Climate Transition Risk and Asset Pricing

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May 14, 2024

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Climate Transition Risk and Asset Pricing

Uncertainty about states of world with climate risks is a key driver of asset prices. Uncertainty about the states of the world with climate risks can be thought with the uncertainty about the climate scenarios.

2.1 Climate Transition Risk Dynamic

The evolution of aggregate consumption growth Δc_{t+1} is described as:

$$\Delta c_{t+1} = \mu + x_t + J_{t+1} \tag{2.1}$$

where μ is the unconditional average, x_t represents the time-varying expected consumption growth and J_{t+1} is the climate transition shock to the economy. It can be referred to the abrupt introduction of a carbon tax or a sudden shift in climate policy.

Example X

Sample Paths: Trend Growth and Above-Trend Growth

The expected consumption growth is:

$$x_{t+1} = \mu_x + \rho x_t + \phi J_{t+1} \tag{2.2}$$

with a persistence parameter ρ and innovations also driven by the shock J_{t+1}. The parameter ϕ captures the way the climate shock J_{t+1} affects future path of consumption growth.

Example X

Sample Paths: Above-Trend Growth,With andWithout a Climate Transition Shock

In any period, the transition shock J_{t+1} can take the value $-\varepsilon \in (0, 1)$ with probability λ_t or 0 with probability $(1 - \lambda_t)$. The probability λ_t is itself time-varying, with the dynamics:

$$\lambda_{t+1} = \mu_\lambda + \alpha\lambda_t + \eta x_t + \xi J_{t+1} \tag{2.3}$$

in addition to an autoregressive term, it depends on lagged measures of economic activity (x_t) as well as on the current shock J_{t+1}.

Example X

Time-varying transition risk

We think about climate transition risk in terms of a relatively low-probability catastrophic event that could dramatically impact the economy.

The parameter λ_t captures the conditional probability of such an abrupt shift occurring and ε captures the magnitude of the shock.

The occurence of the abrupt low-carbon shift also affects the future path of the economy, since it directly affects the expected consumption growth x_t. Specifically, when $\phi > 0$, the transition shock reduces not only consumption immediately but also future expected consumption growth.

Example X

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When instead, $\phi < 0$, there is a partial mean reversion after a transition shock. This case has an especially interesting interpretation when modelling climate transition: it captures the ability of the economy to shift towards a low-carbon economy.

Example X

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Through the parameter ξ, a transition realization also affects future climate transition risk λ_t.

Example X

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Finally, the model allows for feedback effects between climate change and the economy. Climate risks affect the economy (when the climate disaster occurs) and the economy affects climate risks through the effects of x_t on λ_{t+1} (modulated through the parameter η): when economic activity is high, climate risk increases. But when the climate shock materializes, consumption is low.

Example X

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2.2 Climate Transition Risk Valuation

Once the physical process of climate change is modeled, one need to choose an utility function for the representative investor. It implies a stochastic discount factor (SDF) that prices assets in the economy, at equilibrium.

When the uncertainty emanates directly from the climate process itself, climate damage tends to be unexpectedly high in times when consumption is low because climate disaster realization are a primary driver of reduced consumption.

2.3 Climate Transition Risk Beta and Excess Returns

Assets that are positively exposed to climate risk - that is, assets with low payoffs when climate damages are high - thus tend to require positive risk premia. On the other hand, assets that are negatively exposed to climate

risk - assets that payoffs primarily when climate are realized - tend to require negative risk premia since these assets provide an insurance against bad (high marginal utility) states of the world.

DERIVATION OF BETAS

Example X

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2.4 Conclusion

We've focused on climate transition risk, but same approach can be applied to physical risk.

Chapter 3

Empirical Methods for Asset Pricing

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Quantity-Based Approach