Integrating Systematic Climate Risk into Asset Pricing and Portfolio Allocation

There is growing consensus that the world is undergoing an energy transformation. Globally, energy systems are rapidly transitioning towards low-carbon sources driven by technological innovation, governmental regulation, changing resource landscapes, and evolving social norms (Caldecott et al., 2014). The short-termism of capital markets, however, has failed to secure a more sustainable allocation of capital for the long-term. In his seminal speech to Lloyd's of London, Bank of England Governor, Mark Carney, asserted that inaction on climate change will threaten financial resilience and longer-term prosperity (Carney, 2015).

My PhD research examines financial sector resiliency in response to rapid decarbonization. There are enormous uncertainties inherent in predicting how decarbonization may strand existing carbon assets across industries (Caldecott, 2017). Mismanaged systematic risk can constrain a bank's lending capacity by increasing capital provisions, reducing the availability of loans from banks, and effectively stalling sustainable economic development (Saunders & Allen, 1999).

The systematic risks of decarbonization is largely overlooked in financial literature. Whereas climate journals have clearly engaged on topics such as physical (Collier & Skees, 2012) transition (Dietz, Bowen, Dixon, & Gradwell, 2016; Ho, Morgenstern, & Shih, 2008), and liability risk (Caldecott, Harnett, Cojoianu, Kok, & Pfeiffer, 2016) - climate risk is significantly underrepresented across the leading finance journals (Diaz-Rainey, Robertson, & Wilson, 2017). Critical issues of portfolio theory, risk valuation, and asset pricing (which encompass over 67% of finance literature) remain absent in the context of climate change (Diaz-Rainey et al., 2017). While environmental consequences are still not a deciding factor in risk models by commercial banks (Zeidan, Boechat, & Fleury, 2015), recent evidence suggests that environmental consequences do increase a creditors' perception of default risk (Erragragui, 2018). However, financial institutions are unaware of how the complex interactions between sectors will contribute to positive or negative feedbacks across the economy (Battiston et al., 2016).

This research seeks to gain a better understanding of how climate related risks and opportunities affect asset pricing and portfolio allocation. Currently, financial institutions do not price environmental risk in the interest rate, either because it is not perceived as material or because the tools to do so are inadequate. First, there is an ongoing debate on whether the impacts of climate change would generate systematic risk across the economy (Battiston, Mandel, Monasterolo, Schutze, & Visentin, 2017). The complex and pervasive interlinkages of financial institutions could expose investments to indirect environmental impacts from all sectors of the economy (Battiston et al., 2017). There is, however, a lack of formal theoretical models that integrate environmental externalities into portfolio allocation and pricing decisions (Kakeu, 2017). Moreover, relevant data are scarce and there is no consensus on the appropriate methodologies to use (Battiston et al., 2017). New approaches to asset pricing and allocation theory will be required to integrate the low-carbon transition into financial decision making (Guyatt, 2011). This objective is important for doctoral research because it addresses a gap in literature about the materiality of systematic climate related risks on asset pricing and portfolio allocation.

The proposed research question seeks to address the gaps above, by exploring whether decarbonization generates systematic risks for the financial system and whether these risks can be integrated into the pricing of assets. Thus, the research question is, "How do the systematic consequences of decarbonization affect asset pricing and portfolio allocation?" To investigate this question in more detail, I explore 1) how systematic climate risk may contribute to the formal theoretical models of portfolio allocation and pricing and 2) what instruments can integrate systematic climate risk into the price of assets.

This research utilizes recent advancements in computational finance, simulation modelling, and stochastic optimization to develop a robust method of portfolio allocation that minimizes systematic risk affiliated with rapid decarbonization and stranded carbon assets. Computational modelling tackles some of the most pressing epistemological challenges of integrating climate finance in portfolio theory (De Scheemaekere, 2009). Traditional portfolio allocation theory faces three limitations that render them inadequate to address climate risk; they fail to target issues of interdependence (Gramlich, 2018; Nordhaus, 2011), dynamic systems change (Focardi & Fabozzi, 2012; Keasey & Hudson, 2007), and the applicability of historical data in the context of climate change (Low, Faff, & Aas, 2016). First, network theory is used to address the challenge of interdependency to measure the flow of systematic risk across economic sectors and the banking system (Battiston et al., 2016; Cont, Moussa, & Santos, 2010; Nier, Yang, Yorulmazer, & Alentorn, 2007). Stress testing methods will be utilized to evaluate the capacity of the financial system to absorb potentially large shocks affiliated with dynamic systems change, to test the stability of the financial system under different hypothetical scenarios (Alexander & Baptista, 2009). Finally, in the circumstance that historical data is no longer an effective measure of future performance, stochastic tools like scenario analysis and monte-carlo simulations can present alternate projections across a range of possible future outcomes (Rockafellar & Wets, 1991). Scenario analyses are commonly applied in the study of climate change (Moss et al., 2010), but have more recently been applied to understand how businesses or industries might perform in response to transitional risks such as carbon regulations (Clarke, 2015; Guyatt, 2011).

The significance of this research is to present new approaches to traditional asset pricing and allocation theories to assess how climate externalities might influence financing decisions. A framework for pricing environmental externalities can build resilience in traditional portfolio allocation strategies and channel investments towards sustainable growth. The original contribution of this research would be to design and test new financial methodologies, which tie methods of climate risk like scenario analyses with traditional asset pricing and modern portfolio theory. The proposed research will contribute to the advancement of theory and methodology in modern portfolio theory, sustainable finance, and sustainability assessment. Financial institutions and policy makers will also benefit from more comprehensive and rigorous models of integrating climate risks and opportunities for the financial sector.

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