Compound Risks
Combining COVID-19 and Climate Shocks in Macroeconomic Models for Stronger Financial Resilience

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FACILITATOR

Olivier Mahul
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Compound risks are happening

Tropical Storm Delta Strikes a Louisiana Region That Was Already Reeling

Delta made landfall as the 10th named storm to hit the United States this year, and six weeks after Hurricane Laura hit Cameroons Parish.

Coronavirus, climate and locusts

East Africa’s children face multiple crises

Vietnam floods and landslides displace 90,000 people as new cyclone nears

More than 100 so far reported dead or missing after two storms destroy homes and leave trail of destruction

▲ Residents have been shocked by the scale and speed of this year’s flooding. Photograph: Manor Vettiyan/Alamy Getty
Compound risk is not new

How Superstorm Sandy Became a Snowstorm

By Stephanie Pappas  October 30, 2012

Chile earthquake of 2010

WRITTEN BY
John P. Rafferty

Chile earthquake of 2010, severe earthquake that occurred on February 27, 2010, off the coast of south-central Chile, causing widespread damage on land and initiating a tsunami that devastated some coastal areas of the country. Together, the earthquake and tsunami were responsible for more than 500 deaths.

The Global Food Crisis

The End of Plenty

BY JOEL K. BOURNE, JR.

PHOTOGRAPHS BY JOHN STAMMERY


Chile earthquake. Concepción.

The remains of a destroyed building, Concepción, Chile, Feb. 28, 2010.

(National Geographic/Al Jazeera)

EGYPT

Stung by soaring food prices, angry Egyptians throng a kiosk selling government-subsidized bread near the Great Pyramid at Giza. Across the globe, rising demand and flat supplies have rekindled the old debate over whether production can keep up with population.
OPENING REMARKS

Marcello Estevão
Global Director, Macroeconomics, Trade and Investment (MTI) Global Practice, WBG
KEYNOTE SPEAKER

Irene Monasterolo
Assistant Professor of Climate Economics and Finance,
Vienna University of Economics and Business
Compounding COVID-19 and climate risks: implications for macro-financial risk assessment and policy preparedness

Authors: Irene Monasterolo (WU, IIASA), N. Dunz (WU), A. Mazzocchetti, M. Mistry and A. Essenfelder (UNIVE)
Project coordinated by I. Monasterolo and M. Billio (UNIVE)
Supported by: Marco Raberto (UNIGE), Stefano Battiston (UZH, UNIVE)
• **Climate** risks for **financial stability** (Battiston ea 2017)
• Climate change doesn’t happen in isolation: it can **compound with other risks** (COVID-19, finance)
• Our understanding of how risks compound is very **limited**
• Yet it is crucial to **avoid underestimating risks**: non-linear dynamics amplify losses and delay recovery
• **Implications** for recovery policy, World Bank operations:
  – disaster risk financing and fiscal management of climate risks
  – compound risk consideration in financial risk management
Why understanding compound risk is crucial to **correctly assess risk**

What do **macroeconomic models** can/cannot tell you about compounding

How COVID-19/climate risk interact: **risk transmission channels**, direct/indirect impacts, drivers of results

Implications for designing **financial preparedness** to compound risks:
- fiscal risk management and macro-financial risk management
What do we mean with compound risk?

- 2 or more risks of different nature that occur in the same time and trigger non-linear effects

**Non linearity:** the output does not change in direct proportion to a change in any of the inputs

-> magnitude of shock is not proportional to the outcome of the sum of individual shocks
It could be worse

Global financial crises

COVID-19 crisis (today)

Current and future climate

'Sleeping giant' Arctic methane deposits starting to release, scientists find

Exclusive: expedition discovers new source of greenhouse gas off East Siberian coast has been triggered
1. **Understand how COVID-19 and climate change interact** and affect a country’s socio-economic development and financial stability
   • 4 countries: Jamaica, Philippines, Kenya, Indonesia

2. **Analyse risk transmission channels, reinforcing feedbacks**
   • **Focus** on tourism, remittances, export, FDI, government and central bank’s responses: analysis of demand/supply side interactions

3. **Inform COVID-19 recovery measures to build socio-economic and financial resilience** to compound risk
• **Deep uncertainty:** tipping points, domino effects not. 
  Vs: constrained to aggregate averaged impacts on GDP

• **Non-linearity:** historical data poor proxy of future risk. Vs: 
  *perfect foresight, fast return to equilibrium*

• **Forward-looking** nature of risk: *time horizon* of policy/investment decisions vs models (>2050)

• **Complexity:** financial interconnectedness can amplify 
  shocks and lead to systemic losses (Battiston ea 2012, Billio ea 2012). Vs: *market clearing prices, perfect competition*

• **Endogeneity:** agents’ *adaptive expectations* about future 
  risk lead to long term effects

• **In these conditions:** *second best world vs optimal policy*
Main results

1. **Nature of compound risk** challenges traditional macroeconomic models:
   - *risk characteristics vs model assumptions*

2. Compounding COVID-19/climate risks induce non-linear, long term effects

3. Risk transmission channels and drivers of impacts (**expectations**) matter

4. **Immediate fiscal and monetary response is crucial** to signal investors and support economic recovery

5. Policy response may not be enough alone and can have **unintended effects**
How do we get there: EIRIN model

FINANCIAL SECTOR
- Foreign sector
  - Reserves
  - Net worth
- Commercial bank
  - Bonds
  - Deposits
  - Loans
  - CB loans
  - Reserves
  - Net worth
- Central bank
  - Bonds
  - Domestic and foreign reserves
  - Loans
  - Gold
  - Net worth

HOUSEHOLDS
- Worker
  - Deposits
  - Net worth
- Capitalist
  - Deposits
  - Bonds
  - Net worth
- Government
  - Deposits
  - Bonds
  - Net worth
- MFI loans
- bond purchase
- interest
- loan
- interest
- taxes
- subsidies
- coupon
- consumption

NON-FINANCIAL SECTOR
- ENERGY
  - Mine oil
  - Utility (G/d)
  - Deposits
  - Loans
  - Capital Stock
  - Net worth
- Labor intensive Cons. goods producer
  - Deposits
  - Loans
  - Capital Stock
  - Net worth
  - Inventory
  - Net worth
- Capital intensive Cons. goods producer
  - Deposits
  - Loans
  - Capital Stock
  - Net worth
  - Inventory
  - Net worth
  - Investment

TRADE
- resource import/export
- tourism
- remittances
- deposits
- dividends
- wages

MARKET
- FINANCIAL MARKET
  - Stocks green/dirty
  - Bonds green/dirty
  - trading

Bonds
Loans
Gold
Domestic 
and foreign 
reserves
Net worth
EIRIN to assess individual risk transmission channels

Source: Dunz et al. (2020)
And compound risk transmission

Direct impact

Natural Disaster (tropical storm)
- Capital Stock Destruction
  - Firms' production
    - Investment
  - Firms' profitability
    - Prices
      - Contribution to GDP
  - Tourism (Travel Restriction)
  - Lockdown/Social Distancing
  - Macroeconomics
  - Remittances
- Macroeconomics
  - Dividends
    - Households' wealth
  - Employment
    - Households' demand
  - Fiscal revenues
- Private Finance
  - Loans repayment
  - Bank's balance sheet
  - Credit conditions

Indirect impact

Monasterolo et al. 2020

Public Finance
- Social assistance
- Gov. spending
- Recovery/reconstruction
- Gov deficit
- Sov. bonds issuance
- Sov. bonds prices
- Yields
- Gov. debt
- Macroeconomics
- Private Finance
Jamaica and Indonesia: key drivers of results

• Differences in pre-shock economic structure and GDP drivers:
  – Jamaica: external consumption (tourism, commodity) and remittances
  – Indonesia: external demand for investments affecting domestic investment
• Differences in climate risk exposure, COVID-19 entry points, government’s response (public spending, lockdowns, etc)
• Thus, same exogenous COVID-19 shock leads to different performance
• Importantly, non-linearity of compounding emerges endogenously from model simulations, not by construction (same model, different initialization)
# How to design COVID-19 and climate scenarios: Jamaica

<table>
<thead>
<tr>
<th>Scenario No</th>
<th>COVID-19 Lockdown and Policy-response measures</th>
<th>Natural Hazard Occurrence</th>
<th>Graphical Representation</th>
</tr>
</thead>
</table>
| **1** Strong hazard (hurricane) | No | Timing: Q3 2020  
Impact Size\(^6\): \(\zeta_H = 5.35\%\) | ![Graphical Representation](image1.png) |
| **2** COVID-19 emergency | **Impact from RoW:**  
- Aluminum revenues: -20% price decrease (World Bank commodity price data)\(^1\)  
- Remittances: -20% (World Bank & KNO MAD)\(^2\)  
- Tourism: -67% (Dukharan, 2020)\(^3\) | No | ![Graphical Representation](image2.png) |
| **3** Compound COVID-19 and strong early hazard | **Impact from domestic economy:**  
- Lockdown: Consumption -34%\(^4\)  
**Gov response measures** (IMF Policy Tracker)\(^5\):  
  
- Fiscal:  
  - Targeted measures: 0.5% of GDP  
  - Tax cuts: 0.6% of GDP  
- Monetary  
  - J$57 billion liquidity injection (3% of GDP) | Timing: Q3 2020  
Impact Size\(^6\): \(\zeta_H = 5.35\%\) | ![Graphical Representation](image3.png) |
| **4** Compound COVID-19 and strong late hazard | | Timing: Q4 2020  
Impact Size\(^6\): \(\zeta_H = 5.35\%\) | ![Graphical Representation](image4.png) |
Macroeconomic impact: real GDP

**Hurricane:** initial shock (capital stock destroyed) but fast recovery (no fundamentals affected)

**COVID-19:** direct impact on GDP via shock on tourism, export of aluminum

**Compound risk: worst cases**
- Shock on export, tourism and hazard trigger supply and demand dynamics that reverberate the shock
- Limited recovery (Q3/2020) due to gov. intervention and end of lockdown
- Small difference across compound scenarios: predominance of COVID-19 shock; assumptions on recovery of external demand; stabilized expectations

**Real GDP** (5 years time). x-axis: timeline of simulation until 4th quarter in 2024 on quarterly basis. y-axis: Real GDP indexed against BAU (COVID-19 nor disaster), BAU = 100).
Stronger government intervention (0.5 to 3%) during the crisis allows faster and long lasting GDP recovery:
- Signal agents’ expectations
- Avoid loss of productive capital

<table>
<thead>
<tr>
<th></th>
<th>2020</th>
<th>2024</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>BAU</strong></td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td><strong>COVID-19</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease (0% of GDP)</td>
<td>78.85</td>
<td>84.37</td>
</tr>
<tr>
<td>Baseline (0.5% of GDP)</td>
<td>79.54</td>
<td>84.86</td>
</tr>
<tr>
<td>Increase (3% of GDP)</td>
<td>81.95</td>
<td>86.21</td>
</tr>
<tr>
<td><strong>COMPOUND: STRONG EARLY HURRICANE</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decrease (0% of GDP)</td>
<td>77.59</td>
<td>82.87</td>
</tr>
<tr>
<td>Baseline (0.5% of GDP)</td>
<td>78.26</td>
<td>83.16</td>
</tr>
<tr>
<td>Increase (3% of GDP)</td>
<td>80.76</td>
<td>84.81</td>
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<tr>
<td><strong>COMPOUND: STRONG LATE HURRICANE</strong></td>
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<td></td>
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<tr>
<td>Decrease (0% of GDP)</td>
<td>78.17</td>
<td>82.94</td>
</tr>
<tr>
<td>Baseline (0.5% of GDP)</td>
<td>78.84</td>
<td>83.18</td>
</tr>
<tr>
<td>Increase (3% of GDP)</td>
<td>81.18</td>
<td>84.73</td>
</tr>
</tbody>
</table>

Yearly real GDP level across scenarios characterized by different government spending during the crisis (0, 0.5, 3% of GDP). Real GDP values are indexed against the BAU scenario (BAU = 100).
1. **COVID-19**: long negative effects on GDP (expectations affect ext./int demand)
2. When COVID-19/strong disasters **compound**, negative GDP shock amplified
3. **Dependence of the economy on external demand** affects magnitude and persistence of the economic shock
4. **Public spending** contributes to smooth COVID-19 impact by partially replacing domestic consumption
5. Increasing public spending challenges debt sustainability in a context of prolonged low fiscal revenues: **quality and targeting of spending matter**

➢ **Risk channels and response is very different across countries (see next): country specific conclusions**
Hazard: Negative GDP impact (capital destruction). Q12021: recovery (no revision of firms’ expectations)

COVID-19: high public spending, lower dependence on foreign demand mitigate initial shock (Q2 2020)

Negative expectations lead firms to revise investment decision downwards, affecting unemployment, wages, public debt to GDP ratio.

Compound COVID-19/strong flood: capital stock destruction hits production and GDP. Recovery stimulus from investment in 2023 dampened by deteriorated economic conditions due to COVID-19

Real GDP (5 years time). x-axis: timeline of simulation until 4th quarter in 2024 on quarterly basis. y-axis: Real GDP indexed against BAU considering no COVID-19 nor disaster (BAU = 100).
## Cross-country comparison: risk transmission and drivers

<table>
<thead>
<tr>
<th>Country</th>
<th>Main risk drivers</th>
<th>Heterogenous risk transmission channels</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Jamaica</strong></td>
<td>• Foreign demand (tourism)</td>
<td>Foreign demand shock (<strong>tourism and remittances</strong>) affects labor market Unemployment triggers lower domestic consumption Lower internal demand –&gt; lower GDP and tax revenues, higher public debt</td>
</tr>
<tr>
<td></td>
<td>• Domestic consumption</td>
<td></td>
</tr>
<tr>
<td><strong>Philippines</strong></td>
<td>• Foreign demand</td>
<td>Foreign demand (<strong>tourism, export, remittances</strong>) affects firms’ investments Higher unemployment shrinks domestic consumption, GDP, public debt</td>
</tr>
<tr>
<td></td>
<td>• Firms’ investment (sentiments)</td>
<td></td>
</tr>
<tr>
<td><strong>Kenya</strong></td>
<td>• Tourism</td>
<td>Foreign demand (<strong>tourism, export</strong>), domestic (lockdown) Fall in export triggers commodity price volatility Higher unemployment –&gt; Lower domestic consumption, GDP, public debt</td>
</tr>
<tr>
<td></td>
<td>• Food commodity price</td>
<td></td>
</tr>
<tr>
<td><strong>Indonesia</strong></td>
<td>• Foreign demand</td>
<td>Foreign demand (<strong>exports, FDI</strong>), domestic demand (<strong>lockdown</strong>) Reduced firms’ investment (negative expectations) –&gt; higher unemployment, lower internal demand Worsened Economic and Public Finance Conditions</td>
</tr>
<tr>
<td></td>
<td>• Firms’ investment (sentiments)</td>
<td></td>
</tr>
</tbody>
</table>
Key messages:

Largest short-term negative impacts on GDP, unemployment, debt to GDP, occur in compound risk scenarios for all countries

Shocks led by country specific supply/demand side dynamics, previous structural, fiscal and financial characteristics

(Values in brackets: outcomes of BAU scenario, i.e. no shock occurs. Debt to GDP at 2024 to avoid distortions from inflation, bonds’ price, etc)

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>SCENARIO</th>
<th>YEAR</th>
<th>MIN GROWTH RATE</th>
<th>UNEMPLOYMENT RATE</th>
<th>YEAR</th>
<th>MAX DEBT TO GDP RATIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAMAICA</td>
<td>HURRICANE</td>
<td>2020</td>
<td>-0.74% (1.23%)</td>
<td>11.52% (9.98%)</td>
<td>2024</td>
<td>134.32% (131.18%)</td>
</tr>
<tr>
<td></td>
<td>COVID-19</td>
<td>2020</td>
<td>-19.48% (1.23%)</td>
<td>11.92% (9.98%)</td>
<td>2024</td>
<td>166.89% (131.18%)</td>
</tr>
<tr>
<td></td>
<td>COMPOUND</td>
<td>2020</td>
<td>-20.77% (1.23%)</td>
<td>12.8% (9.98%)</td>
<td>2024</td>
<td>171.66% (131.18%)</td>
</tr>
<tr>
<td>KENYA</td>
<td>DROUGHT</td>
<td>2020</td>
<td>4.70% (5.07%)</td>
<td>1.18% (1.12%)</td>
<td>2024</td>
<td>75.89% (72.58%)</td>
</tr>
<tr>
<td></td>
<td>COVID-19</td>
<td>2020</td>
<td>-1.63% (5.07%)</td>
<td>7.00% (1.12%)</td>
<td>2024</td>
<td>88.84% (72.58%)</td>
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<td>COMPOUND</td>
<td>2020</td>
<td>-4.01% (5.07%)</td>
<td>3.72% (1.12%)</td>
<td>2024</td>
<td>93.26% (72.58%)</td>
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<tr>
<td>PHILIPPINES</td>
<td>TYPHOON</td>
<td>2021</td>
<td>4.05% (6.21%)</td>
<td>2.77% (0.46%)</td>
<td>2024</td>
<td>54.02% (52.57%)</td>
</tr>
<tr>
<td></td>
<td>COVID-19</td>
<td>2021</td>
<td>1.84% (6.21%)</td>
<td>5.77% (0.46%)</td>
<td>2024</td>
<td>64.24% (52.57%)</td>
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<td></td>
<td>COMPOUND</td>
<td>2021</td>
<td>-0.27% (6.21%)</td>
<td>7.64% (0.46%)</td>
<td>2024</td>
<td>66.48% (52.57%)</td>
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<tr>
<td>INDONESIA</td>
<td>FLOOD</td>
<td>2021</td>
<td>3.34% (5.69%)</td>
<td>5.47% (3.83%)</td>
<td>2024</td>
<td>22.49% (22.59%)</td>
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<tr>
<td></td>
<td>COVID-19</td>
<td>2021</td>
<td>4.01% (5.69%)</td>
<td>6.03% (3.83%)</td>
<td>2024</td>
<td>26.19% (22.59%)</td>
</tr>
<tr>
<td></td>
<td>COMPOUND</td>
<td>2021</td>
<td>2.08% (5.69%)</td>
<td>7.43% (3.83%)</td>
<td>2024</td>
<td>26.47% (22.59%)</td>
</tr>
</tbody>
</table>
### Cross-country comparison: short (2020) mid-term (2024) impacts

Table shows results of endogenously generated dynamics of GDP and unemployment 2020-2024 across scenarios.

It is a simulation model: focus on trend (not on specific value).

**How to read the table:**
- Values to be compared with GDP=100 in 2019.
- Real GDP values indexed against BAU value 2019 (=100). Unemployment rate (%)

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>SCENARIO</th>
<th>YEAR</th>
<th>REAL GDP (INDEXED)</th>
<th>UNEMPLOYMENT (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>JAMAICA</strong></td>
<td>BAU</td>
<td>2020</td>
<td>101.23</td>
<td>9.96</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2024</td>
<td>106.00</td>
<td>10.06</td>
</tr>
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<td></td>
<td>HURRICANE</td>
<td>2020</td>
<td>98.80</td>
<td>11.88</td>
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<tr>
<td></td>
<td></td>
<td>2024</td>
<td>104.09</td>
<td>11.54</td>
</tr>
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<td></td>
<td>COVID-19</td>
<td>2020</td>
<td>75.63</td>
<td>12.38</td>
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<td></td>
<td></td>
<td>2024</td>
<td>90.00</td>
<td>24.51</td>
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<td></td>
<td>COMPOUND</td>
<td>2020</td>
<td>74.10</td>
<td>12.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2024</td>
<td>87.90</td>
<td>25.34</td>
</tr>
<tr>
<td><strong>KENYA</strong></td>
<td>BAU</td>
<td>2020</td>
<td>105.07</td>
<td>1.19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2024</td>
<td>128.08</td>
<td>2.55</td>
</tr>
<tr>
<td></td>
<td>DROUGHT</td>
<td>2020</td>
<td>104.69</td>
<td>1.35</td>
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<td></td>
<td>2024</td>
<td>127.18</td>
<td>3.06</td>
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<td>COVID-19</td>
<td>2020</td>
<td>98.37</td>
<td>4.95</td>
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<td></td>
<td></td>
<td>2024</td>
<td>114.30</td>
<td>11.06</td>
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<td></td>
<td>COMPOUND</td>
<td>2020</td>
<td>95.99</td>
<td>5.07</td>
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<td>2024</td>
<td>111.75</td>
<td>12.28</td>
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<td><strong>PHILIPPINES</strong></td>
<td>BAU</td>
<td>2020</td>
<td>105.64</td>
<td>3.85</td>
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<td></td>
<td>2024</td>
<td>131.08</td>
<td>4.40</td>
</tr>
<tr>
<td></td>
<td>TYPHOON</td>
<td>2020</td>
<td>103.25</td>
<td>5.75</td>
</tr>
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<td></td>
<td></td>
<td>2024</td>
<td>126.54</td>
<td>7.42</td>
</tr>
<tr>
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<td>COVID-19</td>
<td>2020</td>
<td>102.57</td>
<td>6.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2024</td>
<td>124.81</td>
<td>8.47</td>
</tr>
<tr>
<td></td>
<td>COMPOUND</td>
<td>2020</td>
<td>102.33</td>
<td>2.00</td>
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<td>2024</td>
<td>116.84</td>
<td>11.99</td>
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<td><strong>INDONESIA</strong></td>
<td>BAU</td>
<td>2020</td>
<td>105.07</td>
<td>3.85</td>
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<td>2024</td>
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<td>FLOOD</td>
<td>2020</td>
<td>104.94</td>
<td>4.32</td>
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<td>2020</td>
<td>103.25</td>
<td>5.75</td>
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<td>2024</td>
<td>124.81</td>
<td>8.47</td>
</tr>
</tbody>
</table>
Non-linear impacts of compounding risks

\[
\text{shock}_{\text{compound}} = \frac{\text{shock}_{\text{COVID-19}} + \text{shock}_{\text{hazard}}}{100}
\]

- **Compound Risk Index**: Non-linear effect. Greater (>100), smaller (<100), equal (=100) the sum of individual risks

- **Indonesia**: Investment-driven economy
  - Shock directly impacts investment decision but fast reaction when recovery (investments > flexible than consumption) *(Index > 100)*

- **Jamaica**: tourism/export-led economy
  - Fall in foreign demand affects domestic demand leading to > unemployment and <GDP *(Index > 100)*
  - But amplification effects takes time (firms still invest in the short term) *(Index < 100)*

Different countries’ economic characteristics and shocks vulnerability explain non-linearity
Conclusion

- Understanding compound risk impact is crucial to avoid misunderstanding risk drivers and channels, and thus underestimating risks.
- When risks compound, they give rise to non-linear macroeconomic effects.
- Structural conditions and agents’ expectations, public finance conditions, vulnerability to hazards matter in explaining magnitude/persistence of shocks.
- Policies supporting a business as usual recovery are double-edged sword: short term recovery but could conditions for increasing vulnerability.
- Assessing compound risk is crucial for better risk pricing: internalization in financial risk management, sustainable fiscal policies.
Useful readings


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Modelling Covid-19, and natural disasters through the eyes of MFMod and EIRIN

Andrew Burns
Global Lead Macroeconomic modelling
The World Bank
The MFMod system

• MFMod is a large-scale macrostructural econometric model comprised of 140 individual country models including Jamaica
• Is the main tool used by WB economists for the twice annual Macro Poverty Outlook forecast exercise and is used for country forecast work

The MANAGE system

• Dynamic Computable General Equilibrium system, off shoot of the global ENVISAGE model (covering 121 countries, including Jamaica), and natural disasters notably earthquakes (Turkey, Haiti)
• Has been used within the Bank to understand the implications of Ebola and Covid in Africa, and Covid in East Asia & Pacific; with single country applications for DRC, Chad, Rwanda, Ethiopia, Mongolia, Vietnam
Comparison hurricane responses: EIRIN and MFMod models

1. **Hurricane responses broadly similar**: large initial impact, recovery over time, but long-term output does not recover to no hurricane baseline

   **EIRIN scenario**

   - Impact by 2034 is to reduce GDP by about 1 percentage point
   - Only one hurricane in this scenario in 2020
   - Mechanism at work:
     - initial destruction of capital and economic downturn
     - followed by increased investment
     - Higher debt raises interest rates
     - Higher rates crowds out supply reduce potential output and GDP in long run
Comparison of hurricane responses: EIRIN and MFMod models

1. **Hurricane responses broadly similar**: large initial impact, recovery over time, but long-term output does not recover to no hurricane baseline

   MFMod scenario

   % deviation from baseline

   ![Graph](image)

   - Long run impact of 1 hurricane

   - Impact by 2030 is just shy of 1 percent of GDP

   - Similar mechanism at work:
     - initial destruction of capital and economic downturn
     - followed by increased investment
     - higher debt and capital destruction reduce potential output and GDP

   - Subsequent hurricanes compound effect
EIRIN covid scenario (green line) demand recover is partial

Initial demand recovers partially in 2022 but then deteriorates further

- Very large initial impact (much larger than forecast by WBG (next slide) or IMF
- Double dip post 2022 is marked, doubles the extent of GDP loss (as compared with 2022)
Comparison of covid responses: EIRIN and MFMod models

World Bank scenario is shorter (ends in 2022)

- Much more muted initial impact of around 7 percent (vs about 25% annualized in EIRIN)
- Rebound is relatively quick, but only partial as of 2022
- MFMod has not done a longer-term forecast as yet
- Supply response in MFMod was similar to EIRIN as well c. -2 % by 2022
CGE Estimates of covid impacts from a range of other countries
Interaction effect is small compared to covid effect
Interaction effect is small compared to covid effect
Some final thoughts

1. Despite some (important) differences in design and conception, MFMod and EIRIN are generating similar results at least for the hurricane scenario

2. Very large initial covid impacts may need to be looked at (in both methodologies the depth of the immediate shock has big implications for long term run result)

3. Interaction effect (over and above the additive effect) is important and would exist in both models reflecting supply-side crowding out induced by additional debt

4. Extent of the interaction effect will be decline in line with size of initial shock
PANELIST

Jan Rielaender
Head, Multidimensional Country Review (MDCR), OECD
Covid, Climate and Natural hazards: Multi-dimensional Assessment of Compound risks in Pilot Countries

26th October 2020
Basic impacts of Covid

• Hitting the most vulnerable
  • Unemployment
  • Informal workers often without any social insurance coverage
  • Small firms

• Weakening resilience to climate risks
  • Poverty → food security
  • Evacuations, refugee movements

• But also, driving creation of new support systems
  • Much more comprehensive registration of the vulnerable, often digital
  • Creation of new cash transfer mechanisms that can serve as automatic stabilisers in the future

→ Question for support: to households or to firms?
The COVID outlook: situation in Morocco
Insights on Moroccan exposure and resilience

- Tourism sector: visitors dropped by 100,000 in March alone, a decline of 54% representing a decrease of 46.2% of the revenues associated for a total loss of MAD 7.1bn
- Agriculture: Morocco is facing a drought year and a decline of the export values of agricultural commodities due to the health crisis, as production was cut by 54%
Defining compound risks

Key characteristics

A major concern for OECD risk managers

Defining compound risk

1. Extremes that occur simultaneously or successively,
2. Extremes combined with background conditions that amplify their overall impact,
3. Extremes that result from a combination of “average” events.

Modelling compound risks
A hybrid approach built on GE modelling

Abstract of the model

1. Households
   Let us consider two household sectors A and B. Sector A households will work in sector A firms and sector B households will work in sector B firms. However, household tax burden is capital in both sectors.

1.1 Households A
   Household of sector A want to maintain the following intertemporal utility function:
   \[
   u_{A,t} = E_t\left[\sum_{t=1}^{\infty} \beta^{t-1} w_{t+1} \left( c_{A,t+1} + c_{B,t+1} \right) \right]
   \]
   where:
   \[
   E_t\left[\sum_{t=1}^{\infty} \beta^{t-1} w_{t+1} \left( c_{A,t+1} + c_{B,t+1} \right) \right] = \frac{1}{1-\beta} \left[ \left( 1 - \beta \right)^{1/2} \left( a_{t+1}^A \right)^{1/2} \right] + \frac{1}{1-\beta} \left[ \left( 1 - \beta \right)^{1/2} \left( a_{t+1}^B \right)^{1/2} \right]
   \]
   under the following budget constraints:
   \[
   \left\{\begin{array}{l}
P_{A,t} + P_{B,t} + (1 + r)P_{A,t} = M_{A,t}^A + M_{B,t} + M_{G,t}^A + M_{G,t}^B + (1 + r)M_{A,t}^A + (1 + r)M_{B,t} + (1 + r)M_{G,t}^A + (1 + r)M_{G,t}^B + (1 + r)M_{A,t}^A + P_A
   \end{array}\right\}
   \]
   \[
   \frac{M_{G,t}^A}{M_{G,t}^B} < 0
   \]
Way forward

- Finalising the model set-up
- Feeding in country data for calibration and shock scenarios
- Policy interventions to be tested: large scale public interventions to support wages, or to invest in firms.
- Combining with a structural analysis of exposure and resilience towards multiple risks
- Decision aid for the design of resilience strategies:
  - Support to households or firms? To which within these groups?
  - What automatic stabilisers to set up that would kick-in during a crisis?
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AUDIENCE QUESTIONS

Please use the Q/A Chat Function

Please Address your questions to a specific speaker (when possible) or indicate to ‘all speakers’

Scan the QR Code to join the DRF Community of Practice
CLOSING REMARKS

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