On the Economic Nature of Climate Change in the ASEAN+3 Region: *A Double-sided Sword*

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Background

- Impacts on real GDP (deviation or growth):

  - Assumed *negative*, taking a "damage function" in the form of GDP share (almost all IAMs since Nordhaus, 1992)
  - Estimated *negative* by many empirical studies (see for the literature review, Tol, 2018)
    - found more servere for developing countries (Dell et al., 2012), and
    - paricularly, for poor countries with high income inequality (Cevik and Jalles, 2023)

- Impacts on Inflation:

  - Estimated *rising* in the near term, but somewhat *dampend* in the medium term (Faccia et al., 2021)
  - Found that droughts vs. floods have *opposite* impacts (+ve vs. –ve) on inflation (EM-DAT data, Kabundi et al., 2022)

- To summarize the existing literature, the economic impacts of climate change are …
  - contractionary, and
  - mildly inflationary.

- However, these impacts vary much (and sometimes turn out even to the opposite) with weather types, industrial structure, and income levels, etc.

  - For example, Jirophat et al (2022) study Thailand and find that

    - Largely depending on the weather types (precipitation vs. drought): More specifically, *asymmetric* btw. wet (+ve SPEI) vs. dry (–ve SPEI)

    - *Variational* much across provinces depending on provincial income level and the share of agricultural activities within a province

	Output		*Price*	
	wet (+ve SPEI)	**dry** (–ve SPEI)	**wet** (+ve SPEI)	**dry** (–ve SPEI)
Agricultural	+	–		
Industrial	–	+		
Service	+	–		
Mining	–	+		
Construction	–	+		
Accommodation	+	–		
Transportation	+	–		
Core			+	+
Food			+	+
Energy			+	–
Raw Food			–	+
Rice			–	+
Meat			+	+
Vegetables			–	+

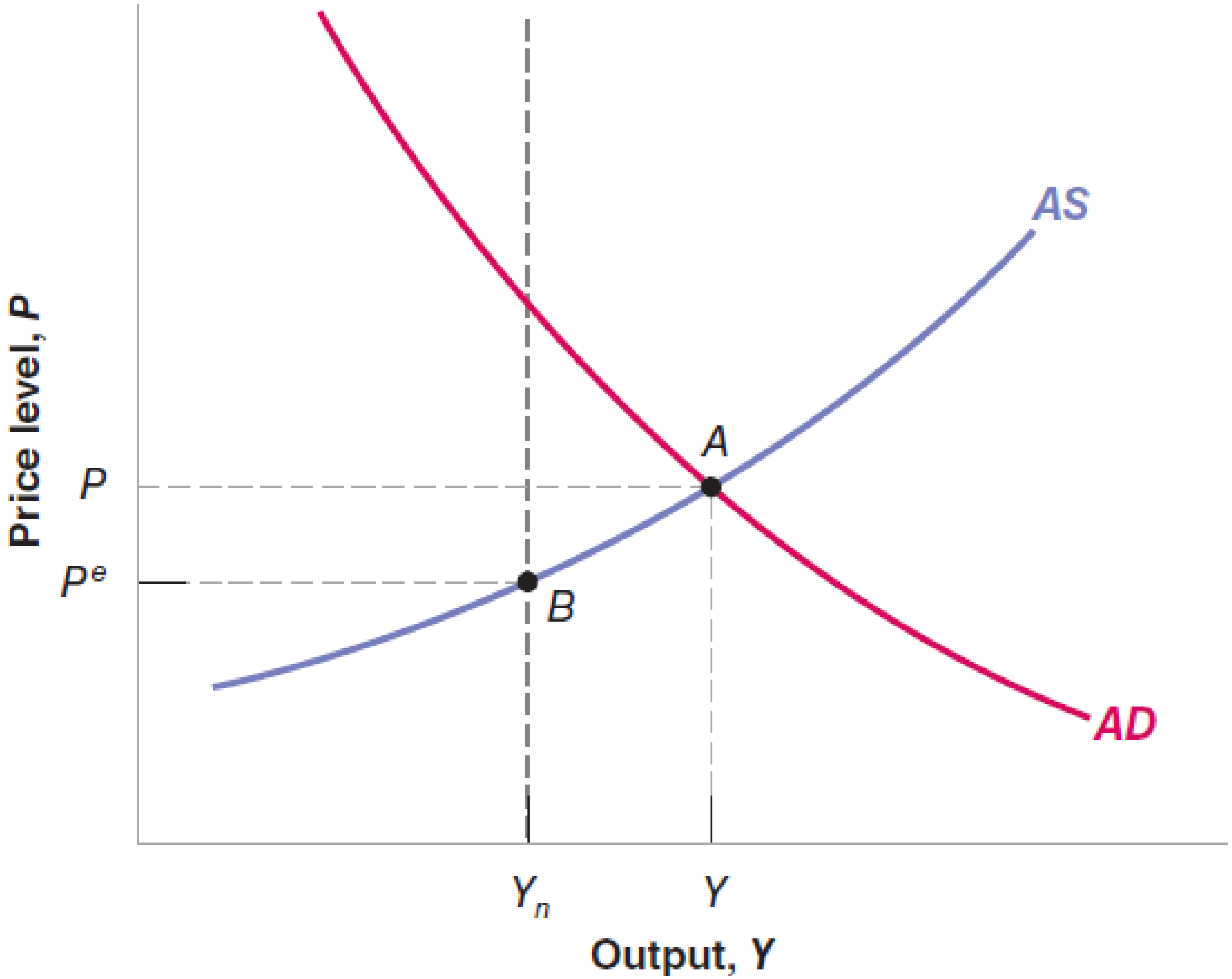
Tabulated based on Jirophat et al (2022)

New Challenges

- *Through which mechanism …*
  - does climate change lead to such impacts varying much with weather types, industrial structure, and income levels, etc.?

- Policymakers who are not properly informed about the economic nature of climate change across different weather types for their country will be *suceptible to a wrong decision-making*.

- For example, consider a country that was hit by extreme heat stress. Hot weather may have
  - people idle (–ve on supplyside), and/or
  - relaxing more time on the beach (+ve on demandside).
  - (and so in long-run / adaptation) reshaping industrial structure.



Blanchard (2013, Macroconomics, 6/E, Ch.8)

- Some UG exercises will reveal that …

  - If observing the extreme weather event to have expansionary and inflationary effects in data, it is means that demandside is a primary channel

  - If observing the extreme weather event to have contractionary and inflationary effects, it is means that supplyside is a primary channel

- The idea is that …

  - **by disentangling** impacts between the **supplyside vs. demandside channels** from observable equilibrium output and prices,

  - **one can study the *economic nature* of weather events** for the ASEAN+3 region and individual members.

Research Methods

- To this aim, we do

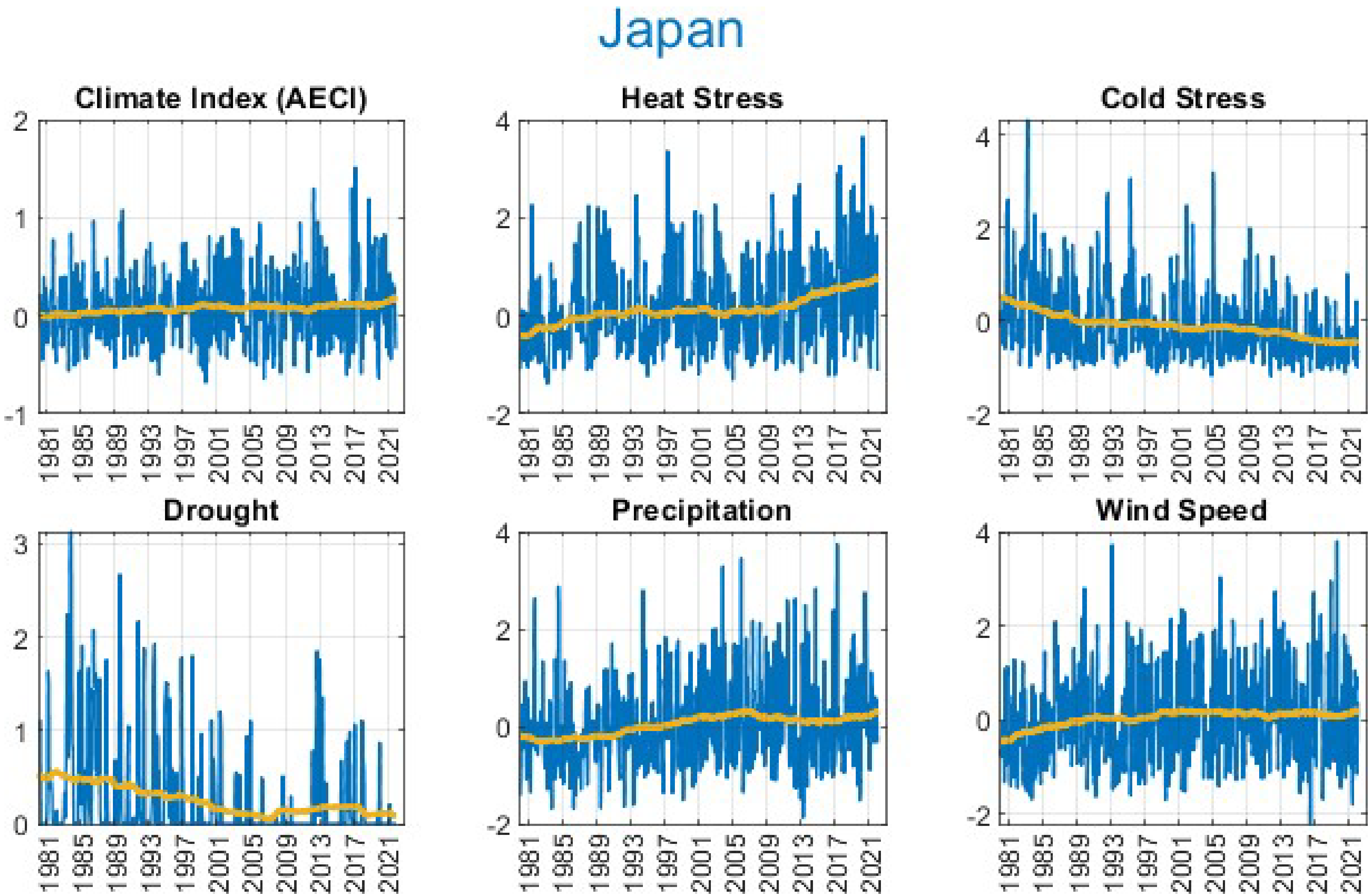
1. **(Index Construction)** construct an index for extreme weather events for each country (10 ASEANs + 3 C/J/K + HK)

2. **(Shock Identification)** identify aggregate supply (AS) and aggregate demand (AD) shocks within a small-open economy framework

3. **(Shock Decomposition)** decompose AS and AD shocks and constructing historical time series for each country

4. **(Regression Analysis: Panel and Individual)** estimate how much weather/climate index contributes to AS and AD shocks

Step 1. Index Construction



Step 2. Shock Indentification

- Model: A 3-variable Structural VARX (2,1)

$$AY_t = B_1 Y_{t-1} + B_2 Y_{t-2} + C_0 X_t + C_1 X_{t-1} + \epsilon_t$$

$$Y = \begin{bmatrix} \text{GDP Growth} \\ \text{CPI Inflation} \\ \text{Interest Rates} \end{bmatrix}$$

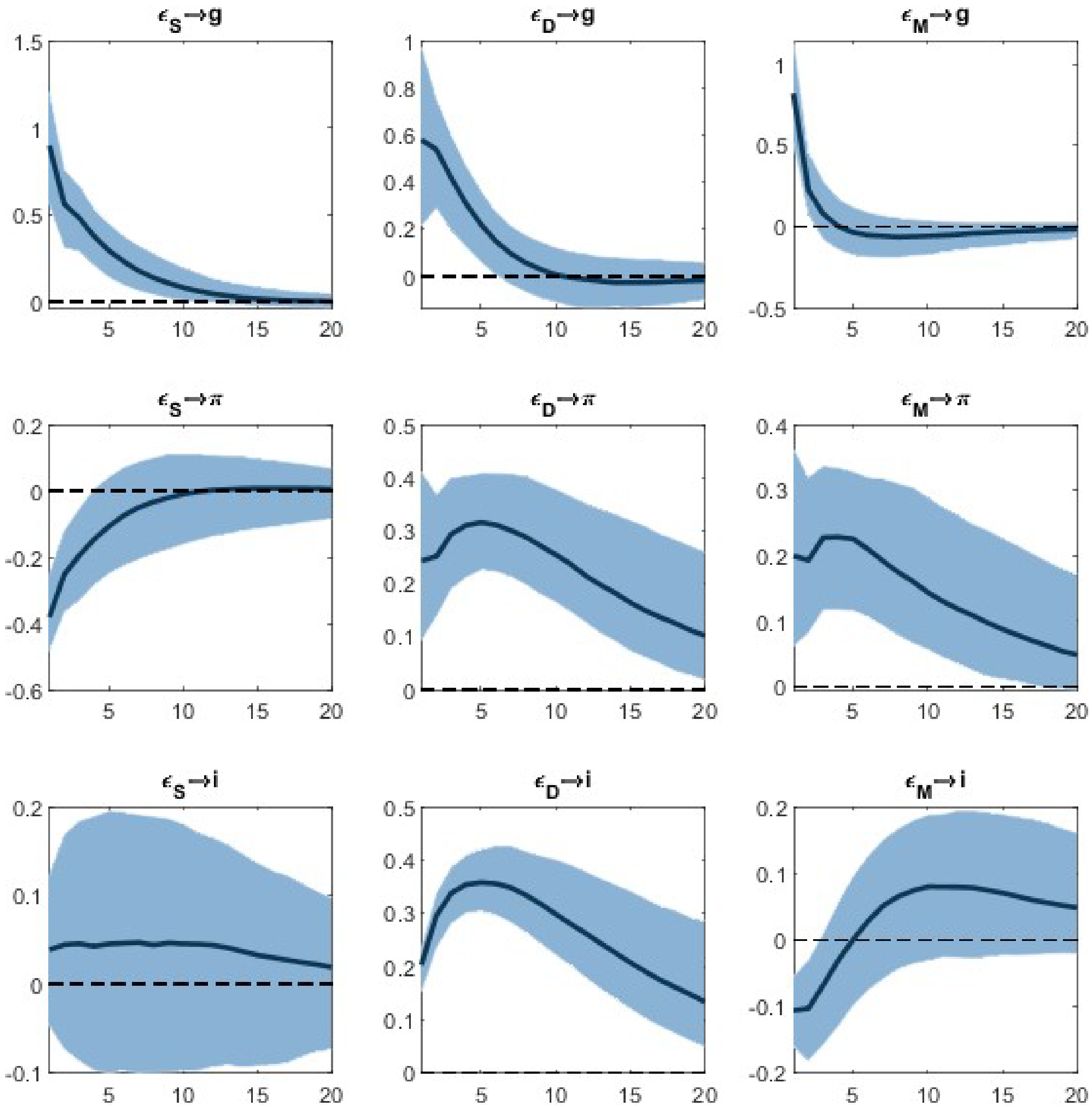
$$X = \begin{bmatrix} \text{US GDP Growth} \\ \text{Intern'l Commodity Inflation} \end{bmatrix}$$

- quarterly frequency
- constant & trend incl.

- Identification Strategy: Sign restrictions based on the fundamental economic theory

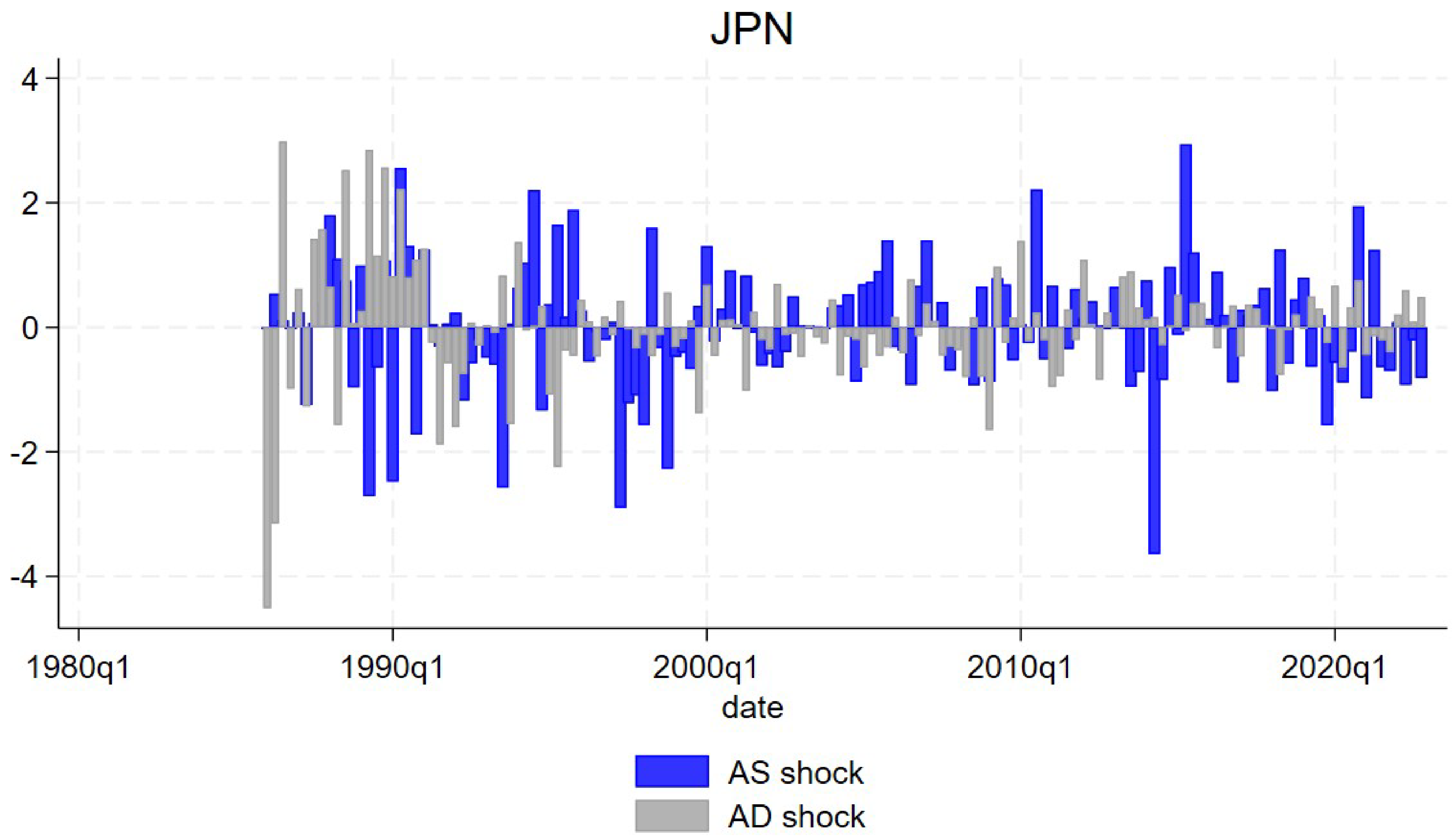
  - A +ve supply shock causes faster GDP growth (+ve) and lower inflation rate (-ve).
  - A +ve demand shock causes faster GDP growth (+ve) and higher inflation rate (+ve) and higher interest rate (+ve)
  - An expansionary monetary shock causes faster GDP growth (+ve) and higher inflation rise (+ve) while lowering interest rate (-ve).

Japan



$\epsilon_S \rightarrow g$
$\epsilon_D \rightarrow g$
$\epsilon_M \rightarrow g$
$\epsilon_S \rightarrow \pi$
$\epsilon_D \rightarrow \pi$
$\epsilon_M \rightarrow \pi$
$\epsilon_S \rightarrow i$
$\epsilon_D \rightarrow i$
$\epsilon_M \rightarrow i$

Step 3. Shock Decomposition



Step 4. Regression Analysis

- Panel
  - Pooling
  - Panel with country FE

$$y_{it} = \beta x_{it} + \theta_i + const. + \epsilon_{it},$$

$$y_{it} = \{s_{it}, d_{it}\}$$

$$x_{it} \text{ drawn from } \{5 \text{ individual indices, } 1 \text{ composite index}\}$$

- monthly index → quarterly by average

Results I: *Pooled Regression*

Depn. var	*AS shock* (1)	(2)	(3)	*AD shock* (4)	(5)	(6)
Heat Stress	-0.045	**-0.082****		**0.081*****	**0.121*****	
	(0.03)	(0.04)		(0.03)	(0.04)	
Cold Stress	-0.017	-0.065		-0.020	0.084	
	(0.04)	(0.06)		(0.04)	(0.06)	
Drought	0.025	-0.029		0.029	-0.037	
	(0.06)	(0.07)		(0.07)	(0.08)	
Precipitation	**-0.086****	**-0.096****		-0.020	-0.025	
	(0.04)	(0.04)		(0.04)	(0.04)	
Wind	-0.017	-0.021		0.036	0.043	
	(0.04)	(0.04)		(0.04)	(0.04)	
AECI			**-0.316*****			**0.217***
			(0.11)			(0.11)
_cons		0.031	0.026		-0.007	-0.018
		(0.03)	(0.03)		(0.03)	(0.03)
N. Obs.	1499	1499	1499	1499	1499	1499
R-squared		0.007	0.005		0.007	0.003
F		2.208			2.086	
Prob. > F		0.051			0.065	

Findings (interim)

- Extreme weather events work like a <u>–ve supply shock.</u>

  - Heat stress and heavy precipitation do so significantly.
  - So do cold stress and strong wind, but statistically insignificant.
  - The composite index (AECI), a good representative.

- Extreme weather events work like a <u>+ve demand shock.</u>

  - Heat stress works so significantly.
  - Other indicators are not statistically significant, though
  - The composite index, a good representative.

- Together from AS and AD channels,

  - Heat stress: mostly inflationary
  - Precipitation: contractionary
  - *AECI: mildly contractionary & strongly inflationary*

- These results are from pooling over countries.
  What if taking into account unobservable country-specific characteristics?

Results II: *Panel Regression (Fixed Effects)*

Depn. var	*AS shock* (1)	(2)	(3)	*AD shock* (4)	(5)	(6)
Heat Stress	**-0.048***	**-0.082****		**0.085*****	**0.126*****	
	(0.02)	(0.03)		(0.02)	(0.03)	
Cold Stress	-0.017	-0.066		-0.021	0.084	
	(0.05)	(0.07)		(0.05)	(0.07)	
Drought	0.026	-0.028		0.030	-0.042	
	(0.04)	(0.06)		(0.06)	(0.07)	
Precipitation	**-0.094****	**-0.100****		-0.022	-0.031	
	(0.03)	(0.04)		(0.03)	(0.04)	
Wind	-0.018	-0.019		0.038	0.045	
	(0.05)	(0.05)		(0.04)	(0.04)	
AECI			**-0.320*****			**0.219****
			(0.10)			(0.10)
_cons		0.032*	0.027***		-0.007	-0.018**
		(0.01)	(0.01)		(0.02)	(0.01)
N. Obs.	1499	1499	1499	1499	1499	1499
N. Countries	14	14	14	14	14	14
R-squared		0.007	0.005		0.007	0.003
F		3.872			26.289	
Prob. > F		0.023			0.000	

Findings

- Much similar to the results from pooled OLS.
- To make a short conclusion from the panel analysis:

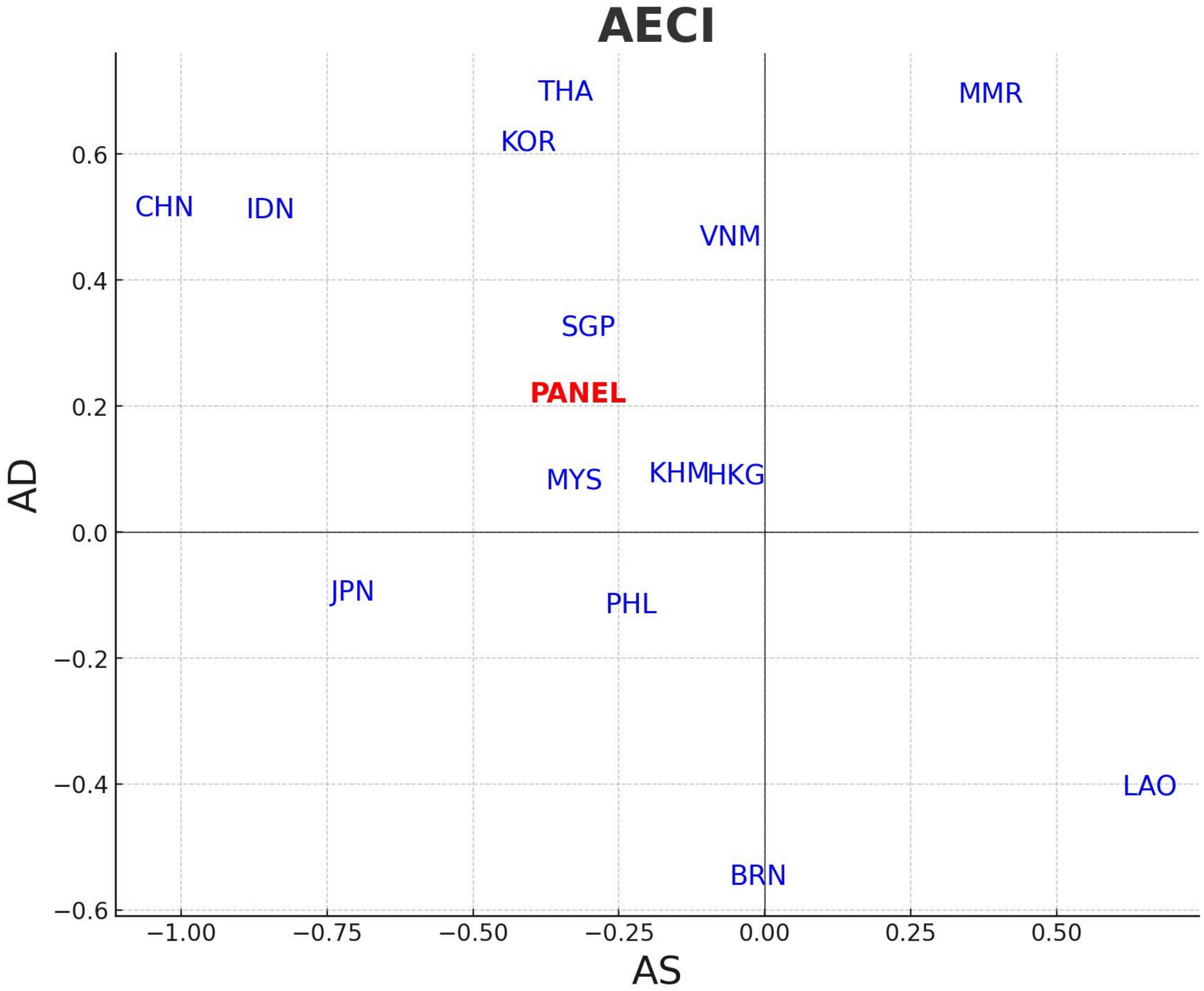
  Affecting the economy through AS and AD channels at the same time, climate change would create cost-push and demand-pull inflation leading to a higher rate of inflation, while lowering the economic growth rate to some mild extent.

- But, different countries may differently respond to the same types of weather events. And, what reall matters to us is how climate change affects our own country.

Results III: *Individual Regression*

Japan

Depn. var	*AS shock* (1)	(2)	(3)	*AD shock* (4)	(5)	(6)
Heat Stress	0.011	-0.140		0.139	0.092	
	(0.13)	(0.15)		(0.12)	(0.14)	
Cold Stress	**-0.288***	**-0.414****		-0.206	-0.144	
	(0.17)	(0.20)		(0.15)	(0.19)	
Drought	0.166	-0.079		-0.017	-0.157	
	(0.23)	(0.26)		(0.20)	(0.24)	
Precipitation	**-0.339****	**-0.385****		-0.115	-0.188	
	(0.14)	(0.16)		(0.13)	(0.15)	
Wind	-0.008	0.085		0.038	0.060	
	(0.15)	(0.15)		(0.13)	(0.14)	
AECI			**-0.706***			-0.096
			(0.38)			(0.35)
_cons		-0.010	0.058		-0.002	0.008
		(0.11)	(0.09)		(0.10)	(0.08)
N. Obs.	148	148	148	148	148	148
R-squared		0.072	0.023		0.026	0.001
F		2.193			0.751	
Prob. > F		0.058			0.587	


AECI
THA
MMR
KOR
CHN
IDN
VNM
SGP
PANEL
MYS
KHM
HKG
JPN
PHL
LAO
BRN
0.6
0.4
0.2
0.0
−0.2
−0.4
−0.6
−1.00
−0.75
−0.50
−0.25
0.00
0.25
0.50
AD
AS

Conclusions

Summary

- We study the *economic nature* of extreme weather events for the ASEAN+3 region and individual member states.

- Most types of extreme weather events work like *adverse supply shocks and favorable demand shocks* at the same time.

- At equilibrium, they will have little impacts on output growth but *large impacts on inflation*.

- When considering size and statistical signficance, heat stress and heavy precipitation are the two most primary types of extreme weather events.

- The composite index, a simple average of the five weather indices, remains representative.

- However, the economic nature of extreme weather events are varying much across countries even within the ASEAN+3 region. For example,

  - In Thailand, the two most primary types of weather shocks are drought and precipitation, related to “water” factor.

  - In Indonesia and Korea, they are heat and cold stressess, related to “temperature” factor.

  - In Japan, cold temperature and precipitation both matter on the AS side and affect negatively.

  - As for the composite climate index, the sign (primary economic nature) is shared across the countries, but the signficance and size are quite different.

    - In Thailand and Korea, the AD effect is dominant.
    - In Japan an Indonesia, the AS effect is so.

Implications

- To the extent that climate change increases the frequency of extreme weather events and extends the length of those periods, the economy will expereinece more often *cost-push and demand-pull inflation at the same time*.

- Without well planned adaptation, climate change may become a source of *repeating* structural changes for our economy in that

    - the *Phillips curve* will repeatedly shift upward,
    - leading CB's *inflation targeting* to *get fragile*.

- Furthermore, due to large variations across countries, policymakers who are less informed about the economic nature of specific weather events to their own country will face further challenges when forming their policy response.

- Understanding the *economic nature* of weather events will be crucial

  - when utilizing short-run macro policy tools (monetary and fiscal) in response to extreme weather events, and
  - when gauging and building up adaptaion capacity through long-run environmental policy.

THANK YOU