Unhedgeable Risk: How Climate Change Sentiment Impacts Investment

Discussion by:

Dr. Irene Monasterolo, PhD, Boston University (US)

Email: irenemon@bu.edu

Bank of England, London, 14th November, 2016

BU The Frederick S. Pardee Center for the Study of the Longer-Range Future

Outline

- The issue at stake: disclosing the climate – finance risk nexus
- Paper’s objectives, methodology and results
- Discussion of strengths and weaknesses
- Conclusion and policy recommendations:
  - contribution of climate stress tests to inform climate – finance risk disclosure and Central Banks’ non-sector neutral monetary policies

Disentangling the climate policy - finance nexus

- **Climate policy** identified as a **source of carbon stranded assets** – i.e., assets at risk of losing much value as a result of *unburnable carbon* (Caldecott and McDaniels, 2014; Leaton, 2012):
  - Assets prices' volatility, complexity of risk from correlated shocks
- **Complexity of risk led by interconnectedness of financial actors** (Battiston et al., 2016) and **intrinsic uncertainty of climate policies** (Gillingham et al., 2015).
- **Risk transmission** from climate policies to finance and the economy is **substantial:**
  - Financial actors' exposure to climate-policy relevant sectors is <u>large</u>, <u>heterogeneous</u>, <u>amplified</u> by indirect exposures via financial counterparties.
- **Fossil fuels subsidies** complicate the picture *distorting investors' risk perception of stranded assets,* thus delaying divesting and capital mobilization in green sectors.

Paper’s objectives

- Assess how short-term (5 years, 2016-2021) shifts in investors’ sentiment induced by awareness of future climate risks could impact on **investments’ portfolios (assets values) and GDP growth:**

  1. Climate change scenarios and sector impact derived from literature

  2. Climate change sentiments based on 1. to test how investors may react in 5 years to potential future effects of different climate change trajectories

  3. Macroeconomic shocks modelled using the Oxford Economics’ General Equilibrium Model (GEM)

  4. Beta values for sector impacts calculated using GEM (equity index by country)

  5. Portfolio’s analysis: relative performance of fixed income, equities and commodities for each country to describe quarterly shifts in mark-to-market values over 5 years in Cambridge portfolio model

- Identify proportion of climate sentiment **risk that can be diversified or hedged** through portfolio structure.

Methodology

- **Stress test** of representative investors' portfolios using economic and market confidence shocks derived from climate change sentiment scenarios
- **3 climate change sentiment scenarios** modelled using Oxford's GEM:
  - **Baseline** (no governments' step up in climate change action)
  - **Two Degrees** limit of average global temperature increase above pre-industrial levels
  - **No Mitigation**: market will self-organize to "allow adaptive responses to climate change impacts" and likely + 4degrees C in 2100
- **Shocks** based on different levels of carbon taxation, energy investment, energy and food prices, energy demand, market confidence, bond market, housing prices, etc.
- Impact assessed on **four typical investment portfolios** for pension funds (Conservative, Balanced, Aggressive) and insurance companies (High Fixed Income).
- Impacts modelled **over five years** at portfolio, asset class, sector and regional levels.

Results

1. There could be **very significant, short-term financial impacts for all investors**

2. Typical aggressive global equity investment portfolio could see **losses up to 45%:**
    - 53% of loss **hedgeable** if investments reallocated (e.g., into low low-carbon sectors)
    - 47% **unhedgeable** without system-wide action to address drivers of risk
    - **Emerging markets** are the worst affected
    - Worst affected sectors across all scenarios: **real estate** in developed, **energy, oil and gas** in emerging economies

3. **Shifts in investors' sentiments could cause global economic growth to slow** in 2015-50:
    - No mitigation worst case scenario in both short and long term
    - 2.2% Global GDP@Risk in Two degrees scenario vs 4.7% in No Mitigation (and 3 Qtr recession)

4. **Need for coordinated stakeholders' action** to secure long-term interests of investment funds and their beneficiaries such as pension holders.

Strengths

- Paper’s interesting novelties in terms of focus of the analysis and methodology used:

1. Provides an analysis of potential *short-term impacts* of climate change risk sentiment on investors’ *financial portfolio’s value and GDP*

    - Previous stress tests focused on *long-term* effects on GDP of climate change *physical risk, neglecting* climate policy shocks.

2. Build sentiment scenarios on recent relevant literature avoiding the use of Integrated Assessment Models (IAM) and their well-known limits:

    - Employing a social welfare function based on arbitrary assumptions about the discount rate (Pyndick, 2013; 2015; 2016) IAM underestimate the impact of climate change on GDP, negative externalities, and optimal carbon tax (Ackerman and Stanton, 2012).

3. Uses net present value (NPV) to compare the long-term impact on global GDP with respect to the Baseline scenario.

4. Provides GDP@Risk calculations for each of the three sentiment scenarios, comparing short and long-term outcomes.

Weaknesses

- **Stress test:**

1. Micro-level approach: the paper considers homogeneous groups of actors thus it doesn’t allow us to identify individual actors’ role in risk transmission, nor winners and losers from alternative climate policy shocks

2. Interconnected financial actors:

- **No indirect effects considered:** it is not possible to identify systemic risk creation and spread though *amplification of shocks due to indirect exposure via financial counterparties:*
- Indeed, financial actors’ exposure to climate-relevant sectors could be amplified by indirect exposures via financial counterparties (40% of investors’ portfolios), as shown by Battiston et al. (2016b).

3. Uses an **aggregate classification of sectors of activities** (e.g., NACErev2), which doesn’t account for heterogeneity of economic activities as regards their contribution to GHG emissions (Scope 1).

Weaknesses: use of GEM with climate impacts

- GEM have well-known limits (Ackerman and Stanton, 2012; Farmer et al., 2015):
  - **Adopt the concept of market equilibrium** that prevents from the analysis of the effects of Schumpeterian technical change on the disruptive innovation necessary to support the green transition (Balint et al., 2016; Lamperti et al., 2016)
  - **Model a small number of representative agents** who maximize an expected utility function , thus preventing the analysis of the dynamics of income inequality related to climate policy and financial risk (Kirman et al., 1992)
  - Cannot display the impact of climate policies on endogenous technological change and green innovation as a result of agents' behavioural response (Dosi et al., 2010; 2015)
  - Macroeconomic results are driven by **exogenous macroeconomic input shocks**
  - **Don't have an explicit representation of capital nor of the financial sector**, which is fundamental for understanding climate policy feasibility (Monasterolo et al., 2016)
- But modelling climate policies is challenging because it involves coupled human-environmental dimensions characterized by strong non-linearity, tipping points and irreversible dynamics above certain GHG emissions concentration.

Open questions: assumptions

- **Sector impacts** from existing climate models that are still unable to deal with sub-regional disaggregation of climate impacts (e.g., small islands which are most exposed to climate change risk and least able to cope with it)
- **Physical effects of climate change** assumed to have limited impacts on the economy over the next 5 to 10 years
- Scenarios **do not model changes in the evolution/dynamics of climate policy implementation** and assume that markets behave consistently:
  - Thus the model doesn't account for uncertainty of policy reaction with the increase of climate change risk (e.g., fast introduction of climate mitigation policies) and markets reaction (e.g., fast divesting from fossil fuels intensive sectors that are at risk of stranded assets, inducing volatility in assets' values).

Role of climate stress tests for Central Banks

1. **Identify investors' individual risks of losses** deriving from financial actors' exposure to climate stranded assets (considering both physical and policy risk)
   - Assess **direct exposure** of financial actors' to climate-policy sensitive sectors

2. **Analyse** how such risks might propagate through the financial system with **implications on systemic risk:**
   - Assess risk from **financial actors' indirect exposures** via financial counterparties (e.g., banks' exposure to fossil fuels sector via their exposure to investment and pension funds)
   - Analyse **amplification effects** and **risk of contagion from interconnectedness**

3. Quantify maximum loss on the book value of the loans that the bank could withstand, as a result of specific climate risks

4. **Identify potential countermeasures** (e.g., regulatory, strengthen monitoring).

Conclusion

- **Climate stress tests are a potentially powerful tool** to show climate change risk of impact on investors' portfolios and their cascade effects on the real economy
- Yet, **lights and shadows could be identified** when stress tests are based on GE models, don't account for the role of interconnectedness of financial actors on systemic risk, and for heterogeneity of risk.
- **Climate stress tests based on network models** of financial interdependencies could contribute to overcome such limits by addressing **indirect** risk effects on **individual** financial actors
- **Climate policy scenarios from evolutionary economics-based models** (e.g., Agent Based and System Dynamics Models) could contribute to relax equilibrium assumptions and **study non-linearity and uncertainty** of climate policy impact:
  - *Important to study how the economy, climate and finance evolve endogenously through continuous cross-sector interactions.*
- *What lessons could derive for a green monetary policy agenda?*

Bibliography

- Ackerman, F., DeCanio, S.J., Howarth, R.B. and Sheeran, K., 2009. Limitations of integrated assessment models of climate change. *Climatic change*, *95*(3-4), pp.297-315.
- Ackerman, F. and Stanton, E., 2012. Climate risks and carbon prices: Revising the social cost of carbon. *Economics: The Open-Access, Open-Assessment E-Journal*, *6*, p.10.
- Balint, T., Lamperti, F., Mandel, A., M. Napoletano, A. Roventini and S. Sapio, 2016. Towards Agent-Based Integrated Assessment Models: Examples, Challenges and Future Developments. Working paper series, Laboratory of Economics and Management (LEM), Scuola Superiore Sant'Anna, Pisa, Italy.
- Batten, S., Sowerbutts, R. and Tanaka, M., 2016. Let's talk about the weather: the impact of climate change on central banks. Bank of England, Staff Working Paper No. 603, London.
- Battiston, S., Roukny, T., Stiglitz, J., Caldarelli, G. & May, R., 2016. The price of complexity in financial networks. *PNAS* www.pnas.org/content/113/36/10031.full
- Battiston, S., Mandel, Antoine, Monasterolo, I., Schuetze, F., Visentin, G., 2016. A Climate stress-test of the EU financial system. Available SSRN id=2726076.
- Caldecott, B. and McDaniels, J., 2014. Stranded generation assets: Implications for European capacity mechanisms, energy markets and climate policy. *Stranded Assets Programme, SSEE, University of Oxford*, pp.1-62.
- Coady, D.P., Parry, I., Sears, L. and Shang, B., 2015. How large are global energy subsidies? IMF Working Paper 15/105
- Dosi, G., Fagiolo, G. and Roventini, A., 2010. Schumpeter meeting Keynes: A policy-friendly model of endogenous growth and business cycles. *Journal of Economic Dynamics and Control*, *34*(9), pp.1748-1767.
- Dosi, G., Fagiolo, G., Napoletano, M., Roventini, A. and Treibich, T., 2015. Fiscal and monetary policies in complex evolving economies. *Journal of Economic Dynamics and Control*, *52*, pp.166-189.
- Farmer, J.D., Hepburn, C., Mealy, P. and Teytelboym, A., 2015. A third wave in the economics of climate change. *Environmental and Resource Economics, 62*(2), pp.329-357.

- Gillingham, K., Nordhaus, W.D., Anthoff, D., Blanford, G., Bosetti, V., Christensen, P., McJeon, H., Reilly, J. and Sztorc, P., 2015. *Modeling Uncertainty in Climate Change: A Multi-Model Comparison* (No. w21637). *National Bureau of Economic Research.*
- Kirman, A.P., 1992. Whom or what does the representative individual represent?. *The Journal of Economic Perspectives*, *6*(2), pp.117-136.
- IEA, 2015. Medium-Term Renewable Energy Market Report 2015.
- Lamperti, F., Dosi, G., Napoletano, M., Roventini, A. and Sapio, A., 2016. Faraway, so close: an agent based model for climate, energy and macroeconomic policy. LEM Working Papers series.
- Leaton, J., 2012. Unburnable Carbon–Are the world's financial markets carrying a carbon bubble. *Carbon Tracker Initiative*.
- Monasterolo I., Raberto, M. (2016). The εIRIN hybrid System Dynamics – Agent Based model to assess the role of green fiscal and monetary policies. Available at SSRN: http://ssrn.com/abstract=2748266. Review and resubmit status at Ecological Economics.
- Pindyck, R.S., 2013. Climate change policy: What do the models tell us?. *Journal of Economic Literature*, *51*(3), pp.860-872.
- Pindyck, R.S., 2015. *T*he use and misuse of models for climate policy (No. w21097). *National Bureau of Economic Research.*
- Pindyck, R.S., 2016. The Social Cost of Carbon Revisited (No. w22807). *National Bureau of Economic Research*