Looking Back; Looking Ahead: Background notes to *Settling Climate Accounts: Navigating the Road to Net Zero*

*Working Paper*

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Looking Back

Epilogue/Ancient History

Accounting for climate has traced out a twisting path. Even now in the middle of our travels, it is perhaps less and less clear where we are going. Although seemingly well clouded in the rapid passage of time between 1990 and 2020, the origins of this odyssey were remarkably idealistic and ambitious. Looking back over the near thirty years since the Rio Earth Summit’s Framework Convention on Climate Change (UNFCCC), the aura of optimism and simplicity that surrounded and supported the initial collective attempt to define and manage climate action is somewhat painful to recall, let alone recapture. The formal climate regime reflected beliefs in, and commitments to:

- political governance through legal agreements (UNFCCC) and multilateral institutions (Inter-governmental Panel on Climate Change);
- a post-Cold War consensus (Washington Consensus; Single EU Market) that the economic rationality of private markets and prices that internalized environmental costs through a single instrument (cap and trade);
- widespread faith in a geopolitics of global development that foresaw universal rules and obligations for advanced and emergent nations, complemented by temporary patches for special treatment of the less well off until expected economic growth allowed their graduation to full and equal status (Clean Development Mechanism, financial and technological transfers, adjustments for fossil exporting states).

More informally, these explicit commitments were built upon a contextual foundation that recognized:

- a macro-economic future of stable, steady (manageable) growth, with increasing demand for cleaner, lower cost energy, transport, food, and space/industrial heat;
- institutionalized innovation in renewable energies and electrified production that would shift the relative prices of low and high carbon technologies to meet new incremental demand;
- the restructuring—to curtail inefficiency, corruption, and wasteful investment—of state owned, administered and financed firms and financial organizations, including state budgeted core infrastructure, in favor of privatized, market driven provision of energy and other carbon intensive services;
- a smooth process of gradual adjustment over the extended time horizon (1990-2050) that would mitigate, under stable macroeconomic growth, dislocations of labor and capital associated with transition from high to low carbon economies;
- convergence of institutions, systems of governance, and cultural/behavioral norms, around democratic and market-centered principles with coordinating multilateral regimes, as emerging and poorer nations traversed the process of economic development.

If this description of the recent past seems incredible, dim, or simply ancient history, dealing with our now quite transposed climate agenda may usefully ask about what went right, what went wrong, and how have we made...
turns to correct our course. On the positive side of the record, two major confirmations of the climate horizons envisioned even at its origins. The relative prices and performance of renewable energy installations—on and off-shore wind and utility and household scale solar—continued to fall towards, and in many places, seasons and times of day, parity or below the marginal costs of fossil energy. Similar progress down learning curves was traceable for electric vehicles. Beyond technology-driven predictions, the haze of climate skepticism that impeded the political and market force of leading-edge science was lifted across large and politically significant populations in advanced industrial and developing nations. The acceptance and socialization of this knowledge facilitated the mainstreaming of climate concern and action from a limited coterie of specifically informed actors in particular geographies to consumers, companies, financial institutions, municipalities and sub-national governments more globally dispersed. Reinforced by the empirical evidence supporting largely accurate predictions about the directions of chronic temperature and sea-level change, and the incidence and volatility of extreme weather events, the climate agenda climbed out of an environmental basement toward a better illuminated and widely recognized status that made credible claims on everyone’s attention.

On the flip side of the post-Rio record, established expectations have gone astray. The UNFCCC multilateral regime abandoned its central role and responsibilities after the 2009 failures at Copenhagen to affirm, reform and update the Kyoto Protocol and its logic of mandatory targets and graduation of nations to their commitments. The 2015 Paris Accords represented a near-spectacular repair of the then much depleted enthusiasm for widely coordinated climate action, but its restructured constitution of pledge, review, and, hopefully, deepen the register of non-standardized national contributions there created surrendered the original pride of place that prioritized legal binding and close to universal climate framing. Similarly, enactments of effective member state enactments of agreed carbon pricing through cap and trade stalled in most principal jurisdictions after its adoption across the European Union. Instead of a single, comparable and monitorable instrument that allowed an easy integration, tracking and review of national climate actions, a diverse portfolio of regulations, subsidies, and low-level fiscal charges that far underpriced estimates of the social cost of carbon proliferated. The Clean Development Mechanism, the complementary trading regime meant to extend cost-effective mitigation of industrial and deforestation emissions to emerging and developing markets was exorcised after pervasive gaming undercut the quality of assets being exchanged.

More disruptive than the displacement of multilateralism as the institutional driver of climate were the contextual political economic conditions in which the idealist architecture was to be carried forward. In the wake of the 2008-2009 financial crisis in the West, and a consequential 2010-2015 diffusion of slowed growth in the lead emerging market economies of Latin America, Southern Africa, and South and East Asia, both the predicted growth in demand and the availability/cost of public and private national infrastructure capital was constrained. Even with declining relative prices for these new technologies, the pace of retirements, additions and system reforms adapted to these alternative proportions of low and high carbon was everywhere economically impacted and in much of the world politically transformed. In this latter sense, the new macroeconomic reality both contributed to, and was managed under, a surprising resistance of globally empowered national polities to converge on democratic and market-centric norms and institutions. Especially in the economic pillar and carbon intensive sectors of energy, transport, heavy industry and agriculture, state production, administration and finance remained prominent, if not reinforced. It is only against this juxtaposition of confirming and disruptive qualities of the original framing of climate action that three principal turns or changes of that initial course that have evolved around the Paris era can be described, understood, and productively evaluated. The three turns to Green Finance, Risk and Net Zero are largely concurrent, overlapping and often ambiguous in their conceptual and practical implications.
As interpretative, rather than formal, characterizations of the current state of climate frames and practice, their scope may be partially clarified with reference to the observed problems around which they arose and were intended to correct.

**Three Turns**

Of the three, the turn to Green finance was the earliest, the most simple and the most consistent with the assumptions inter-woven in the multilateral climate regime- a reaction to the disappointments with multilateral legal regimes post-Copenhagen and to the austerity programs adopted by advanced and emerging market governments after the financial crisis and its associated recessions. The turn to Green finance in the face of these twin setbacks reaffirmed belief that climate progress was actually safe on a type of autopilot in which falling technology prices, a cyclical (rather than a structural) resumption of economic growth and efficient private market operations, even in the absence of expected state action, would propel the world on the path to sustainability and low carbon. The optimism of Green Finance centered on the perception, expressed principally in renewable wind and solar energy, that to build more, was to build green. Where pure market economics dictate that new infrastructure will be clean infrastructure, if a society were today starting greenfield, it would produce a low carbon system from scratch. In turn, it implies that all costs associated with transition involve any costs to be paid for the dismantling of brown assets and businesses, as well as the physical damages that additional climate effects may impose during the length of this overhaul.

Green finance posits that as long as demand sustained growth, each increment of investment would advance transition to a low carbon system, as long as capital markets were efficiently informed and economically motivated. The replacement of higher cost fossil with lower carbon assets would yield widespread, if incremental, gains across society, job growth demonstrated by prior episodes of systemic productivity increase, and only marginal reliance on taxes and public subsidies, whose duration in nascent phases of market penetration would be sun-downed and whose rationale would be both limited to proof of concept/initial scaling and suspected of rent-seeking. Financial market regulation and the facilitation of special purpose financial institutions or funds to reduce organizational inertia might accelerate Green finance, but neither the limitations of public budgets nor the need for substantial reform of public policy would impede transition as the portfolio of low carbon and cost-efficient technical options and a routinized reliance on expanding private demand and private project investment across all carbon-intensive sectors. These articles of climate faith proved favorable in ongoing experience in Northern European and North American renewable energy markets with private capital, light doses of carbon prices or public tax incentives and guarantees, the scheduled retirements of aging (and fully amortized) fossil generation, and flexibility services from abundant unconventional gas and dispatchable hydro resources. They have been, since the COVID-19 pandemic, reinforced in these same OECD economies under the rationales for increased public debt and infrastructure investment under the Build Back Better and Green New Deals rubrics. Further afield and down the road, more rigorous testing of the turn to Green finance may prove more problematic.

If Green finance fixed the climate focus on the upside of low carbon transition and the simple storyline of lower cost technologies that earn investment returns by outcompeting existing plant in competitive markets, the Turn to Risk inverted the lens. Following by several years the rise of the Green finance narrative, it noted that while most new energy investment in the advanced and emerging nations was in clean technologies, the slow pace of brown retirements in low macro-growth conditions that cut new investment was not aligned with expected trajectories to global decarbonization. To reframe climate action around its risks, rather than its returns, highlighted the
downside of transition—who gets left behind and who bears their losses—and shifted the focus of the story from economics to political economy and finance. From the abstract heights of theory, a climate risk frame could mirror the broad failure of governments to enact realistic carbon prices, since properly revaluing assets for climate risks not priced into imperfect capital markets could equally correct for missing climate prices. Green finance was also consonant with most orthodox economic accounts of change in that it emphasized that the increased productivity and job creation of low carbon energy would over time yield benefits that would potentially compensate the sum of downside losses. However, the Turn to risk located the sources of a stalled transition in the political power of embedded fossil interest groups and financial analysis that suggested that, unlike transition benefits that were widespread and in the future, financial losses were concentrated and nearer-term. A Turn to risk attracted attention because it explained, as Green finance did not, the empirics of evolving climate action, reasons for re-thinking the value of government policy, the institutions and mandates through which nations might engage climate change, and the nature of the analytical models that would be needed to do so.

- The main infrastructure-heavy sectors that are carbon intensive—especially energy, mobility, and food—have long been politically sensitive and historically subject to state ownership, financing and administration. Staffed, budgeted, and regulated by political appointees, populated by privileged workforces, the retirement or displacement of dedicated assets, know-how, tax revenues, dependent communities and specialized labor under stressed macro-economic conditions is often perceived as the expropriation of an endowment than as an artifact of creative destruction. Especially where positive returns have been limited, downside risks are claimed as entitled to coverage. Where resources to cover these losses fall upon state budgets or consumer charges, the practical result is often to reinforce the inertia that always afflicts transformative political choice.

- The discovery of concentrated, near term risk and longer-term, diffuse benefits poses financial and institutional problems that economics may disregard. If it were easy to securitize or borrow against enlarged future net revenue streams or monetizable community well-being, up front losses could be compensated in favor of systemic transition. But promises to make up the losses of restructuring on a deferred basis that matches the realization of projected returns threaten unruly, uneven and unfair transitions. The potential financial instabilities of concentrated, uncompensated losses from transition risk have alerted central banks both to the chaotic dynamics of financial crises and to the disruptive impacts of politically empowered groups holding effective puts of climate risks to the sovereign balance sheet. In either case, this asymmetrical distribution of physical and transition risks, and the likelihood that rational actors will behave strategically in these circumstances, argues against delegating the stability of modern economies to the operations of markets alone.

- As fiscal authorities have not imposed serious and ideally universal carbon pricing as mandated by the Rio/UNFCCC climate framework, climate advocacy interests have sought new and less politically constrained state agents to make up for this failure. As the specter of unmanaged, disorderly and inequitable climate risk has increased with time, this substitute champion has more and more been identified among central banks and prudential regulators. Financial authorities have multiple advantages in this regard. When fiscal measures proved impotent and scattered in the wake of the 2008 financial crisis, politically independent, technically staffed central banks stepped up with aggressive, harmonized, innovative, and sustained interventions with targeted monetary policies and asset purchase programs like QE2 to rein in the damage. Similarly endowed national bank, insurance and security regulators are well established across the globe and more accessible to actionable claims than are judicial remedies like fiduciary duties or corporate governance rules for shareholder engagement.
The Turn to risk has successfully brought to the post-Paris depleted climate armory new vehicles and instruments that may ultimately breed the institutional capacity for the orderly, practical and coordinated management of transition risk its institutional attributes and recent organization into the NGFS (Central Banks and Financial Regulators Network for Greening the Financial System) promises. Along this alternative route to effective climate action there lie both political issues such as contestable political mandates and technical questions about combining financial and macroeconomic modeling, with new data-intensive methods in managing more radical uncertainty than heretofore. The irony, if not the limits, of an NGFS driven by European Central Banks, with likely US Federal Reserve backing in the offing, is that transition risk in these nations is relatively light. The real risk lies in South Africa and across Asia, where infrastructure fleets are young, natural gas is expensive, and where Central Banks are less independent and less enabled.

The Turn to Net Zero, emissions disclosure and the announcement of targets for emissions reductions to the net zero goal has amalgamated themes developed in both Green finance and Risk, but with its own particular added references and emphases. It extends the Green finance narrative of primary contributions to, and responsibilities for, climate action from private corporations and assigns primary, if not disproportionate, roles in its implementation to financial institutions and financial markets as does the Turn to Risk. But, at the same time, it situates its climate frame in a wider ambit of socio-economic transition that better reflects the context of environment as one leg of sustainable development and adds the appeal of a more mainstreamed coalition to the politics of climate. Net zero then contrasts a deadlocked, and state-driven centered multilateral process with an implicit nod to the upside future of low carbon production that calls in the concurrent economic transition to information technology. The inclusivity of Net Zero pledges from companies, banks, asset owners and managers, cities, provinces, countries, industry associations mirrors the fourth industrial revolution storylines of “Here Comes Everyone”, and the effective engagement of all of us through platforms and crowds. Its decentralized agenda of climate action is embedded in the enlarged scope of change of ESG, where the G of participatory and S of diverse governance are universalized through climate as #13 of the global development goals. The Turn to Net Zero both reanimates post-Paris climate politics through its allusions to the politics of democratization and equality, while sweeping in the upside growth promises of Green finance and the regulatory (financial) apparatus of the Risk-focused climate frame.

The internal history of Net Zero probably has as many founts of origin as a movement to decentralization should identify, but there are useful links to the widely recognized and well regarded Task Force on Climate-focused Financial Disclosures (TCFD). While processes for monitoring, verifying and reporting (MRV) greenhouse gas emissions has been a core endeavor of multilateral attention since the beginning of the UNFCCC regime, the negotiation of those rules always concentrated on national carbon levels to be carried on as state obligations. In contrast, the TCFD was chartered by the Financial Stability Board, composed by private financial banks, insurers, corporates, accountancies, data users and data preparers, and which described standards for associated organization commitments their practices and plans around four axes of climate-related action. The axes of disclosure covered governance, strategy, targets and metrics, and risk management including scenario analyses that has attracted widespread global adherence to be held up as a credible manual of Net Zero content as concept and as practiced. While the state of play, evolution and evaluation of Net Zero disclosure as a principal frame for climate action is a primary subject of this volume, it is worth spotlighting, given its remarkable rate of adoption, several features of this Turn that will command particular attention even in the most introductory sense.
• The TCFD is governed by voluntary standards agreed in a process of industry self-regulation. It foresees a multiyear development of its guidelines via a mechanism of compliance, report and review, abetted by committees for evaluation of results and consensual sorting out of inadequate outcomes. While analogous in form to the Paris Accords, the TCFD provides for neither explicit interaction with the state centered multilateralism nor demands any reliance on governmental regulation.

• The scope of disclosure boundaries in emergent TCFD and all Net Zero aligned disclosure goes beyond the carbon footprint of conforming agents to include upstream value chains and downstream investees (Scope 3) in their reporting obligations. In a globalized economy, the resulting multiplication of reported emissions will necessarily pick up supplier and financed emissions in regions and nations where national Paris contributions fall short of Western ambitions and political reach. The administrative complexity and cost of net zero, as well as its geo-political sensitivities, will be determined in the yet uncertain obligations of private actors to manage the risk disclosed.

• TCFD standards and reporting practices require that associated organizations both set metrics for calculating and targets for emissions (across multiple scopes) and manage risks (physical and transition) that are carbon related. They define internal organization process for risk management and methods that use scenario analysis to reflect the necessary uncertainties that attend future states of the world and the businesses that produce their returns. But alignment of calculated emissions, those of an organization and of others in its value chains, with a target level of emissions or of targeted path to net zero carbon is not the same project as measuring and managing a firm’s prospective climate-related risks over various durations. This divorce in objective and method between risk and alignment under the single banner of Net Zero was, and perhaps is still, left to evolving practice to be clarified.

• By its decentralized nature, Net zero accounting poses questions about how it all adds up. As the contributors to this volume describe, some of these technical issues of data quality and reporting are already under scrutiny by industry associations of financial institutions, data providers, or consumer (investor) protection agencies. Like other accounting regimes, emissions (or risks) will be reported by organizations at different levels such as nation states, cities, real economy and financial economy firms. Often, they may be assigned or offset across multiple countries or attributed to multiple classes of buyers or asset managers. Financial intermediation that carries capital along normally complex chains of organizations that link taxpayers and investors to carbon emitters shrouds accounts from transparency and coverage. These practices demand accounting conventions, which, in turn, may be more or less adequately built up through the evolution of voluntary standards and market dynamics.

But, other aspects of effective climate accounting threaten to impose demands less tractable to industry regulation or self-enforcement. Since accounting and disclosure standards are usually linked to some (legal) duties for managing quantities revealed, what obligations does Net zero suggest attach to emissions reported? Can these obligations be described without reference to credible and binding transition schedules that must add up to more aggregated and coordinated (national) climate commitments? And, emissions can be, and regularly are, transferred across balance sheets via sales, derivatives, hedges, and pools, with or without reserves adequate to the changed carbon balance sheets or risk topography and appetites. Like tax accounting, strategic behavior and gaming by emitting organizations implies a need for consolidating accounts, or green and brown value chains will separate and flourish. But, to the extent that nations or regulators believe themselves entitled to regulate or
enforce the stringency of climate policies, the reach of uniform consolidated accounting will be politically as well as administratively restricted. Multilateral national emissions (MRV) accounting was contested; the rules of Net zero accounting and its tied climate responsibilities remain yet more obscure.

Three Turns: Interplay and Contest

Nothing is perfect: neither the original climate framing—with its virtues of economic logic, structural simplicity and political idealism—nor any of the three turns taken in reaction to the internal frailties of the initial regime or the changes of political and economic context in which it played out. Each turn was built on valid intuitions, mutually recognized in their overlapping architectures and different points of emphasis and priority of problematic developments in need of adjusted strategies and remedial mechanisms. Through their individual and collective prescriptions, each of the three turns raises the more pertinent questions of whether their directions and corrections have improved climate performance relative to where we were going in climate, and whether they have steered or detoured us along the road on which we now and ultimately ought travel. The Green finance frame combined the UNFCCC’s founding virtue of simplicity with the self-enforcement of rising markets, but shortly ran afoul as the aftershocks of the financial crisis were imported to emerging and developing nations with declining growth and public finance budgets. But even in the more advanced economies, as the falling costs of renewable energy projects and forecast learning effects of vehicle electrification penetrated investment portfolios, questions about systems integration and the uneven rates of technical innovation across carbon-intensive activities cast shadows across the pace of market-driven low carbon transitions. In the power, mobility and agriculture sectors it was soon apparent that the capacity to scale new low carbon technologies toward agreed emissions goals depended upon adaptive reforms in market design, business organization and industrial ecology, and financial mechanisms retooled around differentiated patterns of risk and return. These shifts at the system level implicated state policies and collective actions to reshape embedded standards and incentives that stalled or derailed the timely diffusion through private markets of cost-proven technologies. When added to the increasing empirical recognition of innovation gaps in harder to abate activities like industrial processes and heat as well as in emissions removals like carbon sequestration, the ubiquity and ease of productivity gains at the project level privileged by Green finance was, at least in the short run, constrained.

While these systemic burdens for transition along the Green finance pathway can reappear in alternative guises under either a Turn to Risk or Turn to Net Zero frame for climate transition, each of these storylines equally expose initially unforeseen complications or political economic challenges to be resolved alongside the pace of technology innovation. The Turn to Risk has revealed both methodological and institutional puzzles and features that may already be constraining its development in application and influencing the prevailing directions of Net Zero accounting in practice. First, while the central focus of the Turn to Risk is the downside risks to corporates, investors, communities and governments of losses incurred from the winding down of carbon-intensive production toward agreed stable levels, there are a largely unexamined set of risks associated with the timing and value of the replacement of these activities with lower carbon energy, transport, heat and agricultural services. Since the share of market indices or gross product of these high fossil systems has been substantial in the pre-transition economy, the toll of transition risks will depend on the pace and quality of the implementation of the multiple technology, policy, finance and organizational complements of an adapted production system. Second, on the downside, the efficiency, order and fairness of winding down a fossil resource dependent economy implies risk metrics and management that are methodologically closer to financial than macroeconomic models. Future risks to commodity values and the businesses that employ them at scale are granular across asset prices and volumes, sensitive to
scenarios with multi-variable change drivers and geographical and sectoral differentiation, and subject to private strategic and political economic (institutional) behavior. Risk profiles are then more and less well managed across a portfolio of behavioral and financial options when they cannot be avoided or passed on to alternative actors. Granular risk analytics are then dynamic, bespoke, costly, and variably endogenous due to the comparative ability of firms, investors, labor or industry associations to defer policy measures or put prospective losses to government social insurance, explicit compensation or implicit bailout schemes.

Major advantages of risk analysis are that its diagnostics and management are self-motivating since they relate to private returns and business sustainability. One likely source of resistance to the technologies of risk are their depressing emphasis on what may well go very wrong. Downside risks are less likely to win politicians votes than Green rebuilds. Short sellers that value such downside risks bring disrepute on themselves, as if were inherently diabolical in betting on a less than rosy future. A second disadvantage of exploring the darker sides that inevitably come with effective management of systems in transition is the realization that effective response requires a non-market ultimate bearer of risk which either itself takes on new changes in risk or governs their allocation, timing and distributive effects. Politically, a climate risk framing implies institutional mandates within governments for monetary policy (e.g. Green and brown subsidies like collateral interest paid on returns; asset support programs like QE2), and prudential [reserves] regulation. These mandates, if extended from classical macroeconomic policy goals like financial stability and full employment, can both justify the recent engagement of central banks to increasing climate risk effectively accumulating on sovereign balance sheets, and create political confusion with fiscal policy (tax, expenditure and guarantee budgets), sectoral policy (regulation; delegated allocation of investment funds) and federal divisions of authority. But integrated up and downside risk metrics and correlative risk management are designed to frame the collective action of (climate-related) systemic transition and imply a structure and process of governance that is hierarchical before it is market-driven and self-enforcing.

Net Zero, a rough cut, work-in-progress alludes across its “here comes everyone” roll out to all of the TCFD elements of disclosure, process, alignment with low carbon emissions targets and risk analysis. Yet Net Zero has emerged as the predominant focal point of this volume because of its trending adoption to describe and organize climate commitments at all levels from the UNFCCC’s Glasgow convenings to local banks and city neighborhoods. The Global F for Net Zero announced on Earth Day 2021 [Banking, asset Managers, Insurance, asset owners, etc.] As outlined in this introduction, Net Zero references the Green Finance frame with recorded and prospective clean technology installations serving as proxies for emissions and the Turn to risk with recorded and prospective emissions serving as proxies for risk. In application, it works around principal difficulties in these alternative frames, sliding past the upside risks of systems transitions and the granular and strategic nature of downside risk. Net Zero seeks an outcome that eliminates, or manages, emissions in the real economy, but puts its heaviest weight on financial institutions impacting their real economy counterparties. Necessarily a great part of an empirical analysis of the evolution and evaluation of this predominant turn in climate action must and will examine the ongoing internal dynamics of disclosure accounting conventions in play. But as is often the case with culture or language, what is left out or unsaid may prove more consequential than what is recorded. In the contest among climate frames, the notable feature of Net Zero disclosure accounting in practice is the absence of scenarios, granularity, strategy and management that would be hallmarks of the Turn to Risk. Of the two main tracks that might have emerged from the TCFD disclosure warehouse, the upside and more optimistic practice of aligning emissions with normative climate goals seems to be in the driving position more than are the more costly and more depressing metrics and management of confronting the downside of transition losses and the residual physical risk incomplete or too costly and slow transition may leave behind. But beyond questions of the longer-run effectiveness of
a growing turn to Net Zero in the climate agenda that is now signaled by empirical performance, this volume should call attention to three topics with influence on climate transition is less frequently brought forward:

- **Impact, incentives and organization?** Beyond concerns with data quality and risk or alignment metrics, TCFD requirements allude to questions of the impact of financial actors on the real economy through reporting on corporate organization, incentives and governance. In effect, these qualitative disclosure pillars recognize the problematic nature of indirect channels of supervision—most often relying on delivering behavioral impacts on emissions or risk management through relative Green/Brown costs of capital and/or active shareholder engagement. Consistent with Foucault’s exegesis of the logic of disclosure, more assertive interpretations of the obligations of Net Zero adherents will demand, with further elaboration of the framework, that financial investors impose internal carbon prices to reweight their portfolios, as a surrogate for governmentally imposed carbon taxes or border charges. While this delegation to the private sector is not yet an established norm of disclosure practice, our analysis gives particular stress to the industrial organization and ecology of finance as it became increasingly specialized and complexly intermediated in concurrence with the technologies and risks of a fossil- and resource intensive bullish economy across the 20th century. Neither the business models, incentives, or risk management vehicles functionally adapted to such a high carbon, high variable cost development pattern would likely be fit for purpose for systemic innovations fitted to a low carbon, high capital cost system. These organizational misfits and the inertial force on the pace and diffusion of transition appear as at least lags in financial adjustment and more extremely as effective redlining of new asset classes. A financial architecture in place can compromise the fulfillment of emissions pledges made in the name of Net Zero, undermine the credibility of the normative scenarios that populate most current macroeconomic risk models, or raise technical questions about outperformance and hedging at the core of efficient climate-weighted portfolios. What seems more unlikely is whether private markets alone, even with a little lift from low-cost blended finance, can sort out and deliver agreed climate goals in concept and in time?

- **Changing financial systems?** If research were to support the proposition that private investor behavior as shaped by available instruments of financial regulation might drive meaningful climate action toward a low carbon economy, recent analysis of financial systems might suggest that shifting conditions in financial practice or reformed understandings of the mandates of financial regulation might contribute or deter such re-direction. Traditionally, one rationale for financial regulation has distinguished sophisticated and institutional investors from more retail investors without like capacity to evaluate claims of asset managers and investees. Investor protection could certainly have growing ambit in climate-relevant finance as the scope and popularity of impact investing has spread across Western markets. But two less widely noted or generally accepted developments in financial theory and practice, also may affect prospective interactions private finance and the climate agenda.

Under all conceptions of the duties of financial agents, the expressed sustainability interests of individual principals would be material to the composition of the appropriate portfolio. But recent critiques of the financial incentives of asset managers have argued that pervasive short termism and benchmarking have undervalued longer run risk adjusted returns that characterize more innovative and illiquid infrastructure assets critical to low carbon systems. A movement for more socially regulated corrections toward a more inclusive or multi-varied duty of materiality that all financial agents would owe their principals could imply expansion of the mandates of central banks and prudential regulators to impose and abet these corrections through differentiated standards and incentives for low and high carbon investment allocations. At the
same time, the extent and reform of financial regulation may produce reactive behavior in financial markets to relocate climate-sensitive investment away from politically regulated, transparent and disclosure laden markets like public equity and commercial bank lending toward private equity, shadow banking institutions, and national financial systems where the coverage and rules of extensive regulation are less intrusive and restrictive. If carbon-intensive capital flees from increasing governmental supervision necessary for Net Zero climate action, the efficacy of a financial disclosure main route to transition weakens.

- **Governance in evolution?** The coupling of climate, environment, social and governance in ESG—let alone UN Sustainable Development—goals, metrics, products and rankings can create confusion of categories and investor frustrating noise as they multiply across capital markets. But their combination also connotes the indistinct boundaries between the sustainability, social, and political economic transitions simultaneously in motion beneath the common arc of disruptive general purpose technologies. The centerpiece of this study is the quality and evolution of the data, metrics and impact of climate action as increasingly framed by, and internal to the practice of, a Turn to Net Zero. By the terms of this framing, a primary focus goes to the mechanics of private financial markets and governance through industry self-organization and market dynamics—with emphasis on the still moving scale and proliferation of pledges, data categories and standards, scopes, models, financial products, hypothetical channels of impact with timing, gaming and management obligations that constitute the inputs over which governance processes are exercised and through which climate outcomes are generated. But, all puzzles internal to Net Zero must be eventually reckoned against the record of low carbon transition and resolved through mechanisms subject to parallel and uncertain pressures for participation, accountability, competence, enforcement and scale.

While Net Zero flourishes initially under self-organization and decentralized forums for negotiating agreement on its conventions and technical roll out, recurring memory of the disparate landscape of the initial climate action framework prompt attention to whether, when and how states and hierarchy may need be brought back in? We may anticipate such concerns over governance around:

- Coverage of Net Zero disclosure commitments; adding up between private and public actors; coordinating national commitments and Scope 3 obligations
- Climate transition through a framework of emissions alignment or risk management?
- Mandates and political balance among governmental institutions, agencies, and special purpose vehicles with variable competence and jurisdiction
- Governance as non-convergent between polities, particularly as deployed in societies organized around low carbon systems with extensive use of networks and artificial intelligence

**Net Zero ascendent?**

The studies in this volume are aimed less at a comprehensive recording of the multiply sourced and worked initiatives that, collectively and competitively, compose the Turn to Net Zero, as a deliberate search for their leading, often rough, edges. Each study individually focuses on a core concept or process implied by the logic of Net Zero disclosure as a moving target from its initial formulations, to evolution in practice, through impacts and options for further remedies.
Within this shared program, the contributions are grouped into two broad parts: Part 1—The Dynamics of Private Finance—explores concerns centered on the quality of information and financial analysis deployed principally around emissions alignment (rather than climate risk) that has preoccupied Net Zero accounting throughout its proliferation from TCFD recognition to its current mass confession. Part 2—Markets, States and Transition—adds studies that stress developments or perceptions of holes, methodological or institutional) within this trending Net Zero practice that question the adequacy or prospective reach of the now emergent Net Zero agenda.

Part 1. Dynamics of Private Finance

• **Chapter 1.** Marc Roston in *A Portfolio Approach to Hedging Climate Risk*, lays out the application of Modern Portfolio Theory to Net Zero financial markets and products, with questions about outperformance claims that abound in these markets.

• **Chapter 2.** Soh Young In and Kim Schumacher in *Carbonwashing: ESG Data Greenwashing in a Post-Paris World*, examine the ecology of data sourcing, provision and rating in Net Zero accounting, drawing on broader economic and organizational insights about incentives to selectively publicize or otherwise game their disclosure behavior.

• **Chapter 3.** Marc Roston in *The Road From Scope Three to Net Zero* investigates Scope 3 emissions accounting in practice, and explores its rough edges as a tool for achieving Net Zero goals for financial services, corporates, and governments.

• **Chapter 4.** Richard Kauffman and Marc Roston in *Fixing the Plumbing: Asset Management, Clean Energy Technology and the Valley of Death* recall the adaptative history of predominant business models and economic incentives in the established asset management industry, asking if specialization, fees, and intermediation have delayed or stalled financing of climate transition.

Part 2: Markets, States and Transition

• **Chapter 5.** Esther Choi and Soh-Young In's *Blended Finance for State-led Decarbonization* look at the detailed intertwining of government and private actors in the architecture and financial instruments of Korea's ambitious Green New Deal, raising both global and Asia-specific queries about the concurrent governance of technology and sustainability transitions.

• **Chapter 6.** Lorenzo Bernasconi in *A Natural Approach to Net Zero* focuses on an emerging reliance on nature based offsets to balance Net Zero accounts, pointing out the interdependence of private market and state solutions that add up to effective carbon management.

• **Chapter 7.** Gireesh Shrimali and Tom Heller in *A Note on Transition Bonds and Finance*, report on the movement from green to transition bonds, connecting the current dynamics of proliferating financial products with the largely prospective issues of what will define transition pathways and plans to be negotiated between markets and states.

• **Chapter 8.** Uday Vadarajan in *Securitization as a Model for an Equitable Transition*, travels still more deeply into the scope of transition risk management, looking in both political economic theory and U.S. state regulatory practice the fairness and effectiveness of distributing the gains and losses associated with transitions to low carbon energy systems.

In closing this introduction segment of the volume, and anticipating its conclusions, it may be useful to formulate some preliminary hypotheses about the internal dynamics of disclosure and observations on its now leading
position in re-directing the global climate agenda. These notes may help steer consideration, before and after absorbing the materials here presented, of the strong appeal of disclosure, its development in application, and the likely features of the roads ahead. In this sense, we offer three focal points for examination.

• The evolution in practice of disclosure as a climate frame traces out paths:
  o from past and current carbon footprints to carbon emissions futures.
  o from scope 1 to scopes 2 and 3
  o from the real economy to the financial economy
  o from manufacturing to software
  o from physical assets to intangible assets
  o from public budgets to private finance
  o from North Atlantic markets to Asian state driven economies

• Disclosure in practice is tracking more closely the alignment of emissions pledges with Net Zero normative goals variably tied to Paris Accords, rather than to developing more bespoke metrics and management of transition and long-range physical risk.
  o In TCFD related reporting, there are few elaborated scenarios for risk analytics, little discussion of decision rules like value at risk core to risk management;
  o Where risk is taken into account in connection with emerging disclosure practice, it is usually limited analytically (1) to short run physical risk of acute events already embedded climate impacts or (2) to lifetime physical risks to infrastructure projects if effective climate risk management does not occur;
  o Risk management products are concentrated in extensions of innovative insurance practices around parametric pooling or insurance linked securities, but remains largely confined to off the shelf, sectoral diagnostics for transition risks;
  o Development of analytical models that implement integrated physical-transition risks or coupled financial-macroeconomic methods is rarely specially addressed.
  o The implications of these trending directions that lead toward alignment and away from risk remain limited in Asia where disclosure practice generally lags Western counterparts.

• Two questions to be addressed in conclusion.
  o It might seem a simple matter to reconcile alignment and risk. Once you know that a climate outcome (e.g., zero emissions) at an assigned date (2050 and interim targets) is certain, you can figure out the transition costs and any residual physical costs to be borne by sovereign or private actors consistent with that mandate. If in fact, we introduce empirical uncertainties and strategic behavior into risk analytics, does the use of emissions data or pledges remain an plausible and directionally viable proxy for transition planning and management?
  o If, in the end, the object of climate action is an integrated (physical, transition; global), orderly (financially stable; coordinated wind down of low, and build up of high, carbon systems), efficient (risks assigned to lowest cost managers) and just (equitably financed) transition, when and how will the now divisive tracks of emission alignment and climate risk come together?
LOOKING AHEAD

This volume’s observations of Net Zero in practice have substantially reinforced earlier more conceptual intuitions about the likely development of this ascendent climate account. The centerpieces of these speculations and empirical studies turn around the evolving treatment of transition and coordination. Our conclusions will then suggest that both the coordination of a mainstreamed, but widely decentralized, climate action agenda and an effective transition from a high to a low carbon economy will force a return to the roles of sovereign authority. While the global nature and impacts of climate change have recognized the demands of coordination from its initial formulations, the logic of sovereign and transition has proven more indirect. The stability, cost and fairness of transition are tied to risk, and the metrics and management of risk at systemic scale have migrated over modern history upward to sovereign agencies. In the case of climate, while the Turn to Net Zero has prioritized the performance of crowds (Here Comes Everybody), the Turn to Risk has rooted itself in the experience and expertise of sovereign institutions. These final remarks, divided in four segments, will flesh out the case that within the multiple senses of climate accounting, the exposed rough edges of Net Zero in practice push back from markets toward the roles and responsibilities of sovereigns, that the proper levels and institutions of governmental authority to measure and organize the complex risks of climate remain contested and challenging, and that, once these are adequately sorted, the adaptation to sustainability by private actors and geopolitical systems will be resolved within the wider context of transitions that will have to manage the future.

- Accounting for climate
- Unsettled Accounts: Net Zero dynamics
- States, markets, and risks
- Postscript: where now?

Accounting for climate

In the last period of his work, Michael Foucault talked of a new turn in philosophy. Instead of asking universal and timeless questions—“What is the world? What is man? What is truth?...”—philosophy in the modern age has bounded its concerns toward “Where are we today?” With this re-orientation, what we know might be re-organized in alternative forms: as utopias or goals for human flourishing; as technologies or practices through which these normative ends would be produced; and as disciplines through which they would be worked, updated, kept on track. We usually think of accounting as a technical practice around “keeping the books” and the inquiry in this volume needs to double down on the importance of the technical development of Net Zero as a technology evolving in and through practice as an activity that shapes climate action as it organizes and steers it. The viability, especially while in process, of climate accounting as a technology for record keeping is a necessary condition for the coordination that underlies the operations of successful engineering.

But we also want to take good note that accounting is not only a technology, but also connotes wider uses, as in to give an account in narrative stories and accountability as the discipline to stay on a course. Story telling is a principal force in the imagination and diffusion instructive pathways we could well follow toward the betterment of human conditions, certainly including the felicity of the climate in which we as a species have prospered. In the first sense of account as climate stories, the direction, meaning, sequences, coherence and appeal marshaled by the Turns to Green Finance, Risk and Net Zero are all more or less competing, pedagogical, dramatic plots in which different players and their assigned lines—states and markets, financial and real economy firms, technology
systems and projects, fiscal or monetary regulators, risk and alignment, nations and multilateral regimes, East and West, heroes and villains—take lead and supporting roles in resolving the passage from crisis to (happy) ending.

At the same time, our modern record of human fallibility dictates a third sense of climate accounting that recognizes there must be regular mechanisms to keep examining and correcting the roads down which the storied goal of something close to climate stability sends us and the particular pathways along which climate accounting technologies coordinate diffuse behavior toward that destination. In this third sense of accounting as the root of accountability, climate accounting is about the mechanisms for staying on course, and the responsibilities or duties that attend the practice of shepherding, stewardship, governing, regulating, and, perhaps increasingly, what the emerging discipline of computational science would designate as integrating complex systems. In the end, accounting for climate in its full scope would tie together conceptually, operationally, methodologically and politically the multiple pieces of a systemic and orderly transition from high to low carbon societies. The bottom line of these studies is it unlikely that we are there yet.

Unsettled Accounts

To conclude the introduction of this volume, we offered hypotheses to frame an exploration of the state of play that pitted the Turn to Net Zero against alternative accounts of climate action and suggested trends of development in the internal evolution of Net Zero’s conventions and practice. At a high level, the attributes of the Net Zero storyline have privileged mainstreaming over specialization, markets over states; the financial over the real economy and disclosure of alignments between emissions and normative goals over the metrics and management of climate related risks. At a more detailed level, practices examined within the Net Zero agenda have moved, and will be pressed to move still further, in the predicted directions:

- from public budgets to private finance
- from the real economy to the financial economy
- from past and current carbon footprints to carbon emissions futures.
- from own emissions (scope 1) to emissions of others (scopes 2 and 3)
- from manufacturing to services
- from physical (hardware) to intangible (software) assets
- from projects to systems
- from North Atlantic to Asia (market-driven to state-driven economies).

However, evaluations of these recent prospective developments that fill out Net Zero as an accounting technology have exposed a series of unsettled accounts: problematic and persistent features of its implementation that bring into question both its accountability and credibility in the triple senses of accounting for climate. In turn, each instance of accounts that defy and resist consensual or authoritative settlement increases incentives to game the operating regime and deflect its outcomes away from the climate narrative that justified Net Zero’s ascendent meaning. Before reviewing these troubling concerns with reference to the observations of our research, and noting that we necessarily focus on the open or yet to be settled status of these Net Zero pathways in construction, the roster of emergent deficiencies can be associated categorically with:

- increasing levels of noise in the information Net Zero accounting sends out to its users;
- contested rules over Net Zero’s boundaries for coverage;
• unclear enforceability of future-centric commitments that create incentives to defer compliance and transfer responsibilities;
• undefined management obligations that attend the disclosure of emissions through decentralized accounts that do not add up to, or square with governing processes and institutions consistent with, more inclusive and coordinated politics of climate;

We can reprise these concerns through their most frequent guises in issues of data and metrics, scope 3 coverage, timing commitments, offsets, obligations to manage and adding up. But the quest through Net Zero to settle its accounts threatens to replay the initial record of climate change disappointments by escaping into familiar territory. As the turn to Net Zero leads back through the well explored landscapes of market incentives, extensive globalization, uneven economic development, and non-convergent politics, it holds out fading promise of arriving at an orderly and timely low carbon transition.

Data, metrics and impact: from public economy to private finance

It is universally understood, and often reiterated, that climate transition, and therefore the quality of Net Zero accounting, is highly data intensive and dependent. The contributions of Soh Young In and Kim Schumacher detail an emerging industrial ecology of sustainable finance populated by data providers, data standards, taxonomies, targets, thematic ratings agencies and thematic products, principles and handbooks for their issuance, rapidly coalescing into a fragmented and specialized sub-financial domain. The authors also cite, and add the category of carbon washing, to the well-developed literature on the political economy of information quality. All business and advocacy communications create potential for fraud, selective disclosure and, in their collective effects, systemic noise that can overwhelm the purported value of information flows. The incentives to distort disclosures in the pursuit of self-interest is rooted in the asymmetry between reporting cheap to produce, short run gains through public communications and the diffuse and long run benefits from more costly monitoring and verification of what is reported. In the burgeoning increase of climate-related disclosures under Net Zero, problems are predictable linked to a proliferation of differentiated, unaudited data and metrics; a problematic impact of financial disclosure on the behavior of real economy emitters; and the predominant commercial strategies in financial industry organization and its attendant ecology that enhance dysfunctional incentives around a low carbon transition.

The uncertain quality of data, metrics, products and claims of impact and outperformance in the ESG arena has been an increasingly voiced refrain by asset owners and financial regulators confronted by the growing demand for and supplies of green finance in Western equity markets and bank credit channels. Green bond flows that have exploded since the Paris Accords typify the dynamics of disclosure accounting and noisy interference with investment efficiency. Funds are attracted by project-based, ex ante descriptions of ring-fenced issuances that are destined for uses generally consistent with taxonomies of qualified and disallowed assets. But these segregated inflows to discrete thematic funds are normally invested on through downstream financial intermediaries with green descriptions and ex ante second opinions testifying to the clean character of their intended destinations. Since these funds often inter-mix green (solar energy) and low emissions (health service providers), and since this capital chain engages many more and less disclosed ex-post end users, transparency vanishes from the oversight of green focused investors. Worse, there is rarely any disclosure or evaluation of portfolio-level effects of Green Bond issuances. The same bank or asset manager that (selectively) disclosed its Green products could create non-Green value chains through itself or a related shadow bank or fund that left its overall ratio of green to brown investment unchanged. And, as demand for better transparency, disclosure and external audit of use of proceeds, and
institution wide investment performance evolved, so did new categories of green vehicles—sustainability-linked bonds, transition bonds, and multi-valued ESG products and ratings schemes—to enhance both the reported volumes of Green data and the gaming potentials that In and Schumacher chronicle.

The search for impact in Net Zero accounting adds complexity to the noise of uncertain data facing Green investors. Empirical research on cost of capital (Green premium) effects is prolix and indefinite. Claims of demonstrable impact on environmental ambitions and performance through shareholder engagement with corporate management is generally more future than past regarding, foreshadowing issues of commitment timing under Net Zero discussed below. Far less attention is paid to questions of whether carbon risks are already priced in to securities values that are reflected in normal benchmarking and outperformance considerations. In many locations across the advanced and emerging markets renewable energy facilities are the lowest price option in market operations. The former gap between commercial and impact funding has regularly vanished where such incremental build continues to develop. Short run physical climate impacts should be well incorporated into climate threatened structures since recent data are linear and actuarially well accounted, though these costs are often discounted by the likelihood of disaster relief, below market public insurance, and other puts to the government. Longer-run Infrastructure value at risk from extreme climate events is predictable under worst case scenarios and be accounted in project cash flow analysis. Climate transition risk almost disappeared in the depths of the pandemic and appeared strongly in export coal valuations in South Africa during the years of the post-financial crisis recession as demand fell and relative clean technology prices fell. Where climate risk has been managed in whole or part by hedging or insurance, there is little Net Zero data in circulation on what has been priced in to market or asset values by the type of climate risk, the availability of linear and close at hand data and models, political economic probabilities, and risk management including risk avoidance and transfer. Nor is adequate notice given to the impact on finance-centered climate strategies like Net Zero of evident tendencies to off-public markets finance. As the prevalence of private equity markets, innovative credit vehicles, tokenized markets, and myriad forms of shadow banks and less or unregulated financial intermediaries spread, the turn to such facilities for capital reinforces the strategic gaming of financially centered climate regulation and undermines disclosure-based climate action.

In their contributions on financial theory and sectoral industry organization, Marc Roston and Richard Kauffman, both lifers inside the U.S. financial system, amplify Schumacher and In’s concerns by contextualizing the incentives that motivate the providers, asset managers, ratings agents, and marketers of the data, metrics and products necessary to effective reliance on Net Zero accounts. Their composite storyline takes off from description of the evolution of competitive and deep private financial markets that added economic value (and chased after uneconomic rents whenever given the chance) from diversification and specialization. On one hand, the Western predominance of market-driven solutions to the deployment of capital against the risks of doing business with strangers at a distance explicitly recognized, prioritized and privileged the economic benefits of self-interested and decentralized coordinated behaviors. On the other, the emerging business (financial) models in this context were well adapted to returns from large scale resource extraction/processing and commodity intensive manufacturing that characterized the energy, transport, agriculture at scale and petrochemical sectors of carbon-intensive industrial economies.

Organizational know-how around portfolio benchmarking and segmented practices like project finance or consumer auto loans and compensation incentives (fee structures) showed up as inertial lags in adjusting to newer technologies with different risk profiles and differential speed in servicing innovation according to how quickly
incremental changes could make amended use of familiar vessels (e.g. tax equity). Financial practice might adapt to low carbon demands, but not without resistance to lower margin opportunities, loss of high established clients, and at a pace slower than shrinking carbon budgets deemed healthy. At the same time Roston's essay (Hedging Climate?) on the fit between modern portfolio theory that makes the case for economically efficient financial systems harks back to Schumacher and In's fears that selective disclosure and noise will pervert the claimed impacts of financial services across the landscape of financial markets. Claims of outperformance in the crusade for yielding outsized returns (Alpha) from the endless include/exclude based funds that populate Green markets lie anywhere between unlikely and pure hype, though they consume data on carbon emissions at an exponential rate. Counting emissions and managing risk are essentially different activities—a subject that will preoccupy the last pages of this conclusion.

Acknowledging the substantial and good faith initiatives to sort through the unsettled issues of excessive noise associated with data, metrics, impact that perturbs Net Zero accounting, as we have collectively transposed climate action from public budgets to private finance and from the real economy to the financial economy, we have also noted that institutional investors that control the vast bulk of private financial assets have organized internal specialized groups to interpolate among the multiple scores or invent bespoke aggregated scores for emissions and target alignment that makes no pretense of more technical risk analytics. When sophisticated investors seek such internal protection, regulators and the financial press follow their instincts to the potentially uneven impacts on more retail and less well armed investor communities. The outcome builds toward investor frustration and confusion that reduces the efficacy of reliance on competitive private markets—marked by self-interest on short term horizons and contractual coordination—as supplemented at their edges by voluntary industry self-regulation. More troubling is the mismatch between these governance frames and the demands of accelerated climate action for longer-term systemic transitions and the effective management of collective risks over extended time horizons and across the strategic behavior of multiple polities. Still worse is that an attractive focus on more accurate data reporting and metrics misleads policy agencies to concentrate on the marginal regulation of voluntary markets, and defer or deflect authoritative efforts from far more politically hazardous economic restructuring in the time that global carbon budgets have remaining?

**Scope 3 emissions and Net Zero reach**

While the Net Zero turn from the public and real to the private and financial economies poses challenges in its mainstreaming and privatization of climate action, its widening accounting coverage from a firm’s own emissions (scope 1) to the emissions of others (scopes 2 and 3) tees up internal conceptual and administrative issues that become most apparent to banks, insurers and their corporate counterparties who take seriously their Net Zero pledges. However, these same coverage ambitions, when applied to knowledge-intensive production that embodies the technology transition from manufacturing to services, from physical to intangible assets, from projects to systems, and from the North Atlantic market-centric to Asian state-centric economies throw up questions of control, motivation, and political responsibility for climate action that may extend beyond the pay grade of even the most committed Net Zero adherents. As Scope 3 aspires to accounting for emissions across the full upstream and downstream networks of globalized production and financial systems across non-convergent economies, it leaves behind the contested technical questions of using estimated or actual methods of calculating carbon footprints and projected pathways, or attributing carbon shares over multiple investors or purchasers engaged with emitting businesses. Instead, Scope 3 disclosure becomes a platform upon which larger questions...
about who has the economic power and geopolitical obligation to define, administer and enforce climate action in a post-Paris regime.

Marc Roston’s discussion of Scope 3 accounting conventions describes the current state of play along Net Zero’s most contested and least controlled technical frontier. Because the same emissions are swept in numerous times across the complex value chains that characterize global production and investment patterns, the failure to agree standard methods of calculating and attributing carbon data not under the direct observation and supervision of the reporting entities can become subsumed by more basic questions. In the original UNFCCC design, carbon prices were to be imposed one time by nation states on potential carbon as far upstream as was practical. Profits on emitting sources were taxed or passed on across the downstream value chain where market power and price elasticities allowed. Distributive impacts of the system were to be managed through original allocations of carbon rights or via post-market income transfers. By contrast Net Zero scope 3 counts a firm’s actual emissions with upstream and downstream claw back mechanisms. But whose emissions are to be reported in Scope 3, how far do the reportable linkages of these accountable entities themselves extend, and how should reported emissions be valued relative to the carbon policies of the legal authorities under which they operate? In a globally-connected this surface threatens to explode each time it is scratched. But to limit this explosion and settle Scope 3 accounts would require firms to monitor and manage the behavior of distant and scattered others, incentivize their actions to do so, and open Scope 3 to gaming by their strategic situation of emissions in the organizational form and political space outside wherever its conventional boundaries are drawn.

Consider not so fanciful cases of Scope 3 dilemmas. Easy Scope 3 cases seem to include assigning responsibility for shares of otherwise uncovered emissions in the real economy to travel heavy corporates, infrastructure procurers, large equipment manufacturers, and regulated public or private financial institutions. But Scope 3 practice does not yet allocate emissions shares (and concomitant duties) to consuming households or other presumably value adding services from lawyers, advertisers and public relations or educators. Harder cases still would involve whether Scope 3 discloses only direct emissions data of the actual counterparties on a supply or investment specific value chain or the wider portfolio of data about the Scope 3 emissions of each counterparty along the value chain? It is not difficult to see that carbon records can be transferred through sales or other off-balance sheet maneuvers. Does Scope 3 claw back such emissions or demand a consolidation of balance sheets comparable to the subtleties of comprehensive tax accounting?

To place these high-level questions in a practical and salient context, it can be useful to think about the Net Zero positions of the great internet firms that have displaced fossil commodity equities both in stock indices and national economic accounts. Among their principal lines of activity, their business models engage them in energy intensive computation, with high and growing marketing focus in East and South Asia, and cost-efficient equipment suppliers located in those same regions. While building out their own energy generation or acquiring bulk power contracts with designated green electrons is manageable in the American and European Union markets they prize, this is not the case for either their servers or suppliers in the East and South Asian region where growth is projected and their Scope 2 and 3 emissions are concentrated. Some concerns are administrative. Industrial organization in these geographies is populated by small firms and state enterprises, often themselves associated with massive corporate groups whose topography is not transparent. Ownership and financial ties within these groups is fluid, with frequent churning obscuring the boundaries and stability of the partners with whom one is dealing. While this variability in contemporary corporate and financial systems can facilitate contractual gaming along the frontiers of covered and excluded disclosure conventions, the best motivated adherents of Net Zero have yet to account for
either absent administrative controls or for the limited reach and reception of stakeholder or political pressure to manage emissions in the supply chains or energy policies of spaces and cultures that are themselves ungoverned by local disclosure regimes.

These same regions of high growth and technological ambition are critical not only to the business models of global IT firms, but to the scope and timing of successful climate action. Their design and execution of industrial and sustainability transitions is a subject of paramount climate import and the politics of sovereign autonomy. They articulate and enforce domestic plans to manage their divergent and differentiated risks of parallel economic and carbon transitions, long expressed in the multilateral forums that run alongside more decentralized Net Zero commitments of firms. Even foreign firms with market power cannot easily disrespect these geopolitical realities. Can Net Zero pledges be met through programs for clean energy R&D or technical and financial aid to system transitions in conformity with national programs? Are attributable emissions from sources that are managed in accordance with national regulations that impose energy portfolio standards or idiosyncratic carbon trading to be accounted with adjusted valuations that reflect local carbon policies? As long as demarcations of the boundaries of Net Zero coverage remain contested, it is uncertain what scope 3 reporters supposed to do? Ought they impose internal carbon prices on traded goods or capital budgets as the Net Zero delegated stewards of climate actions that states are unwilling or unable to agree and impose? Or does the unsettled reach of Net Zero re-run into the limits of geo-politics where the Three Turns started? Much as we found with reflection on the unsettled accounts of data quality, the pending issues around Scope 3 and Net Zero coverage have focused on, and made some progress on, relatively more technical matters of standardization in accounting. In sharp contrast, we can note little Net Zero attention or gain in its more conceptual consideration, even as Net Zero in ascendent practice exposes more consequential economic and geopolitical frictions. Such frictions, in turn, suggest puzzles about Net Zero responsibilities or obligations, to which we will return below.

**Timing and offsets: adding up from footprints to futures**

Like comedy, climate action is all about timing. There is little doubt that the landscape of a sustainable future is that of a low carbon economy. The question is only whether we can arrive at that future without doing lasting, if not catastrophic, damage in being too slow in getting there. Concurrently, the low carbon transition is inextricably tied to the pace of change in how we produce goods and services since greenhouse gas emissions are by-products of economic value associated with the combustion of fossil carbon resources or the release of carbon from natural capital stocks. As we increase the share of value created by combining (re)skilled human labor and financial capital with more productively organized data and analytics (software), the substitution of intensive information and knowledge for extensive use of terrestrial resources can maintain needed growth in global well-being without continued dependence on carbon content. In this sense effective climate action is less a story about if transition will occur than when, where and with what degree of costly disorder. Net Zero, like other climate accounts, borrows a clear commitment to 2050 as the end date of the transition's completion. But in the shift of its internal accounting emphasis from past and current carbon footprints to carbon emissions futures, and its evolving practice with substantial reliance on carbon offsets, it admixes (good) intentions, credible delivery of promised carbon value, and how a universal climate regime for transition away from carbon intense systems can be played out timely and fairly across jurisdictions in very different stages of economic development and political capacity.

Carbon budgets are time constrained with constantly updated windows between the narrowing horizon from the moving present (1992, 2000, 2010, 2020) to 2050. The climate history since 1990 has been one of deferral of effective
action in what is essentially a disorderly transition that has drastically shortened the available budget windows. In these windows more and more ambitious promises of targets to be met with rapidly increasing timelines have become more and more central to Net Zero announcements. The TCFD outlined dual responsibilities for participating entities to detail how they would manage climate risk and the targets and metrics to which they would commit. As reporting of current deep carbon footprints gave way to stress on prospective plans to move toward 2050 net zero, the credible accounting of futurity and the relative lack of such practices in standard financial accounting moved centerstage. Disclosures around risks that business organizations faced were necessarily future oriented, if often over a shorter horizon than climate risks endured and understatement stemming from high discount rates.

But the empirics of Net Zero accounting to this point show up risk calculations only for short-term physical climate risks, which reflect principally linear projections of past years’ data over near term (10-15 year?) horizons where climate scenarios are minimally divergent. These risks for financial institutions are also limited by the tenor of lending against these threatened assets and in some cases are now insurable through parametric or insurance linked securities. Beyond these credit risks for banks, the physical risks of Scope 3 networks are more obscure and long run physical infrastructure risks, whose metrics would be subject to scenario variation, are likely to fall back on public balance sheets as owners or providers of disaster relief in years beyond the tenor of private lending instruments. Climate transition risks with different risk appetites for value at risk metrics evaluated under differentiated scenarios appear as emerging practice only by central banks and prudential regulators. For private reporting organizations, transition risk is at best proxied, with whatever conceptual propriety, by pledging to align the trajectory of (declining) future emissions with an alternative normative metric or technology pathway that moves in the direction of Net Zero 2050. Increasingly, given the scientific constraints of carbon budgets on emissions concentrations and impacts over time, these pledges may also announce interim alignments with windows inside that horizon and/or specific plans explaining how these timely commitments will be implemented.

If the predominant interpretation of Net Zero accounting now privileges alignment over risk, in practice Net Zero harps back more closely to the Turn to Green Finance over the preceding Turn to Risk. The proliferation of target metrics and intensity of the debates over their competition for adoption is persuasive evidence of this direction in Net Zero’s emergent conventions and meaning. Consequently, there is a good case for following through the logic and prospects for this specific line of applied climate action. First, once future emissions volumes have been projected by a Net Zero complier, they may be aligned against either an assigned volume of allowed emissions aligned with a required rate of emissions reductions for either global or some more restricted (sectoral? national?) pathway to 2050 Net Zero or interim target. This alignment of entity and composite emissions pathways may suggest equal percentage rates of absolute emissions decline, although some reported declines are in emissions intensity rather than volumes. These intended rates of emissions decline may be arithmetically translated into imputed temperature increases and these evaluated against expected degrees of tolerable warming. Alternatively, the approach of a reporting entity to Net Zero may be aligned with the installation or promised investment with low carbon technologies, consistent with a view that it is easier to game or incredibly describe volumes of emissions than to dissipulate commitments in physical assets in the real economy. Second, the scope at which future emissions are to be projected and disclosed remains uncertain. Projecting your own emissions is often challenging, the state of practice in doing so for supplies and financial counterparties remains speculative. Finally, the correspondence between the design and implementation of operational plans and targeted emissions volumes, intensities, temperatures or technologies is outside the range of transparent or independently verifiable disclosure. But rather than imagine the substance of generally empty sets, it could prove more helpful to look at the future of
Net Zero accounting for timing emission reductions through the lens of carbon offsets, which are daily more and more implicated by reporting entities seeking compliance with interim goals that demarcate their commitments to 2050.

Lorenzo Bernasconi’s contribution describes the value in the management of global carbon stocks that nature-based carbon offset could play, without erasing either the checkered experience of the Clean Development Mechanism (CDM) in the original UNFCCC regime or the pervasive question of accountability in adding up and coordinating highly decentralized and variably timed activities toward an aggregated and stable climate solution. To stylize the timing issues in Net Zero accounting, imagine a corporate A in an advanced industrial economy that needs to convert to a low carbon manufacturing technology that displaces a recently invested higher carbon process. The A firm has a 2050 Net Zero pledge, but believes there will be no adequate substitutable low carbon option available until 2040, and does not wish to write off its unamortized costs or sell its present to an emerging market actor in its same sector. The firm can get its future emissions down to net zero; but it cannot do so now. Imagine another firm B, perhaps owned by the state, in a poorer developing country B’ that would like to preserve its forest or soil carbon stocks, but is under immediate economic to cut into those resources through their conversion to agriculture. The jurisdiction B’, or even the firm B, with 2050 net zero aspirations, will want to account for their carbon stocks in reaching 2050 net zero, but recognizes it is unlikely to be restore its net forest carbon balance through later reforestation. An accountable single global carbon manager could in theory meet both 2050 and interim goals by maintaining forest carbon B now and reducing industrial carbon A later. Moreover, she would properly do so if it were cheaper for the advanced industry A to pay the avoided costs of deforestation B now and the actual costs of technology innovation later. A carbon offset from forest firm (state) B’ to industry A now could replicate this favorable result and reconcile the timeliness of carbon management on both sides of the transaction.

Why should Net Zero not account for such efficient carbon trading in scalable offset markets? Perhaps industry A would fail to make its new investment post 2040 because costs had not fallen as it had predicted. If the term of the offset (carbon lease) had expired, presumably it would no longer have met its Net Zero pledge in 2050 and would be sanctioned by its home country whose own 2050 pledge might then be compromised. If the term of the offset were still operational and carbon delivery by the selling jurisdiction B’ was still intact, the adding up of global accounts would have to debit the account of either firm A or jurisdiction B’ (whose carbon stocks would benefit). But suppose forest carbon services B would fail to deliver. Perhaps the transferred carbon stocks were not maintained after a property dispute or fire, or were not verifiable, or were delivered on the offset forest property, but substituted from forest products or conversion of comparable land in jurisdiction B’, or even from comparable land in jurisdiction C’? The offset transaction would in any of these cases require a debit against global Net Zero accounts, which could with careful accounting assign the liability to some engaged party, but who is the proper party to be charged by the global manager. Perhaps accountability for the risks of defection should be assigned and enforcement directed against firm B for abusing the arbitrage that timing mismatches offered, or against country B’ that failed to account for its net carbon stocks, or even against regional or global forest stock countries including B and C as a selling consortium. But we also know that risks always create incentives to avoid and deflect them onto others, and that these incentives can be made the targets of efficient risk management. Maybe firm A could have invested earlier in the low carbon technology, but used offsets to defer and perhaps later disavow this prospect. Perhaps B or B’ or consortium B’ & C’ could have maintained their nature-based carbon stocks without transfers by investing in precision low carbon agriculture earlier. Or, reminiscent of the baseline manipulations that led to loss of faith in the pre-Copenhagen CDM, high carbon stock nations might game low interim Net Zero goals, opening more assets for near-term lease or sale. If offsets are an instrument that allows reporting parties to adjust their Net Zero accounts
to optimize the timing of their compliance behavior, they do so only at the risk of increasing the overall costs of administration and probabilities of relaxed enforcement. In this instance the empirical trends to load up on offsets and legitimize their Net Zero accounting would seem towards taking timing risks and worrying about how they add up as we get close to 2050.

Obligation and impact: from disclosure to duties

Gireesh Shrimali’s and Uday Vadarajan’s contributions on the record of initiatives to define transition planning and mobilize transition finance may inform better where we stand in the low carbon transition the absence of serious Net Zero efforts to attend the details of how transition and its equitable and effective finance will best be implemented. More generally, the question of what a practicing Net Zero adherent is committed to do once it has calculated and reported its emissions accounts exposes a largely uncharted territory. If Net Zero does not move past reporting accurately and according to agree conventions to which actors in a Net Zero world have duties to add up the decentralized reports, coordinate the fragmented pledges to low carbon put forward, and govern the accountability of disclosure through correlate obligations of its practitioners, then what impact on alternative futures can we expect of a first order disclosure framed, self-organized and administered, and explicitly mainstreamed climate regime? The viability of a Net Zero road to low carbon demands credible complementary accounts of obligation and data, coverage, and timing, before we can decide if we ought reconsider further turns in the climate course we follow. Foucault had proposed that disclosure without renunciation is no road to salvation. If not Net Zero disclosers who are responsible for correction, then who?

The obligation that runs with Net Zero disclosure might be measured against four standards of the materiality of reporting and four of management. This volume has focused explicitly on Net Zero reporting practices. It examined the emerging and widely acknowledged duty of financial organizations and at least their carbon-intensive real economy counterparties to reveal for the inspection of investors and policy makers scope their own carbon emissions and those of networked others above some ceiling of joint activity. For these obligations to report and to manage, however unsettled and problematic at their leading edges, a speculative and summary account looking across the state of play and the direction of travel would seem as of now to imply:

Reporting obligations

• **Physical concerns—Short term**: risk, not emissions, reporting that is asset specific by location; reporting of risk management through insurance products or risk proofing behavioral investments; low incidence of reporting attention by corporates except for acute extreme events; risks to residential mortgages reported by banks and housing credit providers, but value at risk complicated by government emergency relief.
• **Physical concerns—Long term**: risk reporting on location specific basis; financial institution credit risk reporting limited by instrument tenor shorter than asset life and low scenario use with limited climate damage variation over tenor; VAR under single transition scenario with decision metric of extreme (not average or expected) risk. Governments often owners of residual physical risk at end of tenor with pilot disclosure practice not integrated with transition risk.
• **Transition concerns** (frequently observed among large corporate and financial firms in Western markets): transition risks are proxied by self-defined emissions futures and widely variable and selective reporting by boundaries of inclusion and methods (apportioning) of scope 3 coverage; selective reporting of management actions around green (taxonomies compliant) project investments; R&D or system contributions occasionally
mentioned; offsets intent generally listed; reported (unspecified) purchases of short form indices and off-the-shelf alpha-driven climate or ESG themed products and funds and/or intended engagements with counterparty management.

- **Transition concerns** (observed in leading corporates and financials active in Net Zero associations): Firm and time specific carbon targets and compliance plans, including specific offset scale and scope three extension/coverage (with apportioned shares to be externally added up), alignment with normative optimized paths for projected global emissions shares or technology investments toward global decarbonization; reported (unspecified) purchases of short form indices and off-the-shelf alpha-driven climate or ESG themed products and funds and intended and recorded engagements with counterparty management.

- **Transition concerns** (largely unobserved): Transition risk metrics and management plans, accounting for system impacts: self-reported and idiosyncratic reporting of R&D, pilots, scheduled investments, or expected upside returns co-dependent with adapted low carbon technology systems implementation (opportunities); downside reporting of committed retirements of capital assets, expected risks of losses to capital, labor, communities or public taxing or budgetary authorities, and firm specific carbon risk management plans with explanation of opportunity and loss risk management options and fiduciary compliance of portfolio behavior.

- **Public sector concerns** (observed):短期风险是越来越多地度量和保险（特别是灾难；参数产品）；政府过渡风险度量通过试点银行压力测试以系统性风险对部门的风险；报告NGFS会员资格；开发参与排放披露演习；试点在监管设计和监督中的披露条件（遵守或解释；报告公司对报告和假设管理义务的理解）。

**Management obligations** (as observed in descending order of frequency and specificity)

- Divest or single out for particular management of red flagged businesses or investments; evaluate acute short term embedded physical risk with consideration of catastrophic insurance options; experimentation with climate weighting of risks to long-term ownership of extreme chronic physical risk on large infrastructure (generally owned by governments); divestment or other divergence of risks to off balance sheet not controlled.

- Reform own-firm internal carbon emissions governance process with some consideration of carbon weighting during tenor of asset risks and some metrics for weighting of investment or business decisions by ESG or climate ratings; corporate engagement with Scope 3 counterparties; implement off-the-shelf checks and investment portfolio divestment strategies (buy include/exclude funds).

- Pledge specific future targets or trajectories, buy and list offsets, join or create and comply with the data, metrics, Scope 3 and timing norms of a Net Zero association and/or certification as evidence of credible commitment of direction of travel.

- Impose specific internal carbon prices to reweight all supply chain, investment and sales transaction rankings of potential equipment acquisition, investment allocations, or business line and production strategies of the corporate or financial organization reporting.

This subjective and speculative groupings of reporting and management obligations stretches from low level observations of current corporate and state practices to far more demanding, conceptually challenging, but substantially undefined and unimplemented accounting terms and conventions that might lie further down the directions of travel of Net Zero climate action. In North America and Europe where Net Zero is principally in play, a summary panel depicting current Net Zero practice would combine: (1) a plurality of larger corporates and financials variably self-reporting their unaudited actual short term and long term infrastructure physical risks...
and own emissions footprints and projections; (2) an important and increasing segment of public corporates and financials joining Net Zero associations and developing dedicated organizational resources toward compliance with process, standard terms and conventions of that association; (3) Net Zero associations that agree and publish relatively more defined standards on data and metrics, periodic updating (~5 years) against sectoral- or individual firm- proportional alignment targets and metrics (emissions, technology or temperature); (4) few to no agreed operational associational conventions, and wide self-imposed variation on specific Scope 3 boundaries, offset quality and use; obligations beyond reporting and disclosing emissions on agreed association standards (3); (4) little observable private management on (downside) transition risks, system impacts, long-term physical/transition risk integration, or investment in hedging instruments beyond questionable include/exclude vehicles.

Less Net Zero practice is focused on short term physical risk because corporates have immediate self-interest in managing their exposed assets to linear risks that are actuarially measured, likely to be priced into valuations as well-defined and proximate, and to a larger degree insurable. Banks and mortgage providers face more complex conditions in multi-party transactions like residential housing development or municipal finance where developers or current administrations have incentives to under-report and transfer risks to buyers or future taxpayers, but financial industry capabilities for self-protection against such risk lowers association priority to regulate standards. In addition, discussion of fire, flood and other climate-related physical risks are often put to governments through disaster relief and public financing of protective infrastructure. Since private actors are anxious to protect these puts, the silence of non-disclosure is often advisable. Financial institutions have less internal motivation to develop climate-risk weighting for longer-term physical risks since the tenor of their credit instruments is usually less than the life span of the assets and variation in physical risk scenarios over these tenors is limited and priceable. Governments in particular as primary residual owners of infrastructure assets will be liable for these longer-term risks, but these are difficult to calculate since they are intertwined with transition risk that determines the scale of exposure and hazard that not been managed in transition risk administration. It is evidently clear in practice that transition risks are not priority subjects for association concentration that are reported and managed through emissions alignment. Sovereign transition risk is emergent at the margins of association attention and concentrated in the pilot exercises by national Central Banks and Prudential Regulators, themselves connecting through the transnational Network for Greening the Financial System. Since physical climate costs are already treated as risks, and fall for longer-term assets largely on governments, full on transition risk metrics and management for private actors will receive more attention when it descends through state mandates.

As the ambitions of an extended and completely defined Net Zero regime move from observation to still imagined end states evolve across this pathway, the ultimate impacts and contingencies of the ascendent Turn to Net Zero may take more concrete shape.

Consider significant implications of the third and fourth directions of travel for management obligations. With regard to firm or bank specific transition risk planning, there is scarce to no reference to operative obligations yet defined or required for: (1) transition models and methods (firm specific scenarios and decision rules), (2) transition planning at asset or business line level with bespoke and committed risk management strategy/portfolios; or (3) just transition or social justice plans or commitments. Such obligations would suggest a differently structured governance process with heavy reliance on state coordination of multiple reporting organizations to ensure coverage, integration and compliance with detailed organizational portfolio strategies that would seem inconsistent with Net Zero aspirations for Scope 3 conventions of coverage and control of counterparty risk management practice. Similarly, with regard to an obligation to set and charge internal carbon prices on
Scope 3 transactions the schedule of carbon tariffs and the valuation of the risks of others is likely to prove both administratively challenging and impolitic. Carbon corrective internal pricing would be more appropriate at values that discount already managed climate risks (priced in, taxed, regulated in the jurisdiction or markets where emissions occur). More dangerous are imposed pricing rates and valuations fixed in a more carbon sensitive jurisdiction with the multilateral norm that such charges are matters of state sovereignty in the emitting jurisdiction, to which political rights have been recognized since the UNFCCC origins to decide autonomously climate relevant timing patterns, price schedules, or levels of associated enforcement attuned to sovereign control of economic growth, income distribution or financial stability. Private firm or association transactional pricing of cross-border upstream and downstream emissions, like the politics of national trade sanctions for which they may be viewed as gamed substitutes, can generate sanctions unwelcomed to the business interests and motivation of those private entities being asked by such Net Zero obligations to bear these burdens. Even with extreme market power, this level of obligation that has the potential to settle key aspects of Net Zero’s directions of travel seem difficult to sustain.

At the top end of the list that describes current Net Zero states of play cluster around voluntary, self-interested motivation, reliance on data and metrics within a firm’s own control and capacities, and limited norms of materiality that favor internal process and decision on appropriate levels of the reach and social commitment in governing corporate objectives. As we move down the list and project the direction of Net Zero travel, a climate-measured worst case threatens a future that is noisy, self-claiming, and chaotic; a collection of clubby bubbles that add up to gaming and growing physical risk; deferral of mitigative action and deflection of responsibility for near-term action onto nations and actors without capacity to assure it; and divestment based management that can be mobilized only around the most extreme climate miscreants and yields only a psychologically comforting illusion of effective management.

At the other end of the spectrum, a climate-measured best case imagines an outcome where the emerging practice, as well as the logic of the direction of travel, in Net Zero suggests an ascending formation of clubs that agree conventions about standardized data and metrics, the boundaries of Scope 3 inclusion, the use of offsets and timing of reduction commitments, and the reporting and management obligations that members will share. Given sufficient scale, geographic extension and sufficient market power (especially among enrolled global financial institutions and oligopolistic corporates in sectors with exceptional economic productivity) to impose their agreed terms, these clubs could make serious advances toward defining and institutionalizing a low carbon regime.

However, particularly as ambitious Net Zero clubs will climb a prospective ladder of obligations and agree terms that reach deeply into the emissions of others, the imposition of effective prices on value and investment chain transactions, and the broadened norms of material responsibility for risks that will impact system stability, effective management of orderly climate action, and the distribution of losses of income among communities, nations and generations that are inevitable in systemic transitions, the flow and wisdom of this direction of travel turns sharply problematic. One source of concern with climate-measured positive directions of travel is the likelihood of gaming and strategic behavior to transfer risk and obligation to competitors or governments that reflect the change of motivation from self to collective interests. As clubs or coalitions enlarge and include less homogeneous membership, the likelihood of defection from their agreed rules increases and the shared costs of monitoring and sanctioning deviant behavior strain their coherence. More disturbing is that delegating the roles in setting prices and managing risks—decisions about what counts and who governs—initially assigned to a failed public to coalitions of private organizations only defers a replay of the realities of politics in the original UNFCCC climate
design. Most troubling, however, is that along this path to climate goals, private action has morphed into behavior more characteristic of the attributes of state functions and duties. At a not distant point the logic of displacement of responsibility implies less a delegation from states to markets and more a contest over their spheres of power. Clubs will neither succeed nor survive without a turn back toward the state—a turn that affirms both the jealousy and competences of state authority.

In re-negotiating the contested climate interplay between states and markets, the record of what is done and resisted in the turn to Net Zero is significant. Net Zero advocacy and advance has in its turns to mainstreaming and privatizing at once integrated and avoided elements of the earlier turns to Green Finance and Risk. The optimism of Net Zero is grounded in the declining costs of low carbon technologies and the market alignment of Green new build investment with positive economic and environmental returns. But in its observed operations, Net Zero has taken but small notice of the either the empirical patterns or absolute levels of still growing global emissions that signal the downsides of transition and points of resistance to progressive climate action. While the proportions of new investment in Green have been in line with Net Zero consistent assumptions, retirements of existing investment have been far slower than projected timelines. While better engineering has contributed to this outcome, political economic resistance and a weak macroeconomy have preserved high carbon power and industry well beyond expectations. Moreover, the upside productivity gains implicit in the happy conjuncture of growth and climate appear more risky in the speed with which new build low carbon power or transport or agricultural projects are operated under low carbon systems with well adapted policy, business models and innovative finance. Finally, Net Zero accounting for pledges of future emissions and their alignment with normative targets turns away from the complexity of measuring and managing the costs of transition that come with strategic behavior in the avoidance and transfer of downside risks, failures to add up and coordinate decentralized climate action, the distribution of dislocation costs, the accumulation of long run physical climate risks that comes with mis-management of transition and the concentration of market power that would make Net Zero clubs effective climate actors.

Recent efforts to standardize the issue of transition bonds have been sidelined because it is said that transition—without principles or approved definition—is a theme and not a product. The orderly winding down of carbon intensive industry with organization, logistics, and experience core to economy wide employment, taxation and risk management at scale is submerged in the simplicity of divestment. As a whole, an assignment of transition to an imagined intended direction of travel in Net Zero points to recognitions that a transition has down and upsides and that aligned emissions are not a good proxy for risk or orderly risk management, and that there will be a low correlation of outcomes between a Net Zero practice centered on alignment with emissions targets and a climate regime driven by accounting for risk. At the same time, it would be unwise to jump back to the original idealized climate narrative that states can be recharged with responsibilities whose ungovernability led to the multiple fixes of Paris and the turns to Green Finance, Risk and Net Zero. A re-directed turn toward low carbon transition will reconsider the particular roles and evolving capabilities of states in diplomacy, public investment, and risk management, but not to the exclusion of lessons learned from the mainstreaming and inclusive momentum of Net Zero’s direction of travel. The various chapters of this volume on data (In & Schumacher, Shrimali), metrics (Roston), financial organization (Kauffman & Roston), and offsets (Bernasconi) all come back to and emphasize the roles of states as Net Zero inside players in designing and managing the ongoing process of better settling open accounts and coordinating movement in the desired direction if travel. At the same time, other contributions on transition bonds (Shrimali), Korea’s Green record (In & Choi), and transition finance (Varadarajan) push toward a conclusion that a commitment to Net Zero emissions alignments without a corrective (re-)turn to states assuming accountability for systemic issues, around which they have built a record of specialized competence, that lie beyond Net Zero’s best reach, climate action will have limited prospects of tolerable results.
Net Zero ascent to a predominant climate narrative reflects the deep appeals of markets, mainstreaming, and a technology enabled convergence around decentralized governance and sustainability. In avoiding the third rails of downside risk and the uncertainties of managing transitions, Net Zero can become an avatar of projection, denial, and procrastination. Hierarchy may dominate as well as coordinate markets and the technologies that substitute for natural resources may reinforce non-convergence. Risk is the language of transition, and the climate risk migrates to the state. We manage what we measure, but we tend to measure what we can manage. If Net Zero in practice and direction of travel is emissions alignment and it is not an illusion that alignment approximates transition, better emissions accounting can take us a good way down the road to climate stability. But whether in perfecting Net Zero accounting, or suggesting its limitations as a climate narrative, our studies consistently find their way back to risk, accountability, and the place of states in assuring it.

**Transition, Risk and States**

In a world where lower cost new build will be green and not fossil, markets will with time drive a low carbon future. Climate action is then about the timely, orderly and fair management of the systemic risks of moving from a high to low carbon economies. To the extent that Net Zero will contribute to this job through its agreed conventions of emissions-based accounting, this contribution is clearly to be supported and welcomed. To the extent that the voluntary market behavior and self-organized collective action can afford a reasonably close approximation of extensive and effective low carbon outcomes, these push to rely on these mechanisms will often be understandable, if not preferable, in the light of failures of state-centric climate processes like the multilateral negotiations that derailed at Copenhagen. But to the extent that the limitations in practice currently and in concept directionally indicate the roadblocks that will stand in the way of low carbon systems at the global scales climate security demands, there will be a turn back to states and their demonstrated capacities and debilities to deliver the set of voluntary and mandated solutions that stable sustainability and equity require. Ongoing inquiry will encompass what is, and what is better, left out of voluntary and market centered accounts and what states can stake a credible claim, if perhaps with re-purposed instruments, to do well.

**State as steward**

In the domain of climate, states may, and have been, invoked as stewards, as polities, and as sovereigns. Although the original impulses that motivated the turn to Net Zero and its current state of play are market centered, one direction of travel leans toward the state as steward. Stewardship carries a double sense in which states can be active simultaneously as players and regulators. They participate in Net Zero clubs or associations as disclosure players since their stature as asset owners (infrastructure or state enterprises), financial managers (large public pension funds), investors (sovereign wealth funds or bonds issuers/proceeds allocators) runs in parallel to private reporting and disclosing. Sub-sovereign states, provinces and municipalities that receive central government investment and budgetary support may be particularly fitted to the roles of all players in designing and agreeing to the terms and conditions of non-state association peers. But states as stewards may also take on regulatory or policing powers that asymmetrically to other members adjudge how persistently unsettled accounts will be resolved, monitor and enforce the norms as agreed, prod the association to correct and advance norms and standards toward announced collective objectives, and be accountable to coordinate and add up member behavior that will keep the association on track toward its formative goals. States as stewards inside public/private associations both subject themselves to common standards of conduct and steer the coalition to its self-imposed goals. Policing in the modern era was defined by Foucault as the toolkit of instruments by which the state...
shepherded the member citizens toward their own sense of well-being, though each state is at all times tempted to overstep in its own interests. Conjointly, the particular composition of the attribution of powers between states and non-state associates is variable and cyclical, whether through corporatism, delegation of administrative and enforcement capacities, or third-party adjudication. But to the extent that club solutions are effective they incorporate active, open ended, and sequential evolution of persistently troubled accounts through adjustments of governing conventions to which state-members are often necessary parties.

**State as polity**

Although the original climate storyline saw states as the polities or self-motivated and initiating actors, consistent with an historical vision states as primary actors that organize markets and empower private actors instrumentally, the residues of that vision recognize plenty of space and rationale for states in at least two critical ways. The quite particular use of the term polity is to denote the organizational specialization and characteristics of governments and to distinguish the powers and capacities of states from private market actors. In this sense polity implies neither that governments structured markets for their self-interested purposes to extract revenues from subordinate social segments nor that governments were constituted by social contract and delegated limited spheres of authority to produce security and coordination. Polity in this account simply calls attention to the differentiation between states as specialists in the exercise of monopoly power and private actors who behave under the constraints of competition. States share with mafias, local gangs, and pretenders to coup d'etat the field of monopoly organization, though states as polities have different claims to legality and problematic relations between these alternative claimants to polity are frequent and notable. The longevity of governments, whether elected or seized, turns on the efficiency of their performance in the monopolized sectors they service. Equally, states behaving as stewards, may enter into multiple complex engagements with private actors around delegation and shared operations that help explain why issues around polity have preoccupied political science and political philosophy for ages. However, for polity as applied to climate, it may be valuable to focus on state monopoly powers over violence, diplomacy or inter-state relations and the distribution of monopoly rents associated with investment in infrastructure.

Polities are generally afforded an exclusive authority to use violence to police within their jurisdiction and to extend or defend the boundaries of that jurisdiction externally. Climate and its impacts have evident security impacts recognized at the core of the UNFCCC narrative and transborder regulatory implications recognized by the import of Scope 3 accounting to the Net Zero story. These potentials for climate-related violence underlie the prophylactic deployment of diplomacy by states to negotiate inter-se, in the absence of a global monopoly agency for climate management, the division and frontiers between a coalition of monopoly actors with frontiers differentiated programs and strategies for the timing and level of low carbon transitions. Under multinational processes that assign formal veto rights to all participant states and effective veto rights to multiple block coalitions, agreement of specific rules and correlative dispute resolution institutions will face serious problems with holdouts and asks for compensation are predictable. However, as demonstrated in the resistance and threats that have and still surround national legislation of carbon border charges on traded goods and services, that expectation in no way should be taken as license for smaller coalitions of states to take common pro-climate actions that override national sovereignty for differentiated climate action. While such coalitions of climate-proactive states may have the economic or military power to impose their preferences without agreed compensation, it is even less likely that states can end run their limits as polities by explicitly or implicitly delegating this authority in Net Zero obligations to mandate carbon prices through trade and investment. More impolitic, since the capacity to make such delegated
carbon norms and practices effective at meaningful scale would depend on global market concentration in critical production and financial sectors, the prospects for non-diplomatic settlements of these Net Zero accounts would exacerbate the third field in which polities claim exceptional status—the accumulation, administration and distribution of monopoly rents.

Strong rationales for competitive markets do not justify private capture of economic returns that exceed the long run costs of producing goods and services. These excess profits (rents), including the returns that will maximize monopolist advantages, can be extracted from such activities and be redistributed for other uses that may carry more moral or political appeal. States and empires have classically taken ownership, regulatory and financial positions in high value monopoly sectors to appropriate these rents, whether then used for enrichment, patronage, or public purposes. Especially where political (security), topographical (a unique river crossing) or technical (declining costs of scale) facilitate efficient (natural) monopoly operation, states have assumed dominant positions if only to forestall the growth of competing private organizations empowered by substantial monopoly returns. This situation has long prevailed in the build out of common infrastructure goods in economically core sectors like energy, transport, or hydrology at scale (canals, irrigation) or industry (salt, tobacco, iron and steel, and natural resource extraction). Whether its organization is structured around state enterprise, state finance, state regulation, specialized taxation or periodic expropriations, the state manages monopoly activities and distributes monopoly returns in price controls, free services, or monetary transfers as a specialized practice that claims to merit loyalty and state reproduction.

Infrastructure design, financing, administration and maintenance shares all of the features that explain and justify state monopoly presence. The security, developmental, topographic, cost curves and social attributes of infrastructure showed up in (Western) market driven industrial economies initially as state ownership, public budgets and charters that have morphed more recently into public-private partnerships, blended finance, defense contracting and regulation of energy, telecommunications and agriculture. In the state driven economies of Asia and the wider less industrial world, these same infrastructure attributes remain principally represented as pillar sectors (energy, transport, heavy industry) where reform of state enterprises and state banks has been a hallmark of the non-convergence that increasingly haunts climate narratives. On one hand, it is globally apparent that carbon-intense sectors are infrastructure heavy and depend on deeply embedded state production monopolies, state balance sheets, and social interests. Here the weight of state as polity over monopoly rents and powers will invariably constrain the smooth or easy privatization of transition from high to low carbon infrastructure. On another hand, this weight of state monopoly stems from technical features of low carbon systems in which systems integration through soft and information intensive investment in what are often zero marginal cost services challenges routines of public infrastructure investment and management practices that have come to define the familiar forms of collection and distribution of monopoly rents and services. Finally, the privilege of polities, east and west, in infrastructure provision will be manifest in coordinating across the pressures of state involvement in concurrent technology, sustainability, governance and identity transitions that threaten inconsistent appeals of infrastructure configuration and management that lie just across an increasingly near horizon.

State as sovereign

While competing political narratives and empirical accounts of state and markets depict states as primordial and self-interested organizations that reserve to themselves monopoly powers over arms and strategic industry or as the constrained agents of privately organized and market-focused principals, both stories seem to stress that
successful and stable states will behave as, and develop specialized expertise in the metrics and management of, the ultimate agency for bearing risk in the jurisdictions they rule or serve. States therefore must and have developed the discourse, technology and specialized institutions accountable for risk identification, measurement and management, with particular emphasis on the pooling and hedging of the downside risks that attend cyclical and structural and transitional economic activities with significant growth potential. The modern expansion of the scope of mandates and scale of operations of central banks, prudential financial regulators, disaster relief agencies, and social insurance vehicles acknowledges the increasing volatility of multiple risk exposures and pretended expertise and tools for managing them through politically distinct institutions. With particular regard to climate, the recent turn to risk co-located in these same public agencies the development of climate risk-centered, rather than emissions alignment-centered, accounting. This innovative assignment of climate accountability surmises the comparative advantage of government financial institutions derived from their risk competent technicians, their independence, their managerial responsibilities for the sovereign balance sheets to which climate risks privately avoided or transferred would ultimately be put, and their expanding experience in harmonizing monetary policies in the recent financial crisis.

Systemic or political economic risks will be avoided and intensified by the routinely expected motivations for private gain and the laying off of risk through its transfer to others’ balance sheets that prevails in competitive markets. The systemic risks of a necessary low carbon transition and the attendant responsibilities for measuring and managing them that in good part can come to rest on sovereign books will predictably include:

- embedded expectations for ongoing sovereign assumption and financing of climate associated, but increasing exposures and vulnerabilities to extreme events with acute physical risk; development assistance costs for pooling and compensating catastrophic and unmanaged acute physical risks in poor economies;
- trade-offs and distribution of costs between transition risks to be managed and the long-term physical risks residual to deferred and higher cost (incomplete); transitions; distributions of mid-term chronic, physical risk interim to higher cost longer-term transitions;
- systemic risks to the stability of sovereign balance sheets and ongoing political economic transfers of concentrated transition risks within polities to sovereign accounts;
- costs of dislocation of human and financial resources stranded by the trajectory of orderly and well-managed low carbon transitions; re-distributional transfers around dislocation costs under orderly transition planning and management;
- administrative and political costs of managing orderly transition for financial stability, efficient measurement and assignments and enforcement of transition risks, build out of customized financial and strategic tools for assigned climate risk management, and restructured sovereign vehicles for distributing transition costs including puts, transition-specific trust funds, social insurance, and international transition assistance;
- coordination of upside (low carbon) and downside (high carbon) orderly transition over time, including the mismatching of the gains from systems productivity of low carbon investment and the realized costs of the wind down of existing high carbon sectors; efficient re-employment of adaptable assets, firms and labor deployed in installed high carbon production systems, and the restructuring of fiscal dependence and substitution of public finance sources adapted to low carbon, information intensive, and more consumer surplus centered (household) economies.
- additional administrative, economic, distributional and social costs of the risks of disorderly, mismanaged or failed transitions, including macroeconomic losses from systematic price volatility, restriction of supply chains, losses from reduced trade, risks from strategic behavior and unproductive investment and vehicles for social insurance, and coordination across geographies and development strategies.
These are largely classes and types of risk that push the border of risk analytics up against more radical uncertainty, demand technical methods and the interplay of macroeconomic and financial models that are unfamiliar to existing regulatory and monetary institutions, suggest extended mandates for risk specialized public agencies that are politically contested, and require timing and financial coordination between the wind down of the existing and wind up of the new economy that question the fit of practices adapted to smoothing steady growth to the contingencies of transition. Yet, if orderly systemic transitions are the climate grail, effective climate action must look beyond the end state that a well-staged alignment of Net Zero emissions targets imagines. The goals and demands of orderly transition are not just about where we come out, but the likelihood and consequences of how we get there. Orderly transition under increasing risk departs from Net Zero emissions alignment in not only in its emphasis on motivation under constraint and effective coordination of fundamental changes in social and economic organization, but about both the management model it organizes and the metrics or currency in which it accounts its advances or failings in practice.

With regard to management processes, as against a climate narrative that leads upward from the emissions of market actors toward systemic risk, orderly transition suggests there could be higher probabilities of successful transition in a framing that moves down from the sovereign assessment of systemic risk toward differentiated assignments of climate responsibilities and liabilities to distributed firms and communities. A transition framing assumes that the proper exam question to be posed and tested is whether a collection of polities and private actors is more likely to arrive timely at a stable climate and productive low carbon economy by:

1. starting with private actors and autonomous state enterprises calculating the metrics of directly and indirectly attributable emissions & short run acute physical risks; adding up separately attributable emissions outcomes and patching in systemic risk in the gaps at unsettled edges of (Net Zero) emissions accounts, primarily by states either regulating around these accounts or acting in and through associations with extensive global reach and substantial market power; and letting the costs of transition lie where they fall among accountable emitters except as supplemented by sporadic, ad hoc and uncertain series of puts to fragmented governments, puts which will distort the behavior of firms to manage efficiently the risks initially incident upon them and in themselves incentivize and require state control of strategic behavior, or

2. beginning with the metrics of systemic and system-wide political economic risk; assigning clearly and enforcing obligations to manage these risks—upside and downside, chronic physical and transition—to those entities, groups, and sub-sovereign and, as agreed, among external polities with better technical and practical knowledge and organizational capacity to manage and minimize them (cheapest cost avoiders); ensuring the adequacy of the toolkit (risks pools, financial instruments, research and contracting or adapting business models) with which assigned risks can be managed; and evaluating and supporting the distribution of costs and liabilities of transition—not through blame for the resultant behaviors (emissions) of past adaptive and complex system—but against equitable maxims that both finance near term transition losses against longer term gains and recognize norms of well-being and value that continue to evolve around sustainability and low carbon production.

On the side of metrics and methods, accounting in the currency of risk is a quite different practice than in that of alignment of emissions and targets. At first glance, reconciling alignment and risk might seem easy. In standard theory, once a capable and accountable global risk manager is instructed that an authorized outcome (Net Zero emissions or a well-defined overshoot and recovery) on an assigned schedule (2050 + interim targets) is certain, the manager can calculate the cost optimal package of emissions allowances, pathways and timing requirements.
for aligned emissions reductions, and produce a good approximation of any residual physical costs consistent with that mandate. In the alternative world that climate threatens to perturb, risks and the models that compute around them are granular to assets and businesses, rather than sectoral aggregates; differentially and unevenly regulated, priced and managed through a diversified portfolio of financial, organizational and technological options by firms, industries, political institutions; shared (administered prices and quotas, taxes, licenses, puts) and dynamic or subject to transfers and gaming. As a consequence, the behavior of firms and nations is strategic and repeatedly represented in alternative and credible scenarios that continually update the probabilities and time lines of variable, interdependent outcomes, the distribution of associated costs, and the financial and economic stability of the transition passage. In such a world, transition probabilities are emergent and empirically driven by multiple, often interactive, technology, policy, political economic, macro-economic and informational factors. They are less able to be measured and minimized as much as contained, nudged down a glidepath, and continually reappraised under decision rules about value at risk. They are more options to be packaged and hedged than discrete shocks to be repriced and absorbed. If keeping the management of complex futures is the responsibility of those accountable for climate action, then risk rather than emissions alignment is the currency in which the effective practice of systemic change is best accounted. And though it is likely a better bet that risk is the language of transition and, more generally, the political economy of its effective practice, re-situating climate futures there will prove a far from simple matter.

**Stewards**

Where systemic transition is the climate framing and accounting for risk is its currency, then it makes little sense to spend too much effort casting about for heroes, victims and villains. Technological, economies, and adaptive socio-political organizations develop, stabilize and obsolesce with uneven impact across geographies and communities. States and markets recompose throughout these shifts in variable proportions and structures that must be reworked by interested coalitions that represent both the potential gains of future innovation and the mitigation of the noxious by-products of past innovation. At the same time, the historical record to this point shows little reason to believe that the established pattern of states, as organized specialists in the monopoly services of regulation/policing, infrastructure provision and finance, and risk bearing of last resort, will soon depart the field or lose their integrative value in a more information intensive and sustainable low carbon system. In the installation and reproduction of more sustainable and economically modes of production, it will be relevant to reprise what do states do well and poorly and to consider as open questions which particular state agencies are likely to be better customized platforms on which to deliver more likely orderly transitions. Postulating that states will remain central to climate action, inquiry can then focus on how states can best repurpose their time worn concentrations as stewards, polities and sovereigns to the particular details of the low carbon and several linked transitions now underway.

As potential stewards in an ascendent Net Zero framing of climate action whose direction of travel raises prospects of difficult to settle core accounts, states in market and state driven economies have extended resumes of creative adjustment of the boundaries of their monopoly spheres through co-participation, delegation and institutionalized association with private market actors. In an American society that has often fetishized its dedication to markets, consigned state firms and banks to its formative years, and endured long periods of constitutionally foreclosed regulation, composite forms of state-private coordination, delegation or even sector-wide industrial corporatism during depression or wartime have evidenced the fluidity of near universal blended or captured governance. When direct regulation was near its nadir in the late 19th century, both celebrated voluntary national associations like
the Women’s Christian Temperance Unions and local clubs opposed to animal cruelty or pornographic mailings focused less on moral persuasion of individual converts to their cause and more on lobbying for legislative endorsements of their campaigns that delegated to group members the authority to enforce, sanction and retain the financial proceeds of their administration. There should then be little conceptual ill fit between sovereigns, sub-sovereign or state agencies taking active part in the commitments or deliberative processes of membership associations that will continue to push the Net Zero direction of travel or taking on specialized policing or coordinating roles that contribute to effective associational self-government.

The ambiguity of state stewards as participants and particularly enabled mediators can be cumbersome if state infra-associational conduct is easily open to legalistic challenge, but may prove especially beneficial when states behave essentially as peers in specialized networks facing the same problems and incentives as their private counterparts. The (sub-sovereign) state of California, for example, acts in Net Zero mobilization as a financial intermediary that issues bonds and lends on their proceeds and as a leading buyer of infrastructure services and bulk supplies. Like its peers in leading Net Zero associations California is threatened by acute physical risk which it seeks to measure accurately, prevent, and insure; and, again like its peers, relies on increasingly valuable puts to the federal sovereign to distribute the costs of these risks. Like fellow association members, it is committed to disclosing its direct and Scope 3 emissions future, seeks investment support for low carbon transition infrastructure from the central government, and faces rising demands for sustainability as well financial materiality in its credit portfolio. While it is unlikely that California will itself exercise its legislative power to impose multiple materialities in state touched financial markets, it will in implementing Net Zero be subjected like private banks and asset managers peers to the same structural pressures of financial market development including flight from public regulated to private equity markets, innovative credit vehicles from shadow banks and hedge funds that attract securities investors demanding growth returns, and destructive competition from the internet of finance where sustainable materiality is not operative. Beyond the value of collective consideration with peers of shared concerns and positions that can advance accords on terms of unsettled accounts, states-stewards may import to their Net Zero associations their heritage as regulators to function as internal advisors and mediators on the credibility and acceptability of replacing mandatory state solutions to open climate disclosure controversies with associational self-governance. Still further beyond state contributions as Net Zero peers, state stewardship may be broadly facilitative of wider state climate responsibilities as polities or sovereigns, better able to sample, inform, consult and debate within specialized networks of private firms and other participating government agencies around on identifying efficient risk managers, diagnosing and avoiding gaming and strategic manipulation of climate risks, and pre-negotiating distributions of transition liabilities and remedies like income transfers and social insurance.

**Polities**

The record of states as stewards in the markets of 21st century advanced economies offers rich precedents for the added value of public and private peer associations, and only routine cautions against systemic damage linked to joint clubs as vehicles for the corrupt capture of blended networks. However, the record of state performance as polities focused the appropriation of monopoly rents, infrastructure investment and exclusive status in diplomacy, and as sovereigns charged with the ultimate duties of risk management and financial stability, is far more fraught and contested. The arguments and hopes for convergence around markets in the UNFCCC climate narrative were tied to well-grounded studies of the growth-draining effects of government mismanagement of infrastructure investment. Climate politics began its story with multilateral regimes and carbon prices. As projected fiscal measures, whether as taxes or (auctioned) licenses to emit carbon ran up against popular distaste for higher
and new taxes, consumer resistance to energy and automobile price increases, and the fears of politicians for any but broad-based income and sales taxes, climate action migrated in the advanced industrial and emerging market countries to the expenditure side of national budgets. Outside of the state-driven economies of Asia where system-scale budgetary and public bank investment continued into the post-Copenhagen period and government infrastructure finance has retains its place as a primary engine of macroeconomic growth, the pro-market ideologies and post-recession commitments to austerity favored non-budgetary, creative uses of state backed guarantees, subsidies delivered through tax reductions, structured finance with concessionary public assumption of first losses as less visible and more politically palatable fiscal instruments both sought and applauded in the aftermath of the Copenhagen collapse in the incipient Turn to Green Finance. Again, in the wake of the COVID pandemic, the demand for state driven macroeconomic revival, expansive monetary policy, build back better with debt-funded public investment under the tenets of modern monetary theory recall and reinforce the central place of fiscal expenditure as the recognized province of state as polity. Even against a Net Zero backdrop that displaces states as the primary climate actors, the political wave that prioritizes growth via state infrastructure finance has swept climate advocacy back toward alliance with the polity. It is odd that the West, where revisionist economic theory opens a door long shunned, widely turns to unprecedented public debt now embraced by ecological activists, while in China and the emerging markets long derided as overly state infrastructure reliant, preoccupation with debt to GNP ratios causes more friction with this strategy.

Irony aside, the principal charge against state monopoly in the ownership, finance and management of infrastructure systems, whether high or low carbon, is that it is done wastefully, corruptly and in assets with lagging productivity. Stimulation of macroeconomic growth, infrastructure as a class as the object of stimulation, and selection of infrastructure projects as targeted objects may all contribute to the criticism of state capacities to manage this field. For growth to be reinvigorated, there must be unemployed resources to be called forth without yielding price inflation or volatility more likely to slow infrastructure transition through investor quests for the safety of liquidity. Where growth is potentially available, there is substantial criticism that government agencies in politically influenced processes are unlikely to identify projects that increase productivity, particularly if low economic growth is structural rather than cyclical and the productivity of individual projects, like most clean energy facilities, demands concurrent systemic reorganization. If it is the case that new build renewable or transportation investment is the market-preferred choice over new fossil, then why should public finance be involved other than as an agency that stimulates the aggregate growth in demand that will incentivize new low carbon supply? If it is the case that new build renewable facilities or (automated) electric cars will only realize high productivity returns in a restructured energy system, then state finance ought to concentrate on systems development and integration investment and not facilities projects. But public investment in clean energy from Indiana to India is concentrated in construction of physical plant, and the links between structural growth, transition and investment are nowhere simple. While Kauffman and Roston point out why Western private financial sector adjustments to innovative energy solutions is inertially lagged or discouraged, Choi and In’s analysis of state-driven finance in Korea highlights how siloed and duplicative infra-public sector delegations of the state monopoly charter to fragmented and specialized government agencies crowd out private financial development and competing capital. China, where state bank finance of infrastructure-led growth has lifted the nation from mass poverty at unparalleled scale, the time at which almost any infrastructure investment was productive relative to once ubiquitous infrastructure-absence has expired. The political division in Chinese federalism between central government mobilization of capital and provincial portfolio allocations has resulted in recurrent episodes of accumulated bad debt and periodic recapitalizations charged against the sovereign balance sheet.
The practice of public investment in redesigned systemic infrastructure in low carbon transition is often most problematic than in managing cyclical economic fluctuation. Pervasive innovation around complex systems integration that organizes decentralized, two-way flow, intelligently controlled, multi-sourced reliability energy systems that power clean and electrified transport, industry and space heating look nothing like the centralized, one-way, adjustable flow, hard engineered and limited use systems that deliver fossil energy. Yet, transition management requires investment and timing precision to ensure comparable, if not increasing productivity, in replacing without hiatus the high proportion of total market cap or net national product of the fossil economy. While there is prima facia appeal in promoting a tied agenda of lifting macroeconomic growth and low carbon sustainability, the program joins diverging incentives around stress response and transformation. Recovery goals are short-term with low risk/low return profiles that look for “shovel-ready”, planned and licensed, familiar physical (hardware) infrastructure projects with well-established project financing vehicles and immediate jobs for an unemployed labor force to benefit from income distributed through work. Low carbon transition goals are long-term, with higher risks/higher return profiles, stress on systems integrating, digital (soft) infrastructure, and experimental financial structuring around high private uncertainty around investment in capital-intensive intangible assets, zero marginal cost services, upside returns dependent on systemic adaptation to low carbon market design, new business models and disruptive labor patterns suggesting a new transition safety net. For good reason, Choi and In insist upon the reform of the established organization of the bureaucratic and developing banking channels of state-driven infrastructure investment. At the same time, it is worth noting the potential dynamic advantage of state-led systems in the explicit Korean (and Chinese) overlay and coordination between the digital and sustainable transitions. In this regard, Western polities taking up in the context of prolonged low growth and climate their rent distributing and infrastructure financing competences might well reconsider the leading edge of evolving Asian growth models.

Sovereigns

It is indisputable from the self-diagnosed reports of TCFD and the live reporting and op-eds of the Green Finance press, that both the core practice and theoretical frontiers of transition risk measurement and management is centered in central banks and financial regulators. This should not be too surprising since even still young research on risk dynamics and strategic behavior in climate, like financial risk before it, is assumed by and transferred to sovereign balance sheets. Sectorally and geographically concentrated climate transition risk may or may not cause the same forms or levels of systemic risk as did financial risk after 2008, but there are multiple channels through taxes, social insurance, regulated industry terms, and bailouts that facilitate these movements. With discretion and extreme political caution, the expansion and common programs of the Central Banks and Financial Regulators Network for Greening the Financial System associating the cornerstone institutions from advanced industrial and emerging economies recognizes their claim within states to climate jurisdiction. This claim is ratified by the effective abdication of fiscal authorities through taxation to manage climate, which then shows up on sovereign balance sheets as mounting risk; the value attached to independent or non-political and quantitative expertise that has been acquired by expert groups in managing financial (price) stability and full employment; and the recent experience of these same agencies with proto-fiscal policy in taking primary public responsibility for post-financial crisis recovery policy and its transnational harmonization. Perhaps exciting analogies to climate, the difficulties of more political government bodies in dealing with these technical and global problems pushed normally reticent bankers and regulators to step into unfamiliar territories of large scale asset purchases on the state balance sheet and careful investigation consideration of preventive measures to control climate risks including selective Green heavy financial asset purchases and differential reserve requirements or collateral standards that accounted for the climate performance of a regulated entity.
Even in Western advanced economies where central banks and financial regulators have taken on and compiled an esteemable experience with crisis risks, there is a litany if cited limits to replicating an expanded jurisdiction over climate. These external objections or self-restraints expressed regularly by monetary authorities center around:

- the long term recognized responsibilities and regulatory actions of the monetary and financial agencies have been developed under long term economic growth and aimed at cyclical smoothing; they have not been asked or explicitly entitled to deal with structural disruption and potentially deflationary conditions like climate change.
- as noted in the evaluation of pilot stress testing by France’s prudential regulator (ACPR), the orthodox macroeconomic models, including climate integrated assessment models that incorporate macroeconomic models, are not designed, or apt, for: (1) combining highly granular and asset specific financial models that describe concentrated climate transition risks and more highly aggregated macroeconomic models; (2) credible probabilistic and locally differentiated rather widely normative climate scenarios; (3) agent-based strategic behavior rather than normalized first order behavior; (4) price formation and other internal mechanisms that do not reflect disorganized responses to climate risk.
- the management of orderly climate transitions contemplate the assessment and maintenance of financial stability, but also efficient allocation of risk management responsibilities, and clarification and implementation of the distributional impacts of dislocation and economy-wide climate transition that lie outside the built-up expertise of financial authorities.
- political conflicts over the use by monetary authorities of proto-fiscal expenditure tools;
- legal mandates of financial authorities limited to price stability and employment, and to investor protection; further expansion of this jurisdiction to manage other large scale rather than reducing sovereign exposure to these risks in the absence of legislation delegating this competence is contested as inappropriate due to a lack of a legitimate democratic base for non-elected expertise and threatening to the continuing agency independence that has been constituted in explicitly mandated, but limited powers.

However compelling may be arguments against broad climate accountability being recognized by central banks and their financial associates in Western advanced economies, the positive case for their assumption of primary ecological risk management in emerging markets and less developed governments is more obscure. Because of the scarcity and expense of natural gas and the abundance and low cost of coal as an energy source across the still faster-growing economies of East, Southeast, and South Asia, the institutional legacies, policy preferences, and development time tables of these state-driven systems do not signal convergence with those of more market-driven advanced industrial nations. With apologies and full acknowledgement of the inevitable diversity among these carbon-intensive Asian polities, for limited purposes like their relative capacities and inclinations for sovereign risk management, it may be acceptable to draw on a highly stylized account of state typologies. In many cases, certainly China’s, growth paths led through deep state-driven integration of ownership, finance and policy in key development sectors like energy or telecommunications, iron and steel or agriculture. Across the gradual general relaxation, especially in agriculture, of this integration, these sectors recast as pillar industries remained tightly controlled through state enterprises, state banks, and periodic re-stabilization of their balance sheets by the Treasury. In this configuration of state bodies, central banks have been, more than in the West, openly competing, rather than uniquely empowered, risk managers. Financial regulators were forced to share coordination across sectors, enterprises and banks that was historically centered in planning mechanisms like Japan’s Ministry of International Trade and Industry or China’s National Development and Reform Commission. Management of infrastructure productivity, risk and finance ran through specialized state organizations like the China Development,
Korea Development Bank, India State Bank, as supplemented by state directed (commercial) bank loan syndications through commercial bank cartels or highly concentrated state pension funds. Equity finance travelled through retained earnings of state firms, often via wholly owned banks internal to state owned corporate groups.

Even as, with wide-spread economic growth, state driven economies have evolved toward indicative, less mandatory and detailed, planning, and rising financial stability concerns over worrisome debt levels with declining public investment productivity in the waning of an initial era of anything grows, central banks have asserted more authority over the questionable competence of sub-sovereigns to set investment priorities; the scope and reach of their powers in the politics of concurrent technology and sustainability transitions remain fluid. Transitions in state-driven economies may benefit from a political economic heritage that stresses coordination over allocation objectives and a greater habituation to structural change like that required by a shift from natural resource-dependent production models fitted to rapid growth to those better fitted for continuing competition among information-intensive systems. At the same time, Asian state-driven must face embedded and siloed monopolies in the pillar industries core to climate risk management and infrastructure finance, with installed fleets of unamortized assets subject to downside losses on the books of the state. At what pace and by what means to redraw the organizational and political boundaries of state-driven high carbon manufacturing systems around recognized commitments to incipient low carbon, information economies will remain a deliberate and problematic process.

Given the propositions that careful analysis will find that states as stewards, polities and sovereigns have irreplaceable accountability in the management of low carbon transition and acceleration of transition schedule is very likely compelled by better understood trajectories of revealed climate risk, a logical inquiry might turn to whether and how: (1) the know-how and experience of state institutions specialized in public finance and risk management may be best deployed; (2) under the conditions of accelerated and structural transition; (3) with appropriate attention to differentiated local patterns of governance and timing that are unlikely to converge in carbon risk relevant terms. One intuition that might be followed in this inquiry is whether, in the absence of ready at hand state agencies—military, fiscal, monetary or regulatory—designed for, or previously adapted to, such rapid and comprehensive transitions, it makes good sense to consider special purposes vehicles (SPV) constructed around the terms and conditions of the issues in play. An eccentric compilation of such SPVs built to manage extraordinary or crisis situations that could merit such consideration might begin with the US National Recovery Administration (depression), the American Office of Price Administration (wartime economy), the French Commission du Plan or Japan’s MITI (post-war restructuring), or, most recently, the Treuhand Anstalt (German reunification).

Cursory lessons drawn from an examination of transition-related SPVs could be split into their experience with upside transition gains and downside transition losses. Most generally, an asymmetrical focus on coordination of upside transition, including infrastructure, finance is more usual, often due to downside losses having already been realized or mitigated through emergency relief, when depression response is chartered. Similarly, in wartime, expectations of returns from existing assets have also been monetized and accepted by threat of destruction or expropriation. Upside opportunities are frequently managed and assigned in newly arranged corporatist (public-private; sectoral) associations or through amalgamation and reconstitution as state enterprises in broader nationalizations, frequently characterized as temporary. The distributive impacts of non-systemic downside losses within advanced economies have been regularly managed on a project-by-product level with ad hoc solutions under firm bankruptcy process or where larger sectoral/regional reorganizations under the delegated state authority of publicly appointed private sector trustees (receivers). Think of the structured and gradual wind down
of major infrastructure such as the reduction of scale of failing private Pennsylvania and New York Central Railroad networks into the subsidized Conrail and Amtrak lines over a 25-year period. In contrast, the downsides risks of post-1750 economy-wide transition (steam engines, railroads, telecomm, automobiles, mass electrification) have been managed largely through markets in the wind downs of existing asset and business values, moderated by the extended duration of transitions over 75-100 years, low level displacement support as social insurance, and reliance on correlatively timed upside system reform adaptations that allow inter-generational reskilling. Under more exceptional pressures, such as war-forced structural transition of production, and accelerated and mandated downside losses driven by compressed timelines, SPVs have provided public financing of capital accounts and allowed exceptional profits and tax relief to transitioning sectors like vehicles, energy, aircraft, shipping or heavy manufacturing. The same agencies have been accountable for steering wider state response in managing transition damages—in depression through state employment programs for displaced labor and in war and its aftermath through near-universal (male) military employment, direct regulation of post-war re-employment, macroeconomic stimulus, and tailored redistributive transfers such as the US GI bill.

Given the long-term growth and structural stability of existing industrial, energy and resource intensive production systems, whether state or market-driven, it may be more interesting to look closely at the restructuring from socialist to capitalist and globalized production after the dissolution of the Soviet system. In Germany, the management of systemic transition was charged to an SPV (Treuhand Anstalt) with joint authority over a time-limited winding down of multiple industrial complexes (Kombinate) and the sale or other allocation of their assets and personnel to established firms wherein the value of these selected assets and resources would remain most productive. Compensation or support payments for assets and communities that could not be so fitted were retired with macroeconomic (exchange rate), targeted fiscal programs, and themed fund specific transfers from the German Treasury. The mandates and performance of the Treuhand Anstalt as an integrated transition SPV with concurrent and specialized jurisdiction over both upside and downside risk metrics, risk management, and public finance, supplemented by ability to draw on related expertise and experience from both public agency and private enterprise secondees, may throw some light on where state administration of the yet uncertain low carbon transition might be directed. Such institutional reform of more familiar political practice might also align with promising suggestions that climate diplomacy could be productively resituated among smaller, more customized networks of leading national or special agency actors to sort out more flexibly the sluggish debates over political jurisdiction and economic coordination among low carbon economies.

In pretended summary of issues whose history cries out against simplification, conjecture about the next turns toward low carbon might start from a conjunction of three notable features of the close climate horizon that have emerged. Most ownership and investment in production at scale in climate intensive sectors is in the hands of states. The economic and technological systems in which measuring climate emissions or risks and dividing up accountability for their management are globalized, and will principally remain so. Against this globalized backdrop, politics continue to be substantially decentralized and therein the downside of transition is critically important.

In the face of this conjuncture, Net Zero accounting and associations, particularly when they facilitate, inform and coordinate stewardship interactions with states, can complement and shape the work of states as polities and sovereigns. To the extent that Net Zero targets and metrics are imagined as effective proxies for the primary obligations of states in infrastructure finance, diplomacy or risk management, they will delay and deflect climate action from the narrowly time constrained course to which it must once again turn.
Orderly transition is the signpost that demarcates the coming turn with three overarching directions:

- narrative storylines will migrate from alignment to risk metrics to risk management;
- operating methodologies will stress coordination, managing uncertainty, and dynamic planning within non-convergence;
- accountable institutions will extend to special purpose vehicles, whose recommended reference will be accelerated transition.

In the direction of orderly transition, we will do well to build on local, established associational patterns, as well as on state expenditure and risk management practices, but with focused adaptation on technological innovation and on system integration via infrastructure finance and market design.

**POSTSCRIPT: SYSTEM PRIORITIES AND DIRECTIONS**

The ascendence of Net Zero testifies to its attractions: an optimistic embrace of a near and sustainable future, a projection of that future as an incremental correction of familiar patterns of Western development, and as the mainstreaming or democratization of solutions for even the most challenging systemic problems. But, like all compelling storylines, the mainstreaming of politics imports its own kit of techniques adapted to the effective practice of governance at mass scale. These tools often include a regular application of boxes and lines that are useful precisely because they reduce to simple form what may be complex technical, financial and social changes in economic organization. Checking boxes and defining lines work to demarcate contested fields and mobilize mainstreamed coalitions. We learn who are the good and bad guys—who is on the right and wrong sides of history—by checking the boxes that score on which side of the dividing lines groups, corporations, banks and even nations stand. The best strategies for winning games are often to build around coalitions of issues that cluster on one side of a single defining line, even when the positions of firms or countries may actually align variably on particular issues across differently drawn divides. China and the United States may or may not be on the same side of overlapping climate and social identity transitions, though a politics of governance at scale may push to see them as universally juxtaposed. Mainstream politics, especially those like climate with global reach, will profit from the value added by this toolkit and be liable for the costs. Mobilization is a condition of political success; simplified solutions run the risk of incomplete and short-lived results. Within this spirit, we can both applaud the advances of Net Zero and suggest precautionary guidelines to protect against overestimating either its stability or likely scope of its ultimate contribution to managing the climate future.

We’ll conclude by reiterating five precautions that look beyond the likely limits of Net Zero, and will require the constant monitoring and testing of apparent climate advance against their standards:

1. It’s the (downside) risk.
2. It’s the (upside) system.
3. It’s (accountable) management.
4. It’s (mostly) Asia.
5. It’s (multiple, non-convergent) transitions.