SOVEREIGN RATINGS IN THE FACE OF CLIMATE AND WILDFIRE RISKS

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MOTIVATION

- Identify the key variables influencing the variations in sovereign default probabilities (PDs hereafter).
- Test the sensitivity of PDs to different parameter configurations.
- Outline robust methods for projecting the key variables along relevant NGFS climate pathways.
- Project sovereign ratings across numerous countries, using NGFS climate scenarios that account for transition and physical climate risks (e.g., wildfires) [see Klusak et al. (2021)]

METHODOLOGY

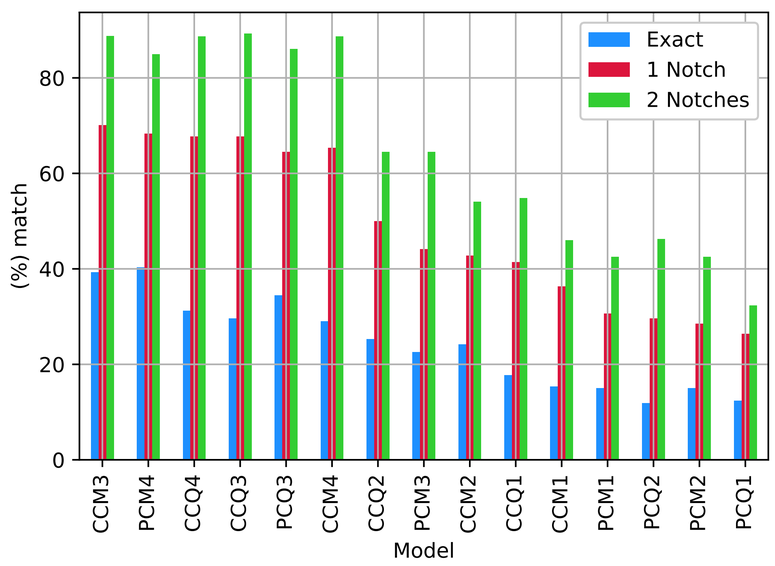
- Employ unsupervised clustering techniques to group countries based on historical ratings.
- Employ regularized regressions within each cluster to identify the sovereign risk drivers - i.e.,

$$\ln(1 - \boldsymbol{PD}_i) = \boldsymbol{c}_i + \boldsymbol{X}_i\beta + \epsilon_i, \quad i = 1, \cdots, n \tag{1}$$

where 1 is a $T \times 1$ vector of ones, $\boldsymbol{PD}_i = (PD_{i1}, \cdots, PD_{iT})^\top$, $\beta \in \mathbb{R}^p$ is vector of coefficients, and $\boldsymbol{X}_i = (\boldsymbol{x}_{1i}^\top, \cdots, \boldsymbol{x}_{Ti}^\top)^\top \in \mathbb{R}^{T\times p}$ is a matrix of covariates. Finally, let $\boldsymbol{c}_i = c_i 1$ and ϵ_i be the vector of error terms.

- Various unsupervised machine learning techniques and regularized regressions are used to assess the out-of-sample performance of the models.

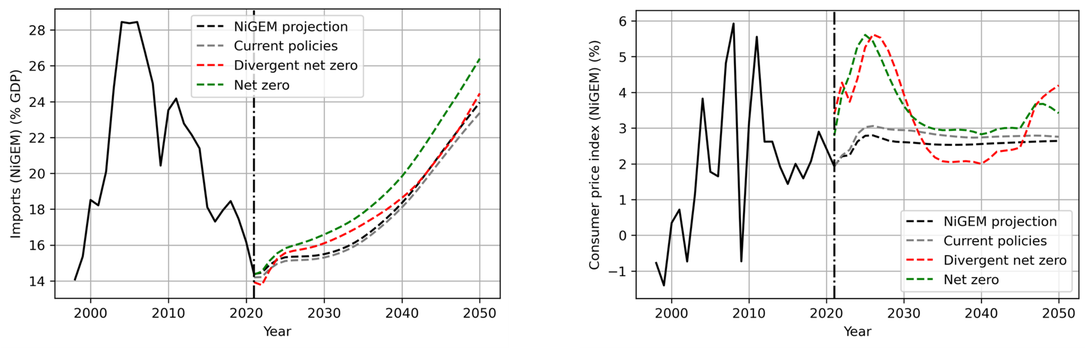
FIGURE 1



Out-of-sample performance (2018 - 2020)

- Use NiGEM to obtain climate sensitive projections of the MEVs.

FIGURE 2



NiGEM-native macroeconomic variables

- In absence of NiGEM counterparts, Sparse Vector Error Correction Model (VECM) proposed by Liang and Schienle (2019) is used for baseline projections of MEVs.
- Let $\boldsymbol{z}_t = (z_{1,t}, \cdots, z_{k,t})^\top$ contain all demeaned and detrended sovereign risk drivers in cluster i.
- Then the VECM model can be expressed as:

$$\Delta\boldsymbol{Z} = \boldsymbol{\Pi}\boldsymbol{Z}_{-1} + \boldsymbol{\Phi}\Delta\boldsymbol{X} + \boldsymbol{E}, \tag{2}$$

where $\Delta\boldsymbol{Z} = (\Delta\boldsymbol{z}_1, \cdots, \Delta\boldsymbol{z}_T)$, $\boldsymbol{Z}_{-1} = (\boldsymbol{z}_0, \cdots, \boldsymbol{z}_{T-1})$, $\boldsymbol{\Phi} = (\boldsymbol{\Phi}_1, \cdots, \boldsymbol{\Phi}_p)$ and $\Delta\boldsymbol{X} = (\Delta\boldsymbol{x}_0, \cdots, \Delta\boldsymbol{x}_{T-1})$, with $\boldsymbol{x}_t = \left(\boldsymbol{z}_t^\top, \cdots, \boldsymbol{z}_{t-p+1}^\top\right)^\top$, and where $\boldsymbol{\Pi}$ captures the cointegrating relationships.

DISCUSSION

- We utilize unsupervised machine learning techniques to cluster countries and select optimal models that explain the PD variations within each cluster.
- We then employ NiGEM for climate-sensitive projections of identified covariates.
- Subsequently, robust econometric methods to generate baseline projections and climate sensitive pathways for diverse scenarios, in cases where climate sensitive NiGEM MEVs are not available.
- Under the Current Policies scenario, NiGEM only provides climate pathways relating to "chronic" physical damages. Hence, attribution analysis using the impact and frequency of wildfires in different region provides MEV pathways that take into account "acute" physical risks.
- Finally, we compute PD forecasts, and consequently ratings, using the coefficients and climate sensitive covariate projections obtained in previous stages.

CLIMATE RISK SCENARIOS

In what follows we will outline the climate pathways (scenarios) proposed by NGFS (2021).

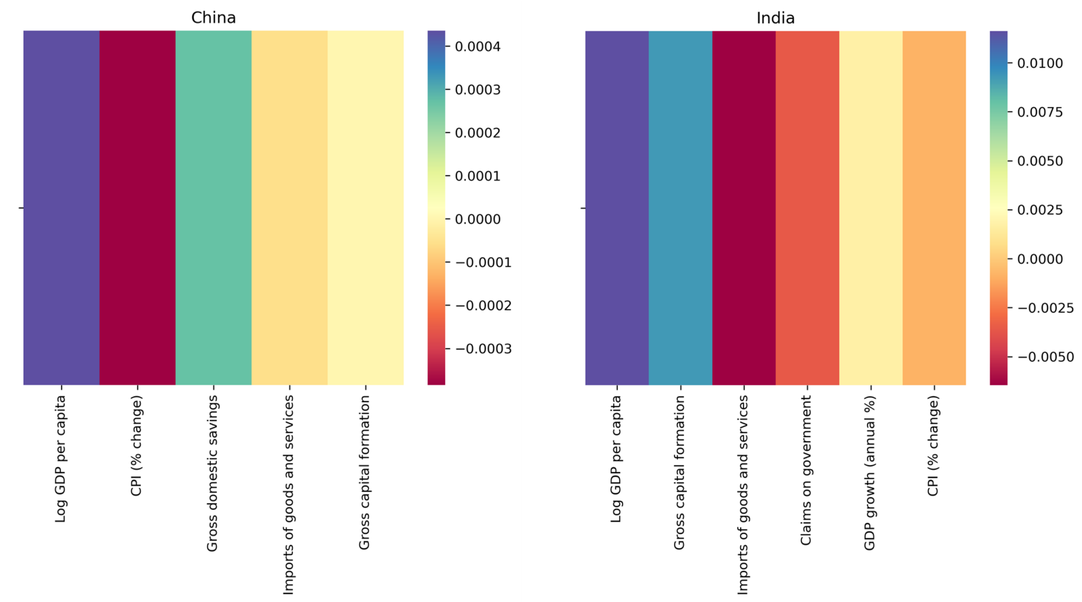
TABLE 2

Orderly	Net Zero 2050: Strict policies to limit global warming to 1.5°C. Below 2°C: Gradual increase in policies giving a 67% chance to reduce global warming to below 2°C.
Disorderly	Divergent Net Zero: Divergent policies across sectors achieves Net Zero by 2050, albeit with higher costs. Delayed Transition: No policies are introduced until 2030, with differing levels of actions across regions thereafter.
Hot house world	NDCs: Nationally Determined Contributions assumes moderate heterogeneous climate ambitions. Current Policies: Only currently implemented policies are preserved.

RESULTS

- Figure 3 showcases the normalized coefficients pertaining to clusters 2 and 3.

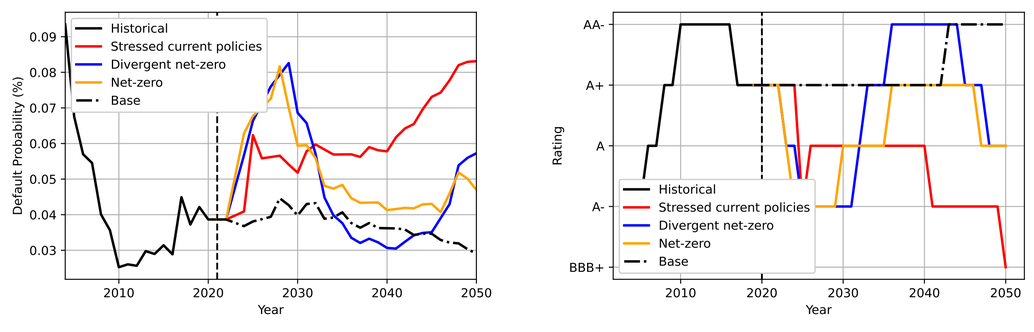
FIGURE 3



Cluster 2 Cluster 3

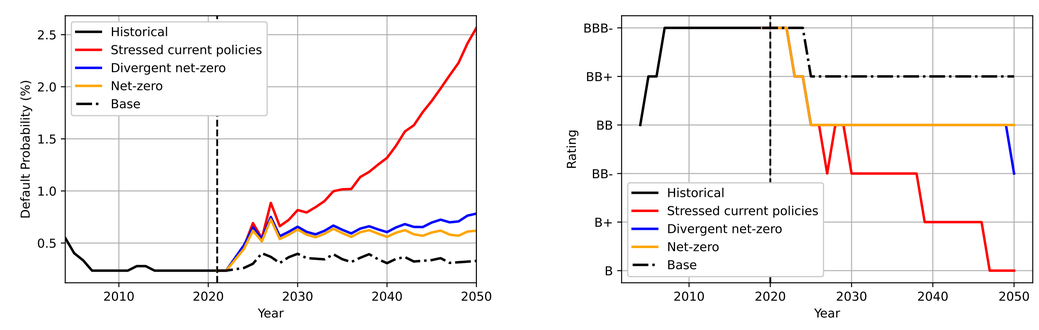
- Figures 4 and 5 in turn show China and India's projected PDs and their respective sovereign ratings under different climate scenarios.

FIGURE 4



China's projection of PDs and ratings across an array of climate pathways.

FIGURE 5



India's projection of PDs and ratings across an array of climate pathways.

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