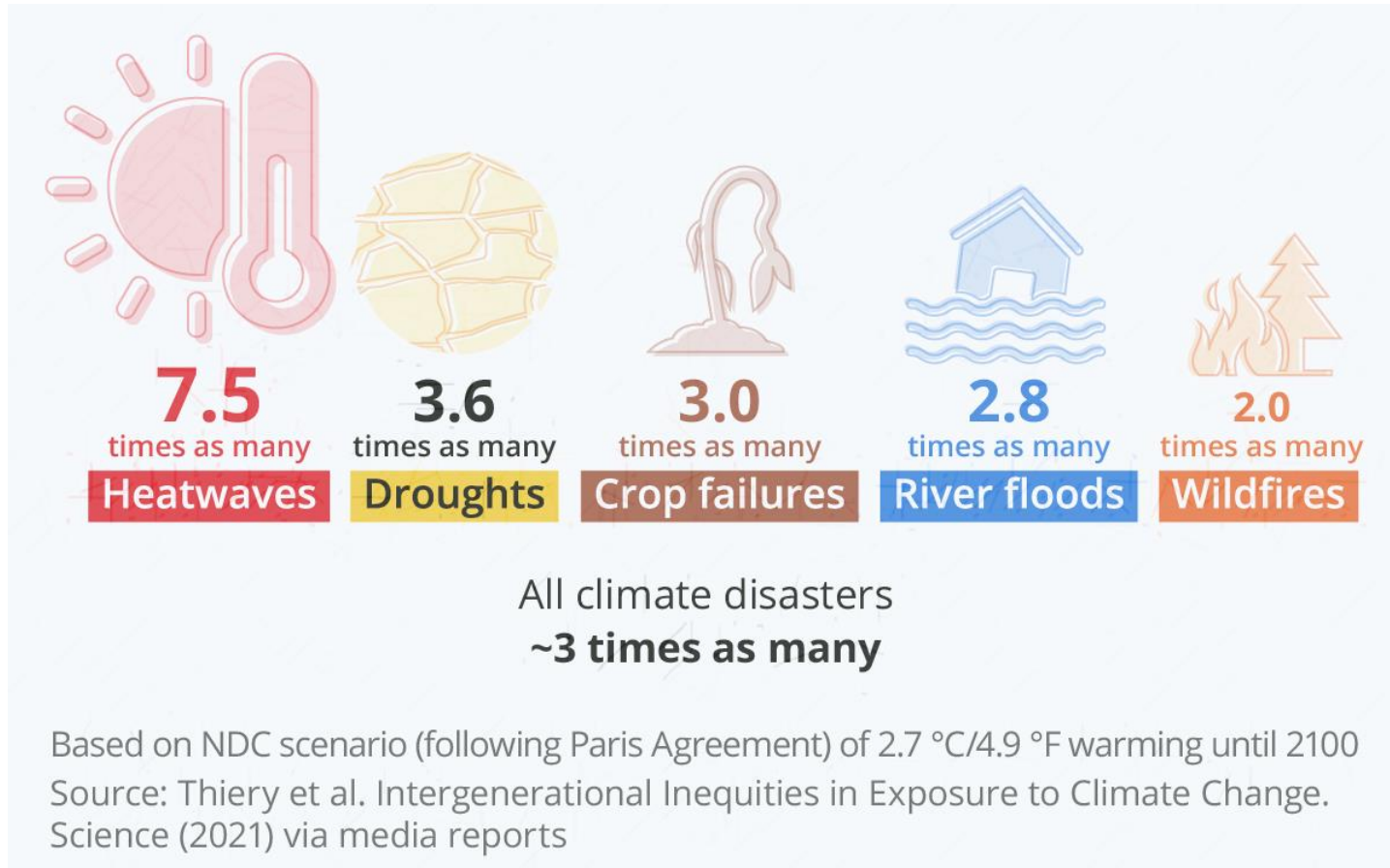
Increased costs of natural disasters

Climatological & Hydrological Natural Disasters 1993-2021



Source: EM-DAT (2022); Austrade Economics

Climate disasters experienced in a lifetime for a person born in **2020** compared to one born in **1960**

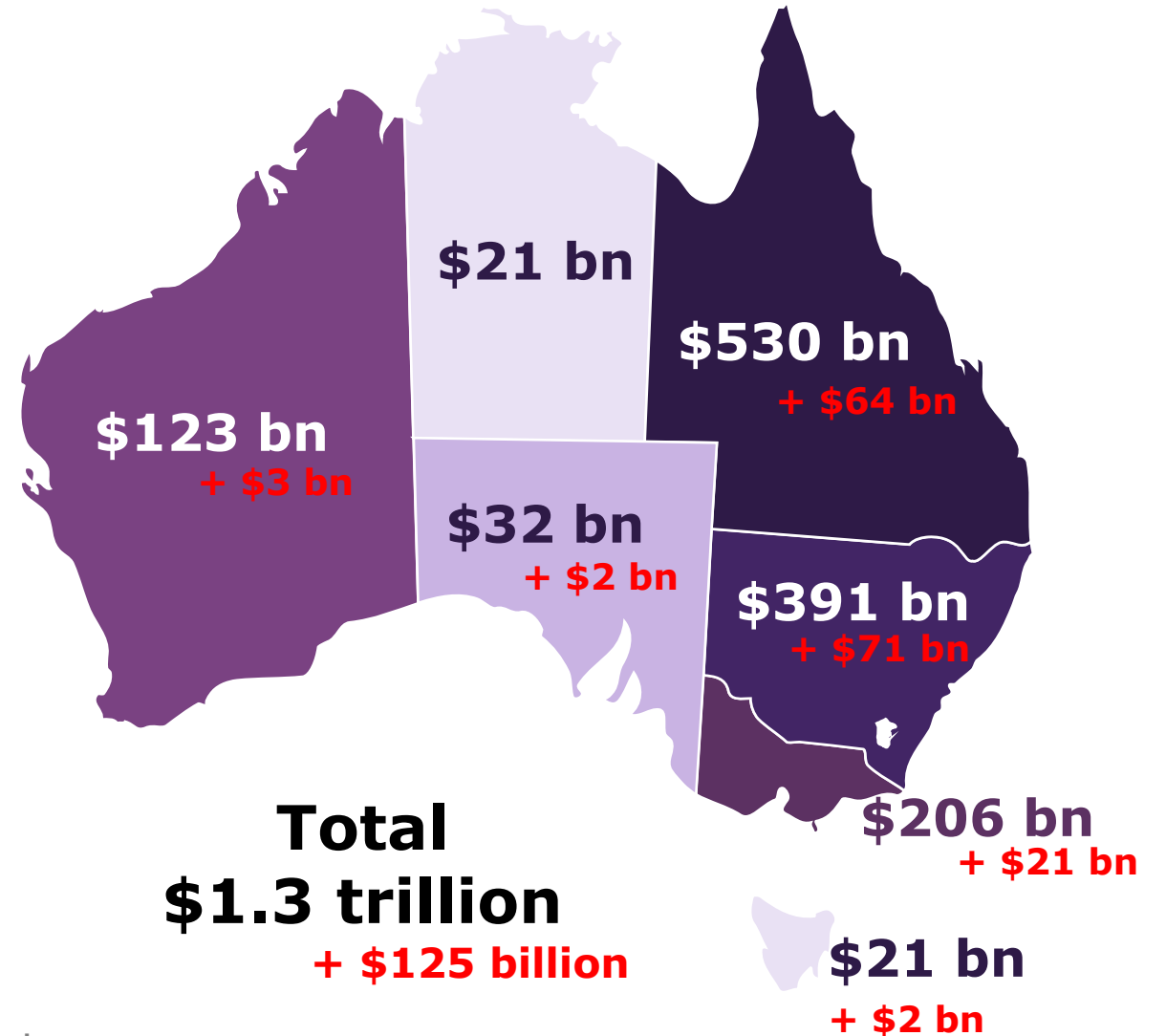
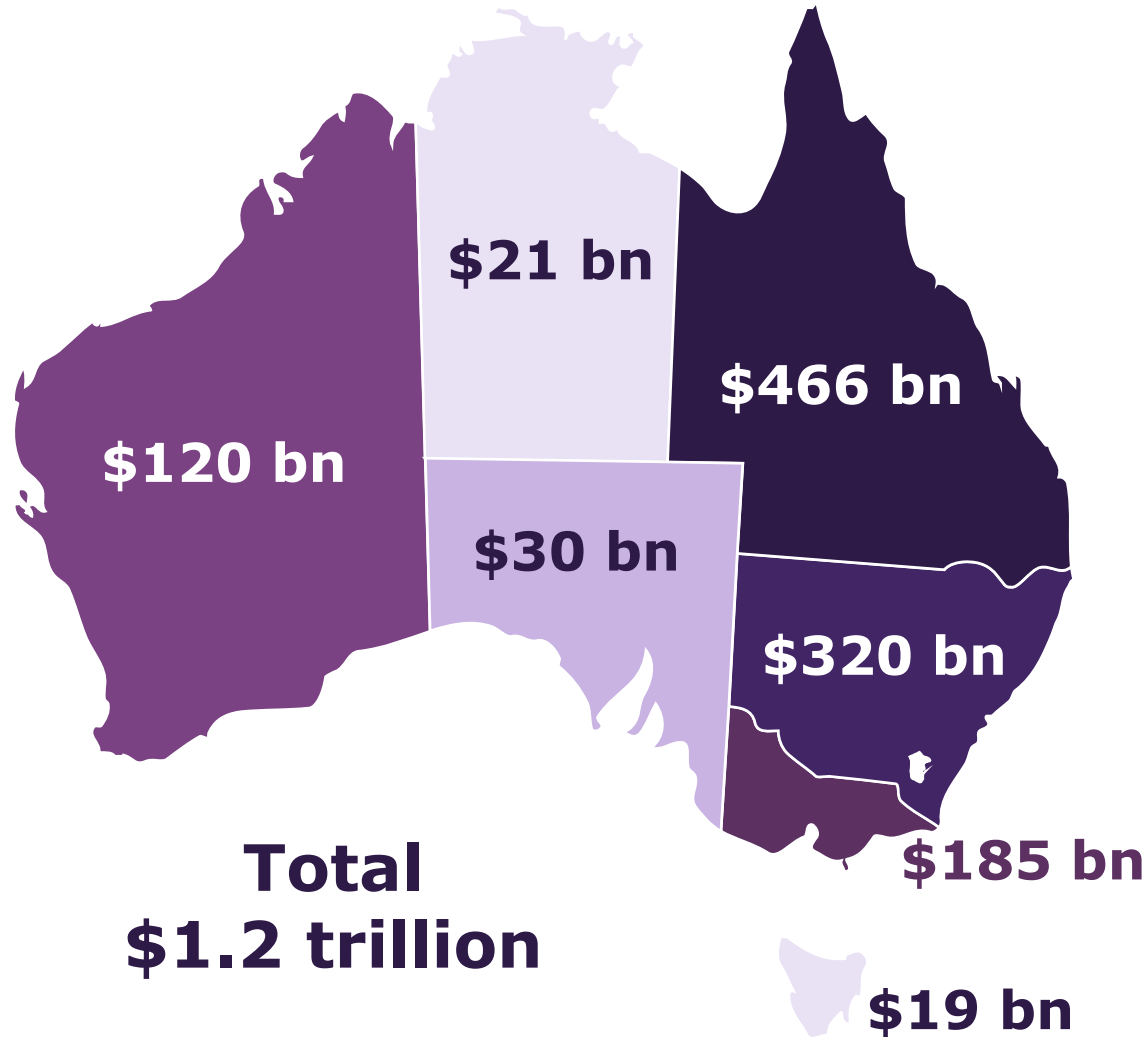


Estimated total economic costs of natural disasters

Cumulative cost between 2020-2060 by state and territory

Low emissions scenario

High emissions scenario



Sources: Deloitte Access Economics (2021); Austrade Economics

How climate change is relevant to investment decisions

Climate change is increasing the severity and frequency of extreme weather events

+ glacial melts and sea level-rise

Impacts on business activities and operations in country

Floods

Extreme temperatures

Drought

Wildfire

Cyclones

Earthquakes & related disasters (landslides/tsunamis)



Damaged infrastructure
factories, roads, schools, office buildings

Decreased mobility
slowing productivity and labour shortages

Decreased arable land
temporary or long-term

Commodity shortages & associated price rises
temporary or long-term

Decreased business and consumer confidence
temporary or long-term

FDI decisions and climate risk

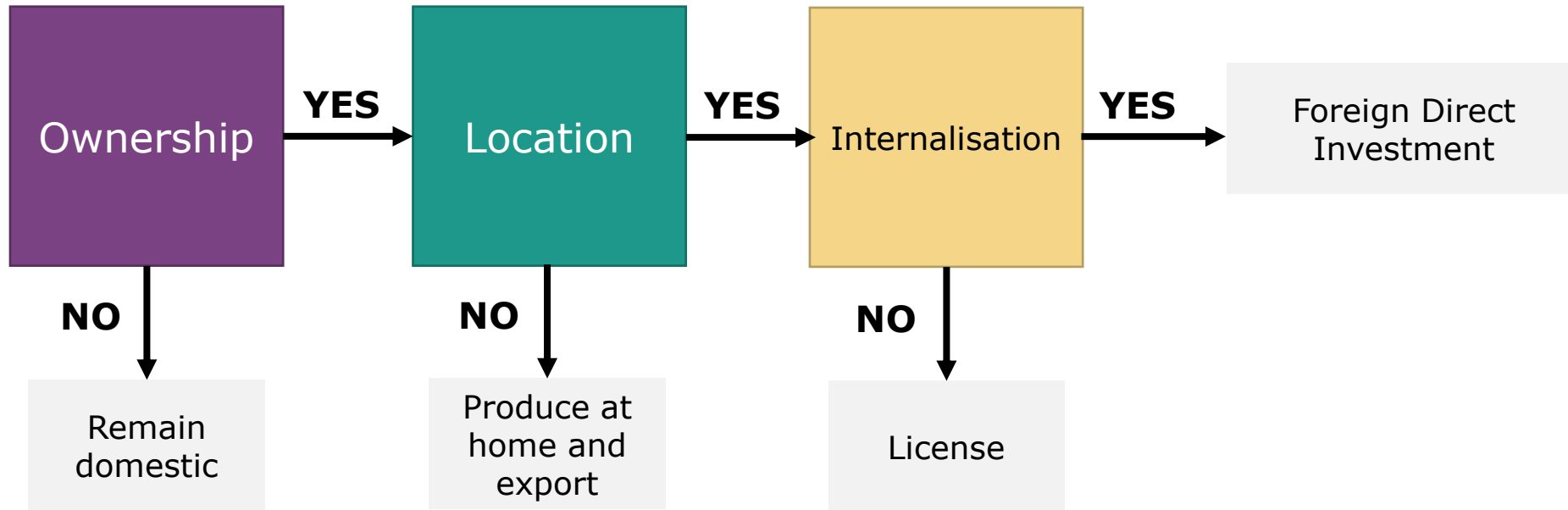
| Local facilities | Overseas facilities |
|------------------|---------------------|
| Heat stress | Heat stress |
| Water stress | Water stress |
| Floods | Floods |
| Sea level rise | Sea level rise |
| Cyclones | Cyclones |

(Li & Gallagher 2022)

Integrating climate risks into FDI location decisions

OLI FDI decision framework

Does the company have an advantage?

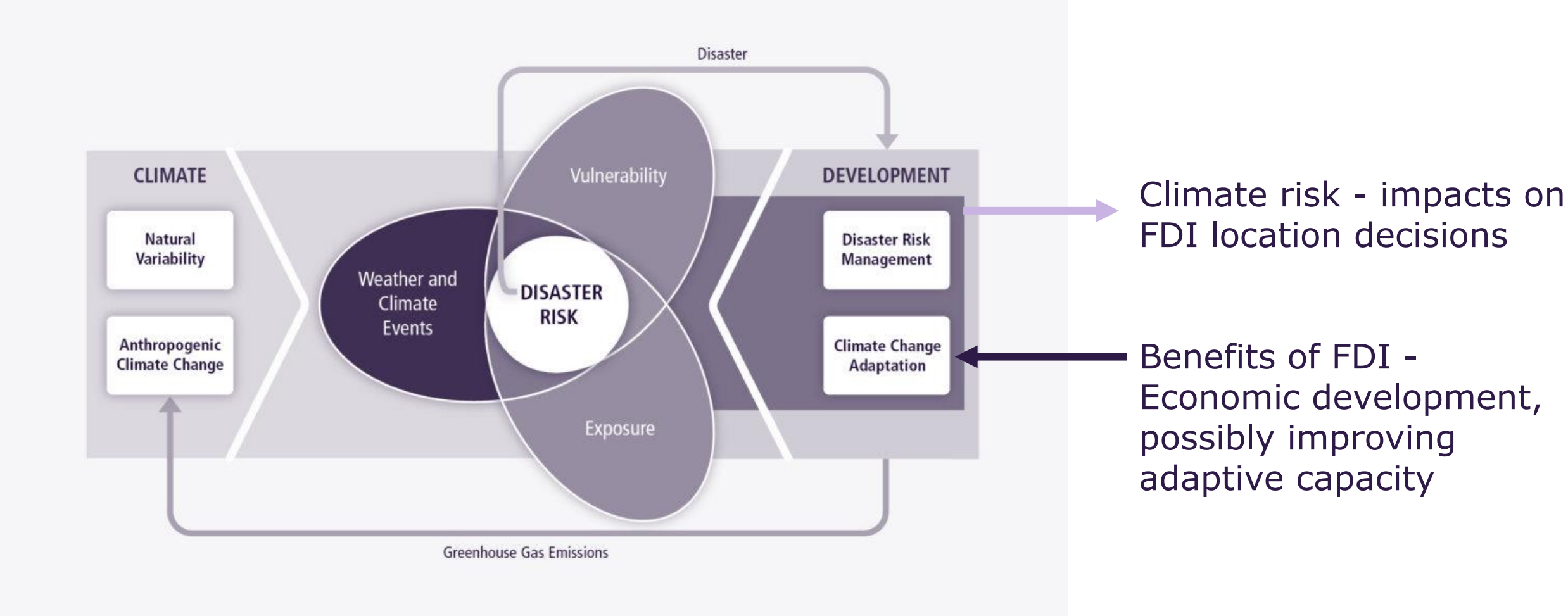


(Dunning 1988)

Summary of Existing Discourse

| Article | Finding/s | | Period | Cross-sections | FDI data source | Climate/ Disaster/ Environment data source |
|--|---|----|------------------------|----------------------|---------------------------|--|
| Cashin, P et al 2006 | Increased investment as a tool for disaster recovery in the Caribbean | — | 1970-2002 | 6 (Caribbean) | | EM-DAT |
| Escaleras & Register 2011 | Natural disasters negatively impact on inward FDI. | ↓ | 1984-2004 | 94 (Countries) | FDI % of GDP, World Bank | EM-DAT |
| Anuchitworawong & Thampanishvong 2015 | Frequency of natural disasters have no impact on FDI inflows overall, however a higher severity of natural disasters tends to lower FDI flows into Thailand. | ↓ | 1971-2012 | 1 (Thailand) | Bank of Thailand database | EM-DAT |
| Budde-Sung & Peacock 2019 | extreme climates = less FDI subsidiaries. Prefer locations with warmer climates, but less sunshine. | ↓ | 2004-2011 (3 periods) | 163 Companies | Company data | Temperature Data |
| Doytch 2019 | climate and hydrological disasters long-lasting negative effects on FDI total disaster have negative impact on manufacturing FDI in short term, but positive impact in long-term | ↓↑ | 1980-2011 | 69 (Countries) | FDI inflows World Bank | EM-DAT |
| Khan et al 2020 | Serious natural disasters negatively impact FDI in the long run . But reveals FDI is more elastic in these countries in response to natural disasters. | ↓ | 1990-2018 | 55 (Belt and Road) | FDI inflows World Bank | EM-DAT |
| Batala et al 2021 | Severe natural disasters had a negative impact on FDI | ↓ | 1990-2016 | 7 (South Asia) | FDI % of GDP, World Bank | EM-DAT |
| Neise 2021 | Impact varies across economic sectors. Positive relationship natural disasters and FDI inflows to manufacturing, construction and tourism. No significant relationship with FDI into creative industry. | —↑ | 2003 to 2015, 13 years | 181 (Countries) | fDi markets & World Bank | EM-DAT |
| Ramos 2021 | No impact on FDI | — | 2011-2017 | 137 (Countries) | UNCTAD | EM-DAT |
| Toner-Rodgers & Friedt 2022 | Large natural disasters decrease FDI in affected areas by 86%. Effects are persistent for at least 6 years post-disasters. | ↓ | 2006-2019 | 1 (India) 16 regions | Reserve Bank of India | Independent research |

Climate Vulnerability versus Exposure



Source: IPCC (2021)

Research Questions

This study addresses the following research questions:

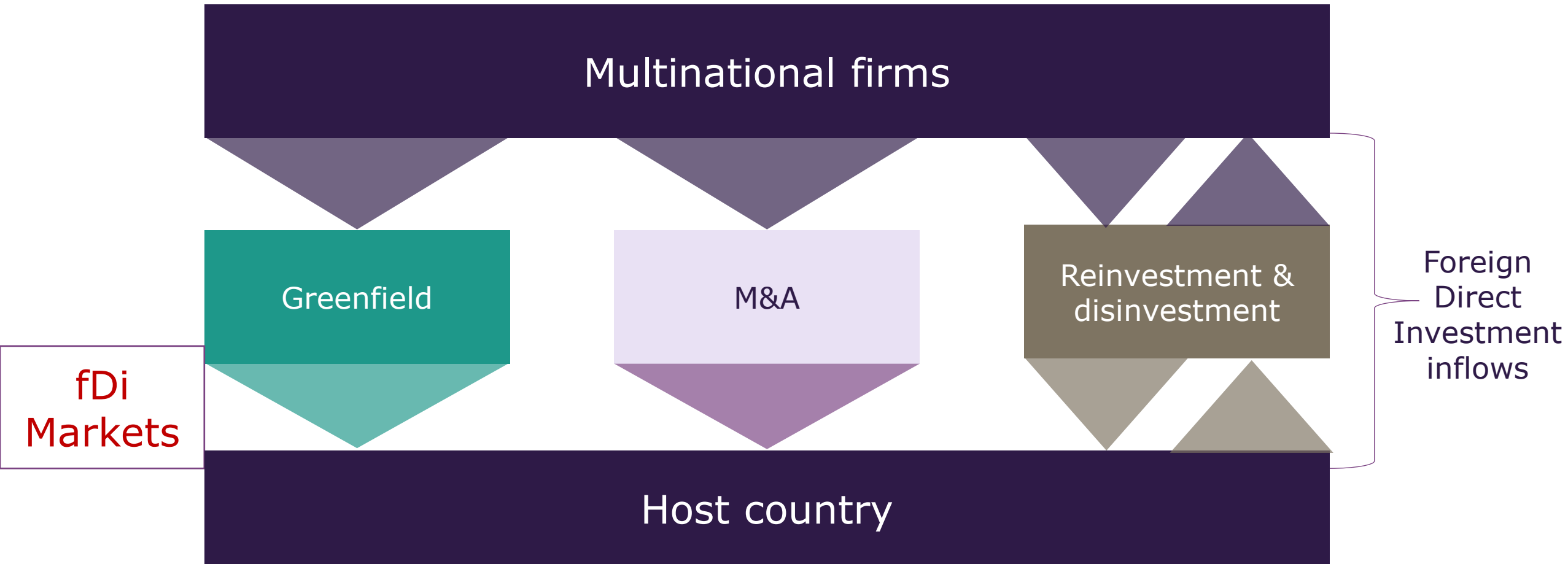
1. How does a country's climate risk exposure and climate risk vulnerability impact on inward FDI?
2. How do these impacts differ between developing, emerging and developed economies?

H₀ 1. Exposure does not impact on inward FDI

H₀ 2. Vulnerability does not impact on inward FDI

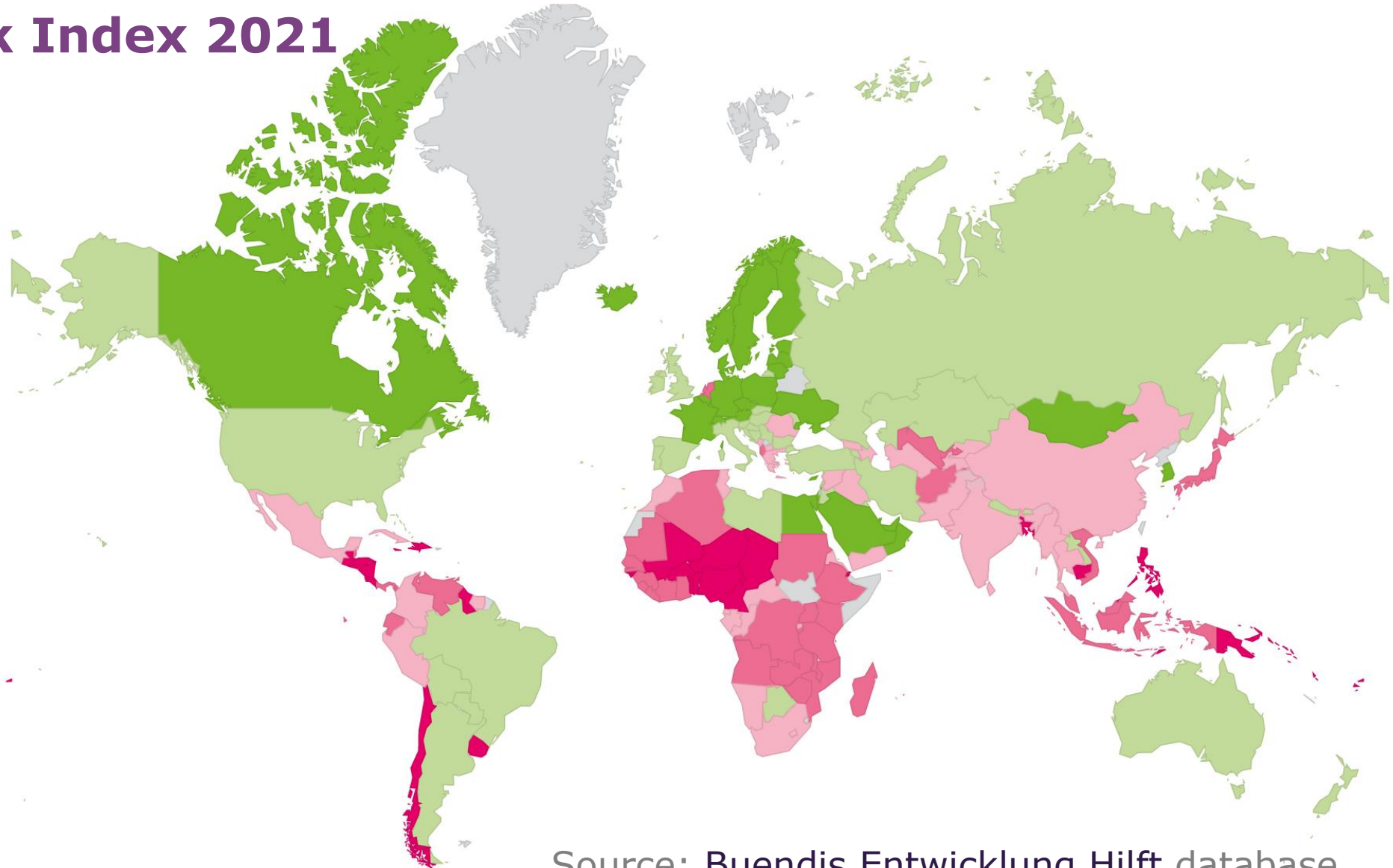
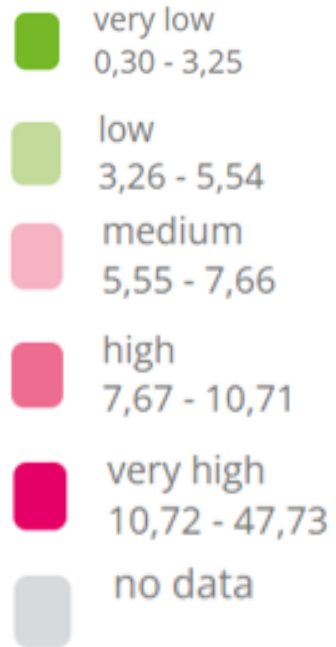
H₀ 3. This is no observed difference in the relationship between developing, emerging and developed economies.

Dependent variable - FDI



Explanatory variable - World Risk Index

World Risk Index 2021



Source: [Buendis Entwicklung Hilft database](#)

Included variables

| Type of variable | Name | Description | Expected impact on dependent | Source |
|------------------|-----------|---|------------------------------|---|
| Dependent | log GFDI | The logarithm of greenfield FDI per capita of host country, US\$ current prices | NA | FDI markets (divided by population data from World Development Indicators - World Bank) |
| Independent | log expos | the logarithm of the host country's exposure to environmental hazards score (higher score indicates higher vulnerability) | decrease GFDI | World Risk Index - Bundis Entwicklung Hilft Database |
| Independent | log vuln | the logarithm of the host country's vulnerability score (higher score indicates higher vulnerability) | decrease GFDI | World Risk Index - Bundis Entwicklung Hilft Database |
| Control | log Tax | The logarithm of the corporate tax rate in host country per annum, percentage | decrease GFDI | International tax foundation, Washington DC |
| Control | log GDP | logarithm of GDP per capita of host country, US\$ current prices | increase GFDI | World Development Indicators (World Bank) |
| Control | log trade | exports + imports as a % of GDP, percentage | increase GFDI | World Development Indicators (World Bank) |

Notes.

1. Population was initially included with total GFDI and GDP, but by using GFDI and GDP per capita we are accounting for population in the model.
2. An indicator for rule of law/ government regulation and stability has been included in some existing models by previous authors on this topic, however research has shown a high correlation between a higher GDP per capita and better government stability and rule of law. Although not a complete substitute, this study has chosen to avoid indexes and indicators where possible given that the independent climate change variables incorporate to some extent the institutional frameworks in place in a country, so this study wanted to reduce any chance of collinearity between explanatory variables.
3. Inflation was also initially included, but there were too many outliers in the inflation data that had more balanced data available for all other indicators so inflation was removed from the model.

Country and time selection

2011-2019 time period

t

108 Countries included

i

Developed

Emerging

Developing

Developing & Emerging

Static and Dynamic models

Static Generalised Least Squares (GLS) estimator

Model 1

$$\ln\text{FDI}_{it} = \beta_0 + \beta_1 \ln V_{it} + \beta_2 \ln E_{it} + \beta_3 \ln \text{Tax}_{it} + \beta_4 \ln \text{GDP}_{it} + \beta_5 \ln \text{Trade}_{it} + \mu_i + \epsilon_{it}$$

Dynamic Generalised Method of Moments (GMM) estimator

Model 2

$$\ln\text{FDI}_{it} = \ln\text{FDI}_{it-1} + \beta_1 \ln V_{it-1} + \beta_2 \ln E_{it-1} + \beta_3 \ln \text{Tax}_{it-1} + \beta_4 \ln \text{GDP}_{it-1} + \beta_5 \ln \text{Trade}_{it-1} + \mu_i + \epsilon_{it}$$

Model 2 GMM results – 1 year lag all variables

Empirical results from system GMM model, Orthogonal Deviations

| | Sample | Developed | Developing & Emerging | Developing | Emerging |
|--|--------------|--------------|-----------------------|--------------|-------------|
| lnFDI(-1) | -0.147564*** | 0.033459* | -0.162522*** | -0.199962*** | -0.036083 |
| lnVuln | -3.738820** | -3.755171*** | 0.285771 | 4.453122 | 0.131464 |
| lnExpos | 1.398962 | -1.916977 | 1.299209 | 2.455327 | -0.732277* |
| LNGDP | 1.517303*** | 1.976306*** | 1.565480*** | 2.131371*** | 0.601050*** |
| lnTax | -0.292949** | -2.636940*** | -0.208577* | -0.127433 | -0.765494 |
| lnTrade | 0.897336** | 2.760685*** | 0.523584 | 0.333958 | 0.056024 |
| Observations | 756 | 182 | 574 | 357 | 217 |
| Cross sections | 108 | 26 | 82 | 51 | 31 |
| Sargan (J) test statistic (aim for between 20-30) | 36.70009 | 24.78170 | 36.64880 | 35.96127 | 26.85695 |
| P-value J statistic (>0.05 good and <0.25 best) | 0.100803 | 0.209911 | 0.101812 | 0.116148 | 0.363069 |

p value level of statistical significance

<0.1*

<0.05**

<0.01***

Conclusions & Policy Implications

H₀ 1. Exposure does not impact on inward FDI

ACCEPT*

H₀ 2. Vulnerability does not impact on inward FDI

REJECT*

H₀ 3. This is no observed difference between developing, emerging and developed economies.

REJECT

Climate risk is an important variable in understanding Foreign Direct Investment decisions

Differentiating between developed, developing and emerging economic classification

Further research breaking down components of vulnerability and testing directional causality

*"conversation about the weather is ~~the last refuge of the unimaginative~~"
fascinating and more important than ever"*

Thank you!

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Australian Government

Australian Trade and Investment Commission

AUSTRALIA

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Climato-economic theory

Anthropomorphic
Climate Change

Worsens



Climate risks
& extreme
events

SHAPE



Cultural
factors

Economic
factors

SHAPE



Behaviour of:
• People
• Firms
• Organisations

Pollution Haven Hypothesis

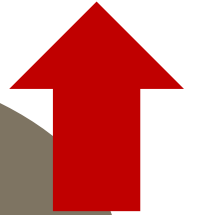
Carbon leakage through FDI

↑ Δ FDI inflows



Worsens

GHG
emissions



Pollution Halo Effect

↑ Δ FDI inflows



Reduces

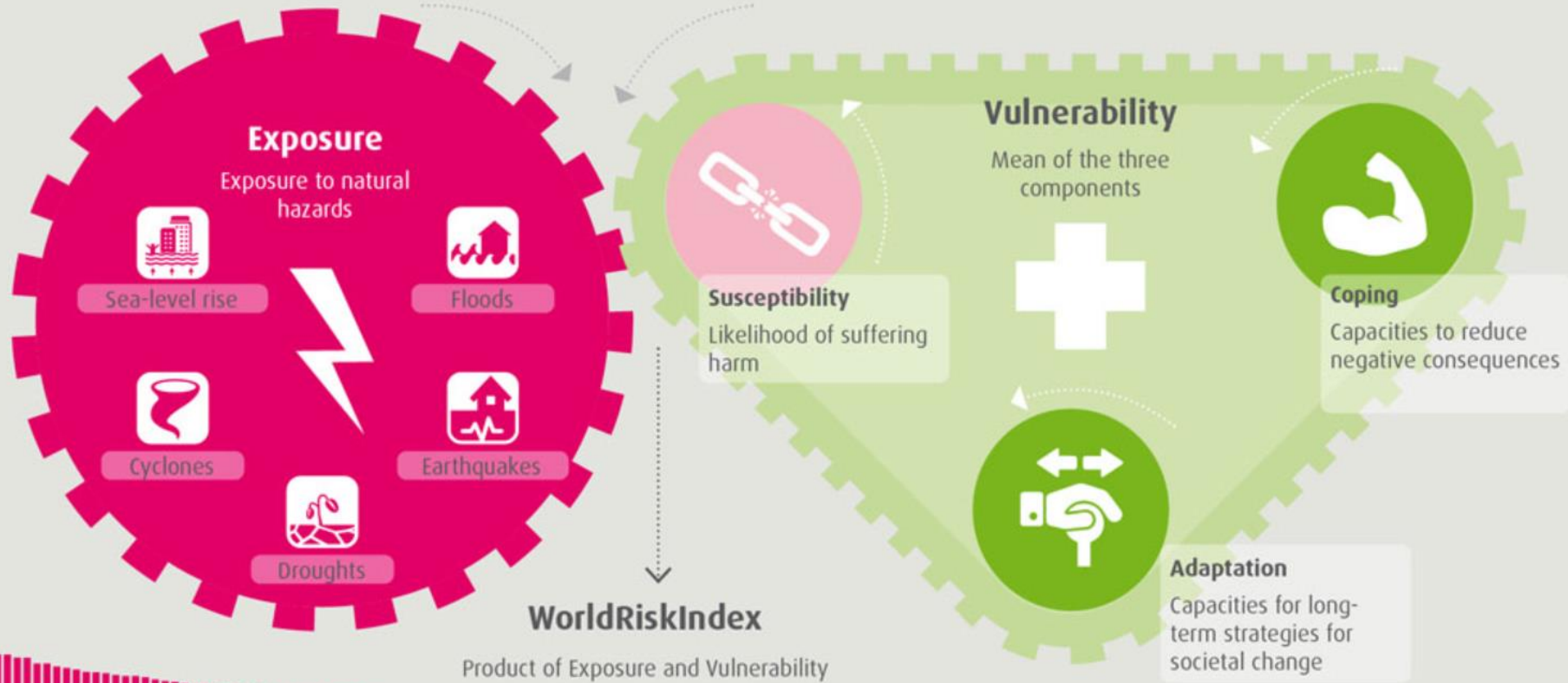
GHG
emissions



The Concept of the WorldRiskReport

Natural hazard sphere

Societal sphere



GMM lag sensitivity

Empirical results from system GMM model, Orthogonal Deviations

| | InGFDI 1 year lag | InGFDI, LNVuln, LNExpos 1 year lag | InGFDI, LNVuln, LNExpos 3 year lag | InGFDI, LNVuln, LNExpos 5 year lag | Model 2 results |
|--|-------------------|------------------------------------|------------------------------------|------------------------------------|-----------------|
| InFDI(-1) | -0.153208*** | -0.143847*** | -0.079993 | -0.035764 | -0.147564*** |
| InVuln | -2.904642*** | -3.542675** | -2.924151 | 1.130432 | -3.738820** |
| LnExpos | 1.365358* | 0.925658 | -5.627864 | 2.491475 | 1.398962 |
| LNGDP | 1.196311*** | 1.182267*** | 0.990530*** | 2.039665*** | 1.517303*** |
| LnTax | -0.244982* | -0.259422* | 0.251111 | -0.083193 | -0.292949** |
| LnTrade | 0.656153*** | 0.691606*** | 0.983851*** | 1.743685*** | 0.897336** |
| Observations | 756 | 756 | 540 | 324 | 756 |
| Cross sections | 108 | 108 | 108 | 108 | 108 |
| Sargan (J) test statistic (aim for between 20-30) | 39.27206 | 38.79502 | 29.09918 | 20.79295 | 36.70009 |
| P-value J statistic (>0.05 good and <0.25 best) | 0.059839 | 0.066127 | 0.216420 | 0.235689 | 0.100803 |

p value level of statistical significance

<0.1*

<0.05**

<0.01***

Model 1 GLS estimator results

Empirical results from panel generalised least squares, cross section fixed effects

| | Sample | Developed | Developing & Emerging | Developing | Emerging |
|------------------------------------|--------------|--------------|-----------------------|--------------|-------------|
| C | 9.825476 | 19.28143*** | 2.638185 | -3.988520 | 5.272528 |
| lnVuln | -1.628074** | -3.687239*** | 0.065622 | 2.262608 | -0.329193 |
| lnExpos | 0.050772 | -1.895870* | 0.330791 | -0.609735 | -0.026133 |
| LNGDP | 0.724519*** | 1.085512*** | 0.729053*** | 0.0801298*** | 0.676773*** |
| Tax | -0.039073*** | -0.077458*** | -0.023261** | 0.8007 | -0.02932088 |
| Trade | 0.008580*** | 0.020836*** | 0.005578* | 0.4502 | 0.005377 |
| R squared | 0.812312 | 0.897379 | 0.766552 | 0.696137 | 0.768543 |
| Cross section Fixed-Effects | Yes | Yes | Yes | Yes | Yes |
| Observations | 972 | 234 | 738 | 459 | 279 |
| Cross sections | 108 | 26 | 82 | 51 | 31 |
| Prob. F statistic | 0.000000 | 0.000000 | 0.000000 | 0.000000 | 0.000000 |

p value level of statistical significance

<0.1*

<0.05**

<0.01***