

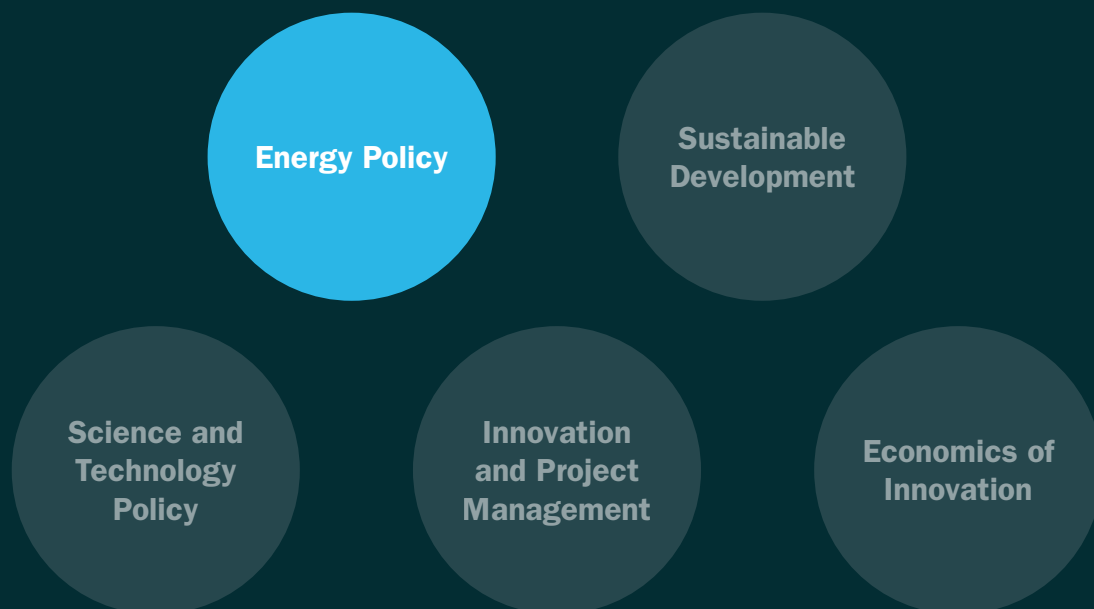
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Relating Financial Systems to Sustainability Transitions: Challenges, Demands and Dimensions

Chantal P. Naidoo



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Relating Financial Systems to Sustainability Transitions: Challenges, Demands and Dimensions

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Abstract

The Paris Climate Agreement, SDGs and Addis Ababa Action Agenda call for the financial system's approach to sustainability and climate breakdown to be "consistent and integrated". So far, sustainability transitions (ST) research fails to engage with such calls, offering limited analyses and conceptualisation of financial systems and transition processes. In this paper, a scoping review of finance and ST research shows a polarised context, ranging from nascent orthodox to critical analysis with limited cross-engagement. The paper applies a novel approach towards bridging the polarity; by interpreting the characteristics of the sustainability transition process from the perspective of the demands, it places on the financial system. Five initial demands emerge - directional changes, temporal dynamics, co-existent systems impact, contested social context and contextual experimentation. Finally, the paper offers initial dimensions for scholars to engage in for informing the response of financial systems to the demands of sustainability transitions.

Research Highlights

- Scopes and interprets cross-engagement between sustainability transitions and finance research
- Identifies limitations in conceptual development of finance in sustainability transitions research
- Applies insights from sustainability transitions to formulate initial demands on financial systems
- Offers initial dimensions for informing response to the demands of sustainability transitions
- Contributes towards evaluating assumptions of response of financial system relative to demands

Key words

Sustainability transitions

Financial systems

Climate breakdown

Characteristics of sustainability transitions

Demands of sustainability transitions

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1. INTRODUCTION

The Paris Climate Agreement (PCA) and the 2030 Agenda for Sustainable Development (SDGs) commitments of 2015 represent a turning point in sustainability and climate action (Nerini et al., 2019). These critical agenda setting and interdependent¹ multilateral commitments draw attention to the urgency and scale of the sustainability and climate breakdown², which affects every nation, every sector and every aspect of modern existence (Nerini et al., 2019). Some also frame the climate breakdown, in particular, as an existential crisis (Spratt and Dunlop, 2019) or as super wicked problems (Lazarus, 2008). The Intergovernmental Panel on Climate Change Special Report on Global Warming of 1.5°C (IPCC Special Report) amplifies the urgency of the sustainability and climate breakdown (IPCC, 2018). Responding to the breakdown requires radical and urgent actions between 2018 to 2030 to limit the global temperature rise to no more than 1.5 degrees and build resilience to increasing effects of climate change (IPCC, 2018). The global commitment context suggests grand scale responses to shift economic development towards sustainability, which extends beyond incremental or quick-fix solutions (Spratt, 2015; Loorbach et al., 2017). Grand scale responses require finance. The financial system, therefore, has an indisputable role in responding to the sustainability and climate breakdown.

The financial system, on the one hand, and social and environmental challenges on the other, have long been associated. For example, in the early 1970s, the US and UK banks were the subject of social campaigns that lobbied against their support of the South African apartheid regime at that time (Fullwiller, 2016). Around the same time, recommendations relating finance to sustainability emerged in the 1972 Stockholm Declaration (UN, 1972) and later the 1987 Brundlandt Report (WCED, 1987). The recommendations proposed that financial institutions such as the World Bank introduce environmental and social risk into project design and investment appraisal processes (UN, 1972; WCED, 1987). Further, the UN proposed for countries to work together on integrating sustainability into global trade, development and finance systems (WCED, 1987). The multilateral commitments of 2015 re-emphasise the centrality of the financial system in responding to the sustainability and climate breakdown, as first mentioned in the 1972 Stockholm Declaration and 1987 Brundlandt Report. They also mark a shift in emphasis. Specifically, the PCA sets as one of its three *main* objectives “make finance flows *consistent* with low emission and climate-resilient development” (UN,

¹ The Paris Climate Agreement and SDGs are interdependent in that, achieving the climate goals is to happen within the context of the SDGs. Not to the exclusion of any of the goals.

² The paper adopts the term “climate breakdown” as the preferred reference to the generally used term “climate change”. Climate breakdown was first used by George Monbiot to convey the urgent scale and intensity of response required.
<https://www.theguardian.com/environment/georgemonbiot/2013/sep/27/ipcc-climate-change-report-global-warming>.

2015a), while the SDGs and the Addis Ababa Action Agenda on Financing for Development call for *integrating* sustainability into trade and finance flows (UN, 2015b; UN, 2015c). The shift in emphasis appears evident in the focus on finance flows having to be consistent and integrated, which implies both a quantitative *and* qualitative role for the financial system in the shift to a new sustainable economic system.

The financial system is capable of driving radical and transformative changes in the economy through large scale infrastructure investment (Schumpeter, 1942; Demirguc-Kunt and Levine, 2008 cited in Mohamed, 2014). With over U\$112.1 trillion global assets under management predicted by 2020 (PwC, 2017), the scarcity of finance to deploy towards the sustainability and climate breakdown is unlikely. However, recurrent financial crises also show that the financial system is capable of creating significant economic and social losses (Reinhardt and Rogoff, 2009; Griffith-Jones et al., 2010). This tempers the view that the financial system can sustain and maintain the radical and transformative changes linked to the sustainability and climate breakdown, without being disciplined to do so (Swilling, 2013). Further, the response required from the financial system in the context of the PCA, SDGs and Addis Agenda resides within an interconnected global financial system attempting to keep pace with the digital economy, big data and building resilience to new risks (Carney, 2019). This global policy context and broader financial system challenges represent the backdrop for this paper.

The paper examines the possibilities for relating financial systems to sustainability transitions. The sustainability transitions field represents the primary research domain for this paper. It is an interdisciplinary field within the social sciences, studying the process of transforming systems over the long-term due to grand societal challenges and examining the influence and role of different actors within such change processes (Geels, 2004; Smith et al., 2010; Loorbach et al., 2017). Extensive academic research over the last 50 years connects finance and sustainability, with many framings for finance emerging in response, such as climate, green, sustainable and environmental finance. However, research on finance within the sustainability transition field remains nascent (Köhler *et al.*, 2019), which is further constrained by its limited conceptualisation of finance therein.

Given the nascent nature of research on finance in the sustainability transitions field, the paper begins with scoping the literature based on the methodology described in Section 2. The review covers the conceptual framings and research themes relating finance and sustainability transitions, including drawing on insights from research on the financial crisis, sustainability-related financial practices and critical research on these subjects. The scoping results are presented in Section 3. The results of the

scoping lead to the proposition of drawing insights from sustainability transitions research to inform the demands such processes place on the financial system, as described in Section 4. Formulating specific demands made on the financial system contributes towards framing the “problem” to be solved. Section 5 discusses multi-dimensional reflections that may be useful for informing the financial systems response relative to such demands, with concluding remarks offered in Section 6.

2. RESEARCH APPROACH

The paper explores the research question, *what possibilities exist for relating financial systems and sustainability transitions?* The paper applies a scoping approach to respond to this question. The approach is relevant in this instance because scoping reviews are useful for new areas of research, providing insights on the prevailing themes and conceptual development (or lack thereof) (Peterson et al., 2017). The scoping results are then used to develop an entry point for responding to the research question, which contributes towards advancing further conceptual and empirical research between finance and sustainability transitions research.

2.1 Methodology

For this paper, the 12 papers published in the 2013 Special Issue of the Journal of Environmental Innovation and Sustainability Transitions (EIST) are the initial papers reviewed for sustainability transitions. These papers represent the first effort by scholars in the field to engage on finance and the implications of the 2008 financial crisis on sustainability transitions. The supplemental information annexed to this paper describes the contents of these papers further. Further texts on finance related to sustainability transitions were identified through Scopus between 2013 to 2019, based on the co-occurrence of the keywords, “sustainability transitions” and “finance”.

The scoping of finance literature combines key word searches using Scopus for the co-occurrence of finance and sustainability, which yielded over 50,000 results. The key phrases such as “environmental finance”, “sustainable finance” and others reduced the search results 2,787 papers, as illustrated in Table 3.2, and later to 14 papers by searching for the co-occurrence of the phrase “sustainability transitions”. Due to the extensive literature existing on finance and sustainability, papers offering systematic and scoping literature reviews on finance and sustainability were prioritised – some of which were identified applying a snowballing approach.

2.2 Assumptions

The paper adopts the view that sustainability transitions concerns the normative goal of achieving reduced greenhouse gas (GHG) emissions and increased resilience through socially just and inclusive means (Swilling and Anneck, 2006; Silveira, 2015), and the process to achieve such normative goals. This means sustainability transitions address the goals of the Paris Climate Agreement and the SDGs. The dominant approach for framing systems in sustainability transitions research is that transitions refer to changes in the socio-technical system. However, transitions also refer to changes in other systems, being techno-economic, socio-ecological, technological innovation systems, social practices, resilience and human geography (Silveira, 2015). References in this paper to systems change in the context of sustainability transitions applies a broader approach, not only socio-technical systems.

Further, the paper applies the description of the financial system³ as the “central nervous system of the economy” (Crockett, 2011:3). Three interdependent components exist within the financial system, being i) *intermediaries* (public and private banks and insurance companies) directly engaging with households and businesses, ii) *markets* exchanging debt, equity, foreign currencies and commodities such as gold and platinum and iii) *infrastructure* managing the regulation, supervision, legal and administrative systems to support the intermediaries and markets (Crockett, 2011).

Finally, the references in the paper to finance aligns with Perez’s classification of financial capital as the agent for reallocating and redistributing wealth in the form of money or other paper assets, such as banks and other intermediaries (Perez 2002:71).

3. CHALLENGES IN RELATING FINANCE AND SUSTAINABILITY TRANSITIONS

The following sections reviews the finance and sustainability transitions literature illustrating conceptual framings and research themes. It further reviews relevant aspects of financial crisis, practice-based and critical emergent literature.

3.1 Finance literature

3.1.1 Conceptual framing

Finance is a subset of economic studies, which defines the role of finance in the economy as facilitating the exchange and transfer of funds from households with excess funds to those in need of funds

³ A recent paper by Urban et al., 2019 applies the sustainability transitions terminology of ‘socio-technical system’ and framework of the Multi-Level Perspective (MLP) to the reforms in the financial system. For the treatment in this paper, I have chosen not to adopt this definition due to the emergent nature of the research. I therefore apply a more general definition to how the financial system is framed.

(Bagehot, 1936 cited in Spratt, 2009). A key point of this literature is that banks create new money (out of the deposits of savers) through lending, rather than just recycling deposits of savers into loans (Werner, 2014). The orthodox theories study how finance fulfils its role in the economy based on the assumptions that markets are efficient, and investors behave rationally and include the Efficient Market Hypothesis and Capital Asset Pricing Model theories, which assign variables on the basis of financial risks (Spratt, 2009; Sun et al., 2011; Urban et al., 2019).

The research methods used in orthodox finance studies apply algebraic, mathematical and econometric approaches, treating environmental and social factors as externalities (Lagoarde-Segot, 2015; Ansart et al., 2018). The quantitative bias of orthodox finance is incompatible with the qualitative focus on environmental and social goals of sustainability transitions. The incompatibility creates challenges for establishing interdisciplinary linkages. Critical orthodox finance researchers are recognising the incompatibility of orthodox finance approaches to sustainability through new collaborations⁴ that aim to embed sustainability and climate breakdown within orthodox theories.

3.1.2 Research themes

Finance research shapes the understanding of the financial system, influences investors and market behaviour educates future finance and business practitioners and facilitates policymaking (Diaz-Rianey et al., 2016). The research trends in orthodox finance are therefore important to reflect upon. Several systematic reviews of high ranked accounting and finance journals show that finance research focuses mainly on the post-2008 financial crisis covering topics such as asset pricing, bankruptcy, credit issues, governance and risk management (Lagoarde-Segot, 2015; Aspinall et al., 2015; Diaz-Rianey, et al., 2016; Brooks et al., 2018). Despite the climate breakdown being classified as one of the top five global risks facing the economic system (WEF, 2018), finance researchers appear not to be engaging on these issues adequately according to these systematic reviews (Goodall, 2008; Patenaude, 2011; Aspinall et al., 2015; Diaz-Rianey et al., 2016).

While orthodox finance journals may be nascent in addressing finance and sustainability adequately, a Scopus search identifies at least 35,000 papers connecting these terms. Narrowing the search entailed identifying terms associating finance with environmental and social concerns from textbooks on sustainable finance, sustainable banking, social finance and environmental finance (Bouma et al.,

⁴ The Global Research Alliance for Sustainable Finance and Investment will host a pioneering event at its 2nd Annual Conference in Oxford, UK on "Purpose-Driven Finance: The Manual" <https://www.susfinalliance2019.org/copy-of-the-manual-side-event-regis> aimed at updating the existing finance curriculum and launch an introductory finance curriculum.

2001; Labatt & White, 2002; Ramiah and Gregoriou, 2016; Lehner, 2016), which yielded 2,787 papers as illustrated in Table 3.2.

Table 1 – Results of key word searches on finance and environmental and social outcomes

Terms linking finance and sustainability	Scopus results	Publication period	# Co-occurrence of 'Sustainability Transitions'
Social finance	99	1988, 1999, 2008-2019	0
Environmental finance	88	1989 – 2019	1
Responsible investment	800	1991-1994, 1996-2019	3
Socially responsible investment	609	1991-1994, 1996, 1998-2019	2
Sustainable investment	300	1992-1995, 1998-2019	6
Sustainable finance	129	1992, 2004-2019	1
Green finance	80	1997, 2005, 2011-2019	1
Impact finance	18	2000-2019	0
Carbon finance	200	2002 – 2019	0
Climate finance	323	2004 – 2019	0
Impact investing	141	2011 – 2019	0
Total papers	2,787		

Source: Author search via Scopus (the numbers in brackets next to each year refers to the number of papers in that year, if there was a broken period of publications bearing the key word).

By applying sustainability transitions (which is distinct from the broader field of sustainability) as an additional filter, only 14 out of these 2,787 papers show the co-occurrence of the key words 'finance' and 'sustainability transitions'. Google searches to supplement the Scopus results identified a solitary paper in the accounting and finance field, which applies the MLP lens in arguing that niche innovations such as sustainable, climate and green finance potentially destabilise the old regime of finance (Ryszawska, 2016). The low rate of co-occurrence shows that academic associations between the sustainability transitions and finance fields are nascent.

Outside of the Scopus results, the open access Journal of Sustainable Finance and Investment (JSFI) is dedicated to sustainable finance related issues. Between 2011 and 2014 based on a systematic review by De Carvalho Ferreira et al. (2016), the research themes prominent in the JSFI were i) broadening the definition of investors, ii) building the business case for climate change and socially responsible investment, iii) generating impacts through investment decisions, and iv) mechanisms to institutionally embed environmental and social factors over the long term in financial systems. The systematic review identifies research gaps relating to i) lack of research on developing countries' contexts, ii) lack of common terminologies on finance, investment and sustainability, iii) need for engaging in theoretical debates to facilitate financial innovations, iv) engaging deeper on the public sector role in finance and sustainability and v) questioning whether finance and investment tools are suited to the sustainability challenge (De Carvalho Ferreira et al., 2016). The critical emergent approaches are promising, though appear to be developing outside of orthodox finance research.

The wide range of terms represents interpretations of financing aspects of sustainability, be they social, environmental or climate-specific, and emerge from conceptual and empirical approaches that are beyond the scope of this paper to explore. Relating finance to sustainability in this way may have validity in terms of specific aspects of sustainability, e.g. governance, environmental and social approaches. However, the finance literature does not yet appear to be drawing on the insights from sustainability transitions literature, which addresses system-level approaches to sustainability.

3.2 Sustainability transitions literature

3.2.1 Conceptual framing

The sustainability transitions field is a subset of innovation studies, which classifies finance as a resource and function within innovation systems. As a resource, finance is necessary for systems change, along with other resources such as equipment, skills, supportive infrastructures and institutional support (Clayton et al., 1999) and is essential for achieving strategies enabling long-term systems change (Farla et al., 2012). As a function, finance is one of seven functions to be fulfilled in building systems (Hekkert et al., 2007). The Multi-Level Perspective (MLP), a widely-used qualitative heuristic in the field to study socio-technical changes, theorises that transitions occur due to interactions between micro (niche), meso (regime) and macro (landscape) levels of individual agency and based on rules (Silveira, 2015). The MLP adopts the framing of finance as a resource and function from innovation studies by incorporating financiers among the additional social groups that influence technical trajectories and embedding them, at the regime level, in user practices and application domains (markets) (Geels 2002: 1259).

The framing of finance in sustainability transitions within the market domain aligns with the orthodox economic view of finance, which is later reinforced by classifying transition processes as creating market, infrastructure and transformative failures (Weber and Rohracher, 2012). The failures view is a useful entry point in the short term for developing policies for sustainability transitions (Weber and Rohracher, 2012; Foxon, 2015). For example, a failures view facilitates the selection of financial instruments that lowers project risk (Naidoo et al., 2014; Mathews, 2015; Volz, 2015), identifies public and private sources of finance best suited to absorb such project risk (Spratt, 2015; Mazzucato and Semieneuk, 2018), and considers market and finance instruments as climate policy tools (Gevorkyan et al., 2016). Justifying policy actions over the long term, however, requires moving beyond the failures view (Weber and Rohracher, 2012; Foxon, 2015). The failures view limits the role of policy to

fixing market failures, rather the promoting the transformative role policy can play in creating new economic pathways (Mazzucato, 2014).

3.2.2 Research themes

The 2013 Special Issue of the Journal Environmental Innovation and Societal Transitions (the Special Issue) titled “Economic-financial crisis and sustainability transitions” published the initial papers discussing finance within the newly founded sustainability transitions field (see Supplemental Information). Five themes associating finance and sustainability transitions are interpreted from reviewing these papers. These themes are i) the recurrence of financial crises which are endemic to system dynamics (Perez, 2013; Geels, 2013; Swilling, 2013; van der Ploeg and Withagen, 2013); ii) divided opinions on the dominance of a green growth narrative (Antal & Van den Bergh 2013, Loorbach and Huffenreuter, 2013, Vergragt, 2013, Witt, 2013, Geels, 2013, Swilling, 2013); iii) the inevitability of poor policymaking due to societal concerns not reflected in orthodox approaches (Foxon, 2013b; Perez, 2013; O’Riordan, 2013; Swilling, 2013; Geels, 2013); iv) structural compatibility of the financial system with sustainability transitions (Perez 2013; Foxon, 2013b; Antal van den Bergh, 2013; Swilling, 2013 and O’Riordan, 2013); and v) policy competition between financial crisis and sustainability challenges (Geels, 2013; Antal & Van den Bergh 2013, Loorbach and Huffenreuter, 2013, Vergragt, 2013, Witt, 2013, Swilling, 2013, O’Riordan, 2013; Perez, 2013).

Subsequent research between 2013 and 2019 identifies eight papers with the co-occurrence of the words “sustainability transitions” and “finance”. The research themes evident in these papers are i) applying the MLP to understand the financial reforms in the retail banking sector of the UK (Seyfang and Gilbert-Esquires, 2018), the emerging storyline of green finance as niche innovation in Italy (Falcone et al., 2018) and the contribution of development banks to the energy transition in the UK, Australia and Germany (Geddes et al., 2018); ii) demonstrating the financial policy challenges that the ecological crisis present for sustainability transitions and the energy sector (Röpke, 2017; Safarzyńska et al., 2017); iii) illustrating the structural challenges and financial innovations for achieving a just transition in South Africa (Mohamed, 2019; Naidoo, 2019); and iv) categorising the financial system as a socio-technical system and adoption of sustainable finance as a business opportunity (Urban et al., 2019).

The 2013 Special Issue mainly highlights the narrative of green growth as a response to the post-2008 financial crisis and the critique that such framing masks the underlying systemic problems of unsustainable production and consumption patterns. The concerns raised by authors in the 2013 Special Issue centre around how green growth narratives affect policymaking and finance innovations.

Concerns raised are whether the financial system is fit for the purpose of supporting sustainability transition processes. Subsequent research between 2013 and 2019 explicitly applying sustainability transitions concepts to finance at a systems level relates mainly to the use of MLP in different geographies (predominantly Global North countries) and at the level of private, state owned and retail banks, with no apparent cross-referencing to the arguments put forward in the 2013 Special Issue.

The section shows that research on finance within the sustainability transitions field is embryonic, though researchers generally agree that further conceptual and empirical research is needed to understand the role of finance at a systems-level.

3.3 Financial crisis research

Research on financial crises show the effects of boom and bust investment cycles ranging from the Dutch tulip investment hype around the 1600s to the sub-prime loan hype in 2008 (Roubini & Mihm, 2010; Perez, 2016).

Transition scholars writing about the 2008 economic-financial crisis in the 2013 Special Issue of EIST describe finance as being ill-disciplined, speculative and blocking the global transition (Antal & van den Bergh, 2013; Perez, 2013; Swilling, 2013), which are valid concerns that may lead to slowing down sustainability transitions processes (Geels, 2013). The remedies to avert future financial crises over time are familiar, suggesting more regulation, separation of investment and deposit-taking functions and calls for global action led mainly by the G20 and other multilateral processes (Griffith-Jones et al., 2010). Critics argue that multilateral processes are relatively weak in enforcing fundamental changes in the financial system (Griffith-Jones et al., 2010). For example, proposals for fundamental shifts in the banking sector that are initially broad and far-reaching immediately after the financial crises are generally set aside once the financial system stabilises (Griffith-Jones et al., 2010; Turner, 2016). The behaviour of financial institutions leading up to the financial crises and subsequently shows that regulation has limited effects on curbing unhelpful and embedded investment behaviours of bankers and other actors in the financial system (Spratt, 2009; Griffith-Jones et al., 2010).

The 2008 financial crisis generated alternative framings of the financial system, which acknowledge the systemic risks to the economy posed by interdependent behaviours of financial intermediaries such as banks. For example, Farmer et al. (2012) and Battiston et al., (2016) categorise the financial system as complex interconnected multi-layered networks rather than single networked systems, recognising the complexities of modern, integrated payment systems within and across global capital markets. While interconnectedness increases competition and improves the way in which resources

are allocated by financial intermediaries (Farmer et al., 2012), the interconnectedness also means that instability in one market reverberates in the markets to which it is connected (Aziakpono, 2006). The interconnectedness of the global financial system represents the incumbent context for directing finance to support sustainability transition processes, which means having to develop conceptual entry points and potentially propose alternatives on this basis.

The propensity for the behaviours of financial intermediaries to contribute to financial crises is important for understanding the demands being placed on the financial system for three academic reasons. Firstly, for critically evaluating the assumptions underpinning the sustainability-related financial practices and innovations as they may inadvertently contribute towards a future sustainability-related financial crisis and amplify the risk of misdirected and failed transition processes. Secondly, for understanding the influence that finance wields over economic activity, which implies reframing the implicit role of finance (currently, as resource and function) in sustainability transitions research. Thirdly, for evaluating the impact of the financial system's response to sustainability transitions, which requires studying causal linkages between response and impact.

3.4 Practice-based research on finance and sustainability

Global initiatives calling the financial system to act on the sustainability and climate breakdown include a diverse range of convened and lobbying processes⁵. Convened processes, to name a few, include the Climate Action in Financial Institutions, Central Banks and Supervisors Network for Greening the Financial System, United Nations Environment Finance Initiative, Task Force on Climate-Related Financial Disclosures (TCFD), the International Network of Financial Centres for Sustainability (FC4S) and the G20 Sustainable Finance Study Group. Examples of lobbying processes include the Climate Action+, Global Investor Coalition on Climate Change (CIC) and The Portfolio Decarbonisation Coalition (PDC).

The ever-widening range of global initiatives contribute to mainstreaming the sustainability and climate breakdown within the financial system. An important example is the Governor of the Bank of England recognising that the climate breakdown influences the stability of the financial system, through engaging with transitions-related⁶ risks (Carney, 2018) and designing climate stress tests for the UK financial system (Carney, 2019). The effects of anti-fossil fuel campaigns targeting investors

⁵ During the 2015 Paris Agreement negotiations, 20 institutions launched the Climate Action in Financial Institutions for mainstreaming climate change into their operations. <https://www.mainstreamingclimate.org/connecting-the-dots/>.

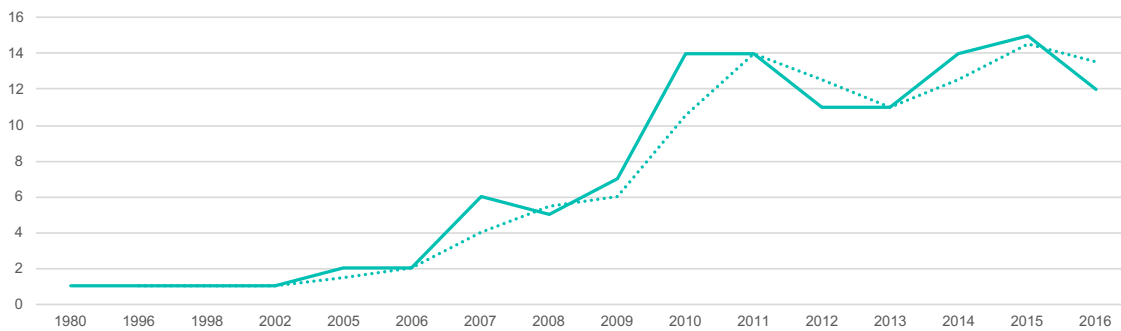
⁶ The Bank of England classifies climate-related risks as physical (in terms of volatile and unpredicted climate-related events), liability (loss and damage claims among affected parties) and transition (sudden and disorderly adjustment towards low carbon economy).

shows trillion-dollar divestment by investors in fossil-fuel companies (Bergman, 2018), which is starting to devalue the investment ratings of the coal-sector (McKibben, 2018). Investment flows reflect support for new industries emerging from sustainability challenges, for example, with renewable energy investment in 2017 reaching U\$333.5 billion (Louw, 2018) and new asset classes termed 'green bonds' reaching U\$162.1bn (CBI, 2018). To appreciate the contribution of these initiatives and investments to promoting sustainability transitions, contextual factors relative to the amount of overall funds invested would be needed. For example, though multilateral development banks are supporting renewable energy, their investment portfolios do not fully reflect a transformational agenda aligned to the climate breakdown (Wright et al., 2018).

A scoping paper by Hafner et al. (2019) shows that finance initiatives on environment and climate breakdown are rapidly expanding and identifies at least 31 initiatives including the United Nations Inquiry into the Design of a Sustainable Financial System (UNE Inquiry) and the European Commission's High-Level Expert Group (ECHLEG) on Sustainable Finance. The UNE Inquiry claims a revolution towards a sustainable financial system is underway (UN, 2018). The ECHLEG says a complete transformation of the "entire financial system, its culture and incentives" is needed (EUC2018:2). Both initiatives, separately, propose a sustainable finance roadmap for policymakers to consider. Such practice-based research is useful in contributing towards finance-related sustainability policies and is gaining strategic importance among policymakers, for example, the UK and German governments' Green Finance strategies.

At the same time, the rapid emergence of practice-based research highlights the need for independent validation of the claims and proposals (Hafner et al., 2019). Academic researchers are failing to engage adequately with such practice-based policy research Hafner et al. (2019). This means that the context, assumptions, impact and generalisability of such research is not being examined or challenged. On contextual factors, for example, Falcone et al. (2018) argues out that the UNE Inquiry recommendations primarily focus on financial systems in the Global North. While Ahlström (2019) argues that the European Commission's response to the ECHLEG is path dependent following the limitations of existing laws and regulations, which may undermine achieving a fully sustainable European financial system.

Graph 1 - Sustainability-Related Finance Practices in Middle Income Countries 1980 to 2015



Source: Adapted by author based on an extract of UNE Inquiry into the Design of a Sustainable Finance System data base as at June 2015.

On impact factors, for example, the UNE Inquiry traced over 200 sustainable finance practices between 1980 to 2015, as illustrated in Graph 1. The graph shows a rising trend in practices, however, studying the impact of practices was outside the scope of the UNE Inquiry. On generalisability of recommendations, for example, the UNE Inquiry offers policymakers a useful financing roadmap towards achieving a sustainability-focused financial system (UN, 2017). However, independently engaging on the roadmap's underlying assumptions would strengthen its usefulness.

The speed at which new sustainability-related financial initiatives are proliferating without critical evaluation can lead to misdirected or failed transitions. For example, on what assumptions are the financial initiatives based? Is there a common understanding of the problems to be solved? Who is defining the problems? Who is proposing the solution? Is policy guidance relevant for the context? Are practices creating specialist financing areas or enabling wider systems-level reforms?

3.5 Critical emergent research

As the sustainability transitions field matures, criticisms are inevitable, two of which are noteworthy for this paper. Firstly, Sorrell (2018) and Svensson and Nikoleris (2018) call for greater reflection on the implicit assumptions of the MLP, highlighting its limitations in establishing the causal linkages of transitions. Secondly, Feola (2019) draws attention to the tacit acceptance of capitalism within the sustainability transitions field, which may restrict forward looking research and application for research in the Global South. The criticisms are relevant because, although research on finance remains nascent in this field, implicitly assuming that finance performs a market role (as a resource and function) in the context of a failures framework is restrictive for facilitating empirical research on a more explicit role for finance at a systems-level over the long term. For example, addressing questions such as: how will new financial practices contribute to long term systems change? On what and whose assumptions of sustainability transitions are the financial practices based? Will new finance

practices create niche areas of finance or create an integrated financial system that is fit for purpose? Who directs and who follows the sustainability-related reforms of financial system? Such questions are presently challenging to respond to if finance is framed only as a resource and function in the sustainability transitions field, which invites more reflexivity on how to theorise finance for enabling transformative systems-level changes.

The sustainability and climate breakdown contribute to the growing movement of rethinking the validity and relevance of orthodox economics, which became heightened by the 2007/8 global financial crisis. Orthodox economic theories fail to account for sustainability and climate breakdown, as they were relevant for the time, place and circumstances that the world found itself in when these ideas originated (Orléan, 2014; Raworth, 2016). Raworth (2016) states that orthodox economic theories that position environmental and social concerns as externalities dominate the policy and educational landscape, which is an inappropriate policy basis for responding to 21st-century sustainability concerns. Similar research draws attention to the need for capital to have a public purpose (Jacobs & Mazzucato, 2016), developing economic alternatives such as green industrial strategies (Mathews, 2015) and promoting circular economies to reduce materials waste, create employment (Perez, 2016). Although the emergent conceptual debates and concepts are critical, they are still fragmented and not yet framed coherently as an alternative to orthodox economics (Foxon, 2018).

Within orthodox finance, rethinking movements are growing too, as scholars question the epistemological assumptions of finance theory and its compatibility with the demands for sustainability (Gray, 2010; Lagoarde-Segot, 2018), raise the need for social rather than economic purpose for finance (Lagoarde-Segot & Paranque, 2017) and reflect on the inadequacy of finance theory to account for climate and social risks (Aspinal et al., 2015; Fullwiller, 2016). New social forms of finance are emerging such as crowdfunding as an alternative to relying upon the formal financial system to promote sustainability objectives (Ansart & Monvoisin, 2017). New approaches are emerging outside of orthodox economics in response, for example, developing climate stress-tests of the financial system (Battiston et al., 2017) and considering the impact of climate change on financial stability (Campiglio et al., 2018). Further, research is emerging that highlights the risks that climate breakdown poses to investors and policy makers, especially since economic models inadequately account for such risks (Monasterolo et al., 2019). Additional examples include the critical work on stranded assets which draws attention to the limited timespan of fossil fuel assets (Caldecott, 2017). In addition, informal networks such as the Sustainable Finance Lab are bridging theory and practice to

study how the financial system can contribute towards averting the sustainability and climate breakdown.

Although coherent theoretical alternatives remain underdeveloped and contested, critical emergent research shows that the sustainability and climate breakdown is agitating the assumptions of orthodox economic and finance theory. The sustainability transitions field is not immune to the agitation. Even though a relatively new field, the critical reflections on the implicit assumptions is essential for further conceptual and empirical development.

3.6 What do the scoping results imply for relating financial systems and sustainability transitions?

Section 3 reveals several challenges. Firstly, extensive research on finance and sustainability exists covering a wide range of terminologies and specific dimensions of sustainability not yet organised under a common approach or mainstreamed within economics and finance. Deciding which sustainability-related finance framing to follow becomes complex. For example, justifying the choices for prioritising green, climate or social finance requires interrogating the conceptual roots, yet each framing may have useful contributions and specific limitations that influence their applicability for sustainability transition processes. Secondly, the sustainability transition field is maturing with finance-related research at systems-level underexplored. Moreover, sustainability-related finance research appears to be evolving in a way that is not yet incorporating the system-level insights from STR. Thirdly, critical engagement with practice-based research on policy alternatives that claim alignment with the Paris Climate Agreement and SDG is lacking among academic researchers.

The scoping results in Section 3 further shows that old theories are being challenged, however new theories are not yet fully developed into coherent alternatives. The research context is challenging for relating the conceptual and empirical research on finance within the sustainability transitions field. This paper, therefore, proposes to invert the research perspective and consider what insights from sustainability transitions research may be useful for relating financial systems to transition processes. Section 4 develops this proposition further.

4. DEMANDS OF SUSTAINABILITY TRANSITIONS ON FINANCIAL SYSTEMS

Sustainability transitions research offers insights for relating financial systems to transition processes, as interpreted in the sections that follow.

4.1 Starting point

A review of finance and innovation research by O'Sullivan (2005) shows that limited research existed inter-relating these subjects, except for the seminal work by Perez (2002) on technological revolutions and financial capital. Perez (2002), like Schumpeter (1942), positions the financial system at the centre of driving fundamental economic change through technology, in the context of technological revolutions or techno-economic paradigms⁷ (Dosi, 1982). Perez, however, places greater emphasis on the resulting changes in the "*institutions of governance, of society, and even of ideologies and culture*" (Perez 2002: 24-5), implying radical changes to the systems that support the technological revolutions. Perez makes an elemental point that the characteristics of a specific technological revolution determines the nature of problems to be solved and the method of solving them. O'Sullivan (2005) reaches a similar conclusion that advancing further conceptual and empirical research on finance and innovation begins with first understanding the characteristics of the innovation process, which in turn informs the resource (finance) allocation. Practice-based policy research by Köhn (2012) follows a comparable argument that the characteristics of the environmental finance market represents the demands (need) for financial markets.

The arguments of Perez (2002), O'Sullivan (2005) and Köhn (2012) are relevant for this paper because STR and finance research is at a similar juncture of beginning to advance research on finance. This paper, therefore, proposes that the characteristics of sustainability transitions represent an essential starting point to understand the demands that transition processes place on the financial system.

4.2 Characteristics of sustainability transition processes

Transition scholars acknowledge that sustainability transitions are complex processes displaying differentiated characteristics across transitions contexts (Berkhout et al., 2004), transition typologies (Geels and Schot, 2007) and transition pathways (Foxon, 2013a). The heterogeneity of transition processes notwithstanding, certain core characteristics of transition processes are evident. Specifically, transition processes are non-linear and disruptive, targeting the goal of achieving a new sustainable economic state (Loorbach et al., 2017). Further, multi-level and contested interactions

⁷ Perez (2002:8) defines a technological revolution as a "powerful and highly visible cluster of new and dynamic technologies, products and industries, capable of bringing about an upheaval in the whole fabric of the economy and of propelling a long-term upsurge of development".

are typical in transition processes, which result in the co-evolution and emergence of new systems; such systems display variation and selection in achieving the new sustainable state (Loorbach et al., 2017).

The paper interprets the classification of the characteristics of sustainability transition processes as illustrated in Table 3, informed by Loorbach et al. (2017) and the practical implications of the Paris Climate Agreement and SDGs. The interpretation represents an initial proposition, to be further developed as conceptual and empirical insights from sustainability transitions research emerge.

Table 3 – Characteristics for informing the demand on the financial system

Characteristics	Indicative demands placed on the financial system
Directional changes	The intermediaries, markets and infrastructure of the financial system consistently directs itself toward achieving a new sustainable economic system.
Temporal dynamics	The financial system responds across short, medium and longer-term timeframes to address the systemic needs of transition processes.
Co-existent system impact	The financial system generates environmental and social system-level impacts, by creating new socially inclusive, environmentally sustainable economic systems <i>and simultaneously</i> destabilising old environmentally unsustainable, socially unequal economic systems.
Contested social context	The financial system engages with a broad base of stakeholders in developing its response to support the transition process.
Contextual experimentation	The financial system experiments and applies adaptive approaches to address the contextual needs of sustainability transition processes.

Source: Author interpretation.

The paper distinguishes between the characteristics of sustainability transitions and innovation processes. Perez describes the process of diffusing technological revolutions as a period of profound change that leads to modernising and rejuvenating the economic system, and whose influence stretches beyond the new industries or technologies created (Freeman and Perez, 1988; Perez, 2002). In this way, technological revolutions are a form of transition; however, at least five characteristic-related differences exist. Firstly, sustainability transitions process direct change towards achieving new economic, environmental and societal goals and are connected to existential threats; whereas, technological revolutions appear agnostic on these issues. Secondly, sustainability transitions are inherently time-bound processes requiring acceleration to manifest transformative environmental, societal and economic impacts by 2030 beyond fossil-fuels (IPCC, 2018); whereas, technological revolutions have no specific time constraints. Thirdly, achieving just and equitable sustainability

transitions is critical; whereas, technological revolutions are silent on the social quality of new innovations. Fourthly, sustainability transitions processes directly target rejuvenating the entire economic system as the primary goal, placing greater emphasis on the system-level influences that can be achieved through different types of innovations; whereas, technological revolutions focus on innovation, with system-level influences positioned as an indirect consequence of diffusion. Finally, the Paris Climate Agreement and the SDGs underpin the financial focus of sustainability transitions, which both require the integration and consistency of finance flows; whereas, financing technological revolutions does not prescribe such preconditions. For the reasons stated here, the sections that follow focus primarily on relating the characteristics of sustainability transitions processes to the demands on the financial system.

4.2.1 Directional changes

Transitions can emerge through evolutionary changes within an economy (Smith and Grin, 2010; Silveira, 2015). However, sustainability transitions are different in that they represent a normative goal with a predetermined outcome, being low emission, climate resilient development that is socially just and inclusive (Swilling and Annecke, 2006). Setting new directions and goals for development are political and contested processes. At a multilateral level, the Paris Climate Agreement and SDGs signal these directional changes, although countries will apply varied ambitions in achieving such goals in the midst of competing and contested national processes (Spratt, 2015).

Loorbach et al. (2017) describes sustainability transitions processes as targeting a new sustainable state, which implies two directional shifts - directing *and* redirecting economic systems towards responding to the sustainability and climate breakdown. Firstly, directing transition processes means such processes are purposive and objective-oriented with some ability to be controlled or directed (Smith et al., 2010, Raven and Verbong, 2009, Geels, 2011; Kemp and van Lente, 2011). Secondly, redirecting means shifting from unsustainable to sustainable practices in production and consumption patterns, structures, sub-systems, cultures and behaviours (Mersmann et al., 2014; Köhler et al., 2018), to meet societal needs in fundamentally different ways (Rotmans et al., 2001).

The demands on the financial system relate to deploying large amounts of resources towards investment that address the sustainability and climate breakdown (Geels, 2013). The nature of this demand is not unusual, in that large amounts of finance inevitably flow towards new investment opportunities arising during periods of rapid change (Perez, 2002). However, the directional shifts for sustainability transitions also imply ensuring finance flows are consistent and integrated (UN, 2015a,

b, c). This implies a qualitative aspect to the role of the financial system. Maintaining a consistent investment direction implies, for example, divesting from existing investments in unsustainable industries (such as fossil-fuel investments) and terminating any new investment in unsustainable industries. New approaches to project development and investment appraisal criteria that prioritises environmental and social outcomes may be needed (Spratt, 2009). For the infrastructure of the financial system, consistent and integrated finance flows may mean reflecting on the fundamental changes needed within the financial system that address incentives and behaviours. For example, misdirected intermediaries, ill-disciplined markets and poor infrastructure within the financial systems poses a risk to transition processes. The risk of misdirection and short-term profit seeking is reflected by the recurrence of financial crises (Perez, 2013; Geels, 2013; Swilling, 2013). The directional changes implied by sustainability transitions requires assessing whether the financial system is fit for the purpose of directing *and* sustaining such processes.

Antal and Van den Bergh (2013) point out that financial-economic relationships are biased towards debt, financial returns and resource exploitation (Antal van den Bergh, 2013; Geels, 2013) and the short termism of markets (Swilling, 2013; O’Riordan, 2013). Directing the financial system towards sustainability transitions can only occur by dislodging the power of finance (Perez 2013; Foxon, 2013b; Antal van den Bergh, 2013; Swilling, 2013 and O’Riordan, 2013). This means addressing investment behaviour and incentives, disciplining finance to act in line with societal and environmental interest and repurposing finance away from its dominant focus on financial gain (Swilling, 2013).

4.2.2 Temporal dynamics

The IPCC Special Report shows that there is a narrow response window for implementing targeted interventions by 2030 (IPCC, 2018), which means the context for sustainability transitions is inherently urgent (Schmitz, 2015). Stern (2018) argues that intertemporal⁸ values and issues should be at the core of policy responses to the climate breakdown and outlines mounting societal challenges and the doubling of infrastructure demands over the next 20 years (Bhattacharya et al., 2016). Transition processes generally unfold over long periods of time (Geels, 2011; Alkemade et al., 2011) and in a non-linear manner (Loorbach et al., 2017) as do technological revolutions (Perez, 2002). The longer durations associated with transition processes is problematic for the sustainability and climate breakdown because of the temporal dynamics underpinning the Paris Climate Agreement and SDGs.

⁸ The term “inter-temporal” relates to past, present and future events and conditions. In this paper, it refers to the time-sensitive nature of climate breakdown and how, for example, choices are made between current and future benefits.

However, transitions-related empirical research shows that accelerating transition processes is possible (Sovacool & Geels, 2016; Sovacool, 2016).

The temporal dynamics causes tensions where the sustainability and climate breakdown compete for policy and political attention with the risk of a re-emergent financial-economic crisis, as each emerge over different timeframes with specific causes and solutions (Geels, 2013; Antal & Van den Bergh 2013, Loorbach and Huffenreuter, 2013, Vergragt, 2013, Witt, 2013, Swilling, 2013, O’Riordan, 2013; Perez, 2013). For example, the policy concerns over the course of a transition process differs, with immediate challenges including how to mobilise large sums of money, initiate policy and institutional changes and for governments to gain public support and legitimacy during such time (Geels, 2013). Accelerated transition processes, while a necessity, also competes with having to regulate the speed of the transition to maintain financial stability (Campiglio et al., 2018; Carney, 2019). Greater support for accelerated action may emerge from initiatives such as the Bank of England’s stress-testing of the climate risk of its financial system (Carney, 2019).

The demands on the financial system imply understanding the temporal needs of transition processes within the narrow window identified in the IPCC Special Report and the longer-term impacts of such processes. The needs primarily focus on instilling a sense of urgency among intermediaries, markets and infrastructure to orient resources towards financing interventions that lower emissions and build resilience to the escalating effects of the sustainability and climate breakdown. For intermediaries and markets, the temporal needs may mean programming investment priorities across different time scales and ensuring access to resources when needed. For example, in the short term investing in re-building and repurposing critical infrastructure due to climate events⁹ without locking in high carbon options and facilitating access to emergency reconstruction efforts. Over the medium term, allocating resources towards sustainable production, consumption and other system-level changes. Over the longer term, maintaining the new sustainable economic state through the quantity and quality of investment. For infrastructure, the temporal context means ensuring that the legal and administrative processes and funding partnerships exist so that resources are matched with the temporal needs. This may include having to understand the capabilities and limitations of the national finance system and its interdependence with the global financial system. These factors are relevant especially for the Global South, where access to international development support may be necessary. To facilitate the

⁹ Cyclone Idai for example resulted in Mozambique having to take out a \$118.2 million emergency loan from the International Monetary Fund for Mozambique because external funding was lacking to invest in the reconstruction efforts. The loan was heavily criticised by civil society and climate activists <https://jubileedebt.org.uk/press-release/imf-loan-to-mozambique-following-cyclone-idai-shocking-indictment-of-international-community>

temporal dynamics, institutional innovations may be necessary to the fast track implementation and deployment of resources, for example, accelerated lending practices, special purpose vehicles for project implementation and alternate funding platforms to ensure access to resources.

4.2.3 *Co-existent system impact*

Loorbach et al. (2017) describes sustainability transitions as processes that allow the co-evolution and emergence of new economic systems, addressing unsustainable practices in economic systems which incremental solutions cannot shift and imply transformational systems-level impacts (Raven and Verbong, 2009, Geels, 2011; Kemp and van Lente, 2011; Mersmann et al., 2014). Unsustainable practices, in this context, refers to the expanding global influence of economic systems which is destructive to the social, biological and geological processes of the earth (Mathews, 2015). Industrial development, in particular, is resource intensive and directly linked to high carbon emissions and requires far-reaching system transitions (IPCC, 2018). Spratt (2015) argues that transition processes focused on technology-focused fixes such as carbon emissions trading may implicitly assume that once the environmental impacts are achieved, the underlying systems may continue as before (Spratt, 2015).

Sustainability transitions therefore imply broader impacts in the economic system, which go beyond technology directed solutions (Perez, 2002; Swilling and Anneck, 2006; Gower et al., 2012; Mathews, 2015; Spratt, 2015). This means the systems-impact should address environmental *and* social dimensions. Swilling and Anneck (2006) highlight the social systems-impact, identifying the risk that the sustainability transitions can exacerbate existing and unsustainable social inequalities by favouring those with access to resources. The environmental systems-level impact requires shifting the incumbent economic system away from its lock-in of high emission infrastructure (Unruh, 2002; Foxon, 2011) and resource-intensive production and consumption processes (Antal & Van den Bergh 2013).

Addressing the dual environment and social dimensions of system-level impacts requires effort in two ways. Firstly, policies that cause the new system to emerge and secondly, policies that destabilises the old system until it eventually fades over time (Kivimaa & Kern, 2016), occurring simultaneously to ensure the transition is realised. The simultaneous creation-destruction process is difficult to achieve in practice due to the lock-in and inertia of incumbent economic, social and political systems and vested interests (Unruh, 2002; Stirling, 2006; Voß et al., 2009; Newell, 2014), which means that progress towards sustainable pathways will struggle to emerge voluntarily. As the 'old and new'

development pathways co-exist, tensions between the two may lead to what Gramsci (1971) called 'morbid symptoms' such as inertia and an inability to act, actions that are too late to achieve any benefit to those affected, struggle for survival by incumbent institutions and practices, risk of further social inequality and fear of job losses.

A potential morbid symptom is the dominance of green growth imperatives inherent in creating the new economic system, which reflects the high growth expectations of governments, business and citizens and influences the emergence of financial crises (Antal & Van den Bergh 2013, Loorbach and Huffenreuter, 2013, Vergragt, 2013, Witt, 2013, Geels, 2013, Swilling, 2013). The new sustainable economic path is framed as green growth (Jacobs, 2012) and the new industries that emerge represent opportunities for entrepreneurs and venture capitalists (Perez, 2013; van der Ploeg and Withagen, 2013; Swilling, 2013). Such framing potentially masks the deep systemic and cultural problems of unsustainable production and consumption and of social inequalities that need addressing (Antal & Van den Bergh 2013, Loorbach and Huffenreuter, 2013, Vergragt, 2013, Witt, 2013, Geels, 2013), which requires, in turn, social activism and engagement (Witt, 2013; Vergragt, 2013; O'Riordan, 2013) and the willingness to experiment (O'Riordan, 2013) to bring a new economic system to the fore. Navigating these tensions requires political efforts to destabilise old systems towards the point of crisis and nurturing the new economic system to become dominant (Voß et al., 2009; Mathews, 2015; Kivimaa & Kern, 2016).

The demands placed on the financial system to deliver systems-level impact relate to accepting the inherent duality of the co-existence of old and new economic systems. Firstly, the financial system needs to evaluate its rationale for supporting sustainability transitions, potentially shifting the dominant investment framing of *opportunity* (which incentivises the pursuit of high growth and implies an option exists whether or not to support sustainability transitions) towards environmental and social imperative of *necessity*, which conveys the existential imperative of creating a new economic system. The opportunity rationale for transitions contributes to mobilising resources in the short term, which though useful fails to address the inappropriate behaviours and incentives among financial intermediaries and markets. The necessity rationale requires financial systems to identify and address upfront the unsustainable practices within the intermediaries, markets and infrastructure to mitigate against them resurfacing in the new economic system, and potentially creating a green finance or transitions-related financial crisis.

Meeting the social demand requires, for example, ensuring resources are made available to vulnerable and marginalised groups, such as rural communities, indigenous people, women and youth, which implies reflecting on investment appraisal and lending practices. Meeting the environmental demand means prioritising and incentivising finance to establish a dominant new economic system (Geels, 2013), by investing in environmental-focused innovations that reduce harmful emissions such as renewable energy and alternative transport systems, and build resilience to climate breakdown, such as improving port infrastructure for rising sea levels. The financial system also needs to actively promote practices and policies that destabilise the old economic system through disincentives for investing and maintaining harmful, high carbon emitting industries and offer financial innovations¹⁰ to assist such industries in transitioning. Since the speed of the transition process impacts the stability of the financial system, as recognised by the Bank of England, stress-testing and disclosure of climate related risks is useful in managing its pace and scale (Carney, 2019).

4.2.4 Contested social context

Sustainability transition processes result in multi-level and contested interactions among new social drivers of sustainability transitions (Loorbach et al. 2017). The social context of transition processes contributes towards different long-term visions of the new sustainable pathway emerging typified by iterative and non-linear policy-making (Loorbach et al., 2017).

Transition processes bring forth new pioneers of change such as communities, youth and civil society who are promoting visions of the new sustainable economic pathway and demonstrating desirability, legitimacy and feasibility (Stirling, 2006; Scoones et al., 2015). The new pioneers show that governments are not the sole architects of sustainability transition processes. Networks form among these pioneer's form networks combining actors that have not worked together before with the collective potential to challenge the status quo of development (Stirling, 2006). Broad coalitions emerge from among the networks of different social actors that build support and maintain public pressure until the new economic pathways emerge over time (Stirling, 2006; Foxon, 2013a; Scoones et al., 2015). For example, the School Strike for Climate and the Extinction Rebellion activists draw attention to the immediacy of the sustainability and climate breakdown and the need for accelerated responses by government and business. While social movements such as 350.org draws attention divestment from fossil fuels and maintains pressure on the financial system to prioritise the directional changes.

¹⁰ A practice-related example is the transition bonds recently proposed by AXA Investment Managers to support carbon intensive companies finance the transition away from reliance on fossil-fuels https://www.axa-im.com/content/-/asset_publisher/alpeXKk1gk2N/content/axa-investment-managers-calls-for-new-transition-bonds-to-help-companies-go-green/23818

The social dynamics of sustainability transitions means that policy-making is challenging. Framing the long-term vision for the new sustainable economy requires transparent and clear goals. Such goals should reflect behavioural and institutional shifts, the uncertainties of different pathways, social and other costs and the barriers and opportunities for implementation (Stirling, 2006; Scoones et al., 2015). The escalating levels of deprivation, degradation and inequality relating to the sustainability and climate breakdown means framing such long-term vision becomes even more complicated (Gower et al., 2012). The policy-making process is, therefore, marked by competing and uncertain policy options and demands (Loorbach et al., 2017).

Bridging the social and policy context of sustainability transitions requires inclusive, participatory policy processes that draw together the broad coalitions and includes flexible feedback loops that allow for learning through failures and successes (Stirling, 2006; Smith and Stirling, 2007). All of which are difficult to navigate in practice. Open, dynamic and reflexive policy options, therefore, become necessary (Foxon, 2013b). More precisely, policies that challenge the roles of government acknowledge the bias of human actions recognise the institutional complexities of banks and financial regulation and acknowledge the dynamic processes shaping technological and institutional changes (Foxon, 2013b; Perez, 2013; O’Riordan, 2013; Swilling, 2013; Geels, 2013). Different policy mixes are therefore necessary, which allow for studying the feedback effects of transition processes (Edmondson et al., 2018).

The financial system resides within a contested social and policy context, where it may itself be subject to questions about the legitimacy of its response to the sustainability and climate breakdown. The Paris Climate Agreement and the SDGs require that finance flows be consistent and integrated towards achieving the new sustainable economy. The demands on the financial system, in this context, relates to the willingness to transparently engage in inclusive and participatory processes that collectively frame a shared vision for a new sustainable economy. It also means that the financial system opens itself to insights from broad coalitions on the contribution of the financial system to transition processes and how to operationalise the goals of consistent and integrated finance flows contained in the Paris Climate Agreement and SDGs. Further, the financial system may need to develop inclusive approaches for designing new projects to support the transition process to prioritise environmental and social outcomes. Non-traditional business models and new financing arrangements that accommodate different social partners’ project development and implementation needs may be useful (Brown, 2018; Bidmon & Knab, 2018).

The policy mixes supporting the new sustainable economy may be costly to implement in the short term due to low tax bases, immature technologies, insufficient technical capacities or other barriers (Granoff et al., 2016). Policy objectives in the short term, therefore, may take priority over those policies focused on longer-term structural shifts. The policy context of transition processes contrasts starkly against the financial system's preference for clear policy signals before engaging in new and untested economic initiatives. Since policy uncertainty is inevitable in transition processes (Loorbach et al., 2017), the financial system may need to focus attention on contributing to sustainability transitions within the prevailing policy context.

4.2.5 Contextual experimentation

The IPCC Special Report shows the contextual reality of the sustainability and climate breakdown, with a higher incidence of droughts, famine and wildfires, species and biodiversity loss, increased risks of disease, job losses, food and water shortages and social conflicts (IPCC, 2018). Designing the range of new sustainable economic possibilities varies with the scientific evidence and requires iterative, non-linear, learn-by-doing and innovative processes (Rip, 2006), which implies experimentation and testing of different approaches in different contexts. Such approaches could relate to new technology shifts, new concepts of welfare, new social innovations and alternate forms of international and national cooperation (Mersmann et al., 2016). The Paris Climate Agreement recognises the need for experimentation in that countries are required to generate increasingly ambitious climate actions over time (UN, 2015).

Experimentation is, therefore, an inherent characteristic in the variation of contextual setting and selection of potential responses, as described by Loorbach et al. (2017), which implies experimenting with implementation approaches. Given that a range of outcomes may be possible, experimentation also implies adaptive approaches that incorporate different stakeholder views throughout the transition process to promote iterative learning (Foxon et al., 2008). Experimental approaches also require policy interventions to guide and induce innovations, replacing previous and shaping future economic states (Voß et al., 2009). Therefore, innovations need to be transformative and designed to trigger deep levels of systems change (Schot & Steinmueller, 2018).

The demands on the financial system in terms of contextual issues depends on the intensity of the system-level shifts. Spratt (2015) argues that less intense and localised ambitions for addressing the environmental and social ambitions of the sustainability and climate breakdown may, depending on

the context, be supported by the financial system. However, more ambitious environmental and social goals for the transition process may be more demanding on the financial system (Spratt, 2015). The contextual issues suggest the need for experimental and adaptive approaches to be applied across the financial system. Experimentation requires lengthy gestation periods to allow for transition processes to unfold to facilitate an ongoing process of learning by doing (Avelino, 2009; Voß et al., 2009), which is incompatible with the financial imperative to demonstrate immediate and precise results. The pre-requisites for investment by intermediaries and the markets may depend on a given range of certainty associated with the return on investment and proven approaches, which may not exist in a transition context. Investment may, therefore, fail to materialise or occur at high costs passed to the project. The investment shortfall may create spaces for public institutions and international development organisations (in the case of the Global South) to bridge the funding gaps. However, it also implies re-evaluating the return expectations of the financial system within the context of a transition and incorporating environmental and social returns to meet the other demands discussed in this section.

4.3 What do the demands imply for relating financial systems and STR?

The demands on the financial system interpreted in Section 4 holds the potential for creating common entry points for relating financial systems and sustainability transitions, as interpreted from the characteristics of sustainability transitions which the financial system is being asked to respond to. The value of this approach is that framing the problem facilitates the design of solutions and enables the critique of the responses (Minsky, 1986; Perez, 2002).

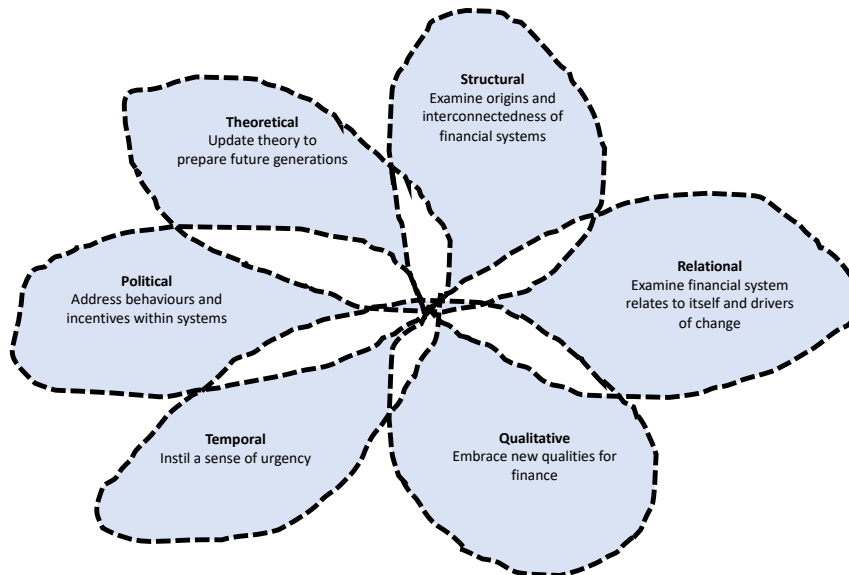
Formulating the explicit demands that such processes place on the financial system means creates space for open examination, adjustment and challenge. Explicit demands, in turn, facilitates informing the method by which problems are solved (Perez, 2002; O’Sullivan, 2005, Köhn, 2012) and reflecting on the assumptions that inform such methods. The next step in relating financial systems to sustainability transitions involves exploring the dimensions for designing responses to such demands, as discussed in the next section.

5. DIMENSIONS FOR RESPONDING TO THE DEMANDS OF SUSTAINABILITY TRANSITIONS

The sustainability and climate breakdown as framed by the Paris Climate Agreement, the SDGs and the IPCC Special Report invokes a systems-level response to manifest the new sustainable economic systems - in every country, every sector, every household. The demands that sustainability transitions place on the financial system set an explicit tone for the depth and breadth of the response required.

By inference, designing responses to the demands requires multi-dimensional reflections, which are entwined and interdependent, non-linear and iterative, as illustrated in Figure 1¹¹.

Figure 1 – Dimensions for relating financial systems to demands of sustainability transitions



Source: Author.

Based on the demands formulated in Section 4, this section offers insights on the initial dimensions for developing the method of response by the financial system. The discussion includes initial research avenues for further developing conceptual and empirical research that relates financial systems and sustainability transitions.

5.1 Political: Address behaviours and incentives within systems

The characteristics of sustainability transitions shows that the financial system needs to direct and generate both environmental and social system-level impacts while simultaneously destabilising unsustainable economic systems. While finance is a fluid and adaptable resource, it is not a neutral participant in the economy. The lack of neutrality implies a political dimension to the response of the financial system, raising questions about the scale and nature of the response to achieve the systems-level, directional and other demands inherent in transition processes as described in Section 4.

Responses to the sustainability and climate breakdown offer plentiful investment opportunities which can drive radical shifts, for example, shifting towards clean energy systems – opportunities framed as contributing towards green growth. The directional changes and systems-level impacts that

¹¹ The uneven, overlapping and differentiated shapes and lines with the open spaces that merge at centre represents the nature of transition processes, as interpreted in Section 4.

characterise sustainability transition processes and the implications of the IPCC Special Report carry *temporal necessities*, which extend beyond new investment opportunities. Finance is likely to flow towards the new sustainable technologies, based on the natural ebb and flow that accompanies new opportunities (Perez, 2002). While new reorientations in investment management such as impact investing, sustainable and green finance exist (Brooks et al., 2018), pursuing the optimal risk-return investment profile remains the dominant pre-occupation of bankers (Spratt, 2015; Lagoarde-Segot, 2015). The Paris Agreement and SDGs call for consistent and integrated finance flows, which indicates a deeper response is required beyond making funds available for the new economic path. The type of response required from the financial system to create and direct the new economic state comes under question – for example, how does framing the sustainability and climate as an *opportunity* for green growth affect the *necessity* of what needs to be done to achieve the new economic state? Who controls the flow of funds?

Schumpeter (1942) diagnosed the banker as one who acts independently of other influences in the economy, making possible radical changes through the bankers' decisions. At the same time, significant economic losses over recurrent financial crises are directly attributed to the investment behaviours of bankers (Reinhardt & Rogoff, 2009; Griffith-Jones et al., 2010). Therefore, the ability to effect radical changes depends on the influences acting on the bankers, which relates to the mandate, reward incentives and risk tolerance levels of the intermediaries and the markets. These influences, in turn, translate into investment positions, which are determined by investment committees, deal makers and risk managers. Their personal and institutional values guide the individuals represented in these structures, their training and prior experiences within different cultural contexts – all of which influence how they relate to the problem they are solving (Bronfenbrenner, 1972). Therefore, the political dimension may need to reach to the level of the bankers, other asset managers and those that require such funds (Knafo et al. 2018).

The response of the financial system to the demands of transition processes depends on how it frames the sustainability and climate breakdown. Is it about new financial innovations, managing climate or sustainability risks, or pursuing new investment opportunities? What needs to happen in the short term that has long-term implications for sustaining the new economic system? Is more required? For example, practice-based research calls for a transformation of the entire financial system (EC, 2018; UN, 2018). Why is that the case? What informs the transformation process? Who will direct the transformation process? What does consistency and integration mean to the financial system relative to policymakers and social drivers of change?

Directing the institutions and individuals within the finance system towards sustainability will be an inherently political and contested process, arising in tensions between the changes the finance system is *willing* to make compared to those it *needs* to make. The political dimension implies going beyond the quantity of finance available for investing in the new sustainable economic path, to recognise that finance may only flow under certain conditions achieving the new sustainable economic state. Key questions to ask would be what are those conditions, and what informs those conditions? The political dimension also draws attention to how the financial system relates to itself and the social drivers of change, as examined in the next section.

5.2 Relational: Examine how the financial system relates to itself and drivers of change

The financial system comprises intermediaries, markets and infrastructure. The intermediaries are banks, institutional investors and national development banks, among others. They serve as the point of access and exchange of finance between those seeking money whether they are from households or businesses, and those offering finances represented by the intermediaries. The relational dimension relates to how different components of the financial system regard their individual and collective role in responding to the sustainability and climate breakdown and their contribution towards building a consistent and integrated financial system compatible with responding to the demands of transition processes. Meeting the demands of sustainability transitions requires engaging on social issues of inclusivity, with new social drivers to contribute towards shared visions of change and applying experimental approaches to achieve the new sustainable economic state. To what extent is the financial system able to meet these demands?

Reflecting on how intermediaries, markets and infrastructure of the financial system relate to each other, and how they define their purpose in the economy is critical. The relational dimension engages directly on the Paris Climate Agreement and SDGs call for consistency and integrated finance flows within the financial system, which, in turn, impacts the degree to which the financial demands of transition processes are met. Further, the response to the sustainability and climate breakdown is not homogenous, as it depends on individual countries' ambition for meeting the goals of the Paris Climate Agreement, the SDGs and recognising the urgency implied by the IPCC Special Report. Therefore, the demands placed on the financial system and its ability to meet them also depends on the intensity of the response to the environmental and social aspects of the breakdown (Spratt, 2015). Sector-specific changes may be less demanding on the financial system, compared to more intense economic shifts that address economy-wide transformations (Spratt, 2015). The intensity of the

economic shifts influences the type of financial innovations that emerge, the inclusion of new social players, and how relations among intermediaries evolve in response.

For example, at the level of designing new financial products and business models, each intermediary offers a range of financial instruments such as loans, shares, guarantees to reduce risk and grants based on their different investment mandates and priorities. Public and private intermediaries relate to each other in a particular way, depending on the country context. The relationship defines their investment decisions, collaborations and support of specific interventions. For example, public intermediaries such as state-owned banks are expected to invest in economic development objectives such as health, social welfare and infrastructure, and support high-risk investment where other forms of finance fail (Mazzucato & Penna, 2016). In contrast, private intermediaries such as banks and institutional investors mainly focus on investment opportunities that minimise risk and maximise their returns on investment for their shareholders (Spratt, 2009). Incentives are required to attract finance flows towards alternative investments (Spratt, 2009). However, public institutions can also create and shape new markets to promote new investment opportunities (Mazzucato, 2013; Mazzucato & Semieneuk, 2018). Each intermediary in the financial system offers different types of finance, depending on where they engage in the transition process. For example, different financiers across the innovation cycle in the renewable energy sector engage based on the investment mandate and preferences (Mazzucato & Semieneuk, 2018). The relational dimension within and among different institutions affects the temporal dynamics of sustainability transitions, as interventions in the short term are required to deliver long-term impacts. Several questions arise. How much finance flows? How accessible is such funding? Will finance flow organically over time to support the transition process? Moreover, who holds the financial system accountable in its response?

Relating to the social drivers of change also requires the financial system to engage in the design interventions to drive the new sustainable economic path. Since systems-impact is a demand placed on the financial system, the scale of interventions implies going beyond the traditional approach of financing single projects and shifting towards portfolio approaches (i.e. recurring combinations of projects and programmes) that support scaled-up interventions. The interventions also require experimental and adaptive approaches as the future impacts may be uncertain, including the policy context. An example of an experimental financial innovation is the Green Fund managed by the Development Bank of Southern Africa since 2012. Designed for learning-by-doing, the Green Fund provides evidence of the developmental needs of green projects and their environmental, social and financial returns (Naidoo, 2019).

Evaluating the traditional roles and mandates of the components of the financial system relative to their purpose in creating and sustaining a new sustainable economic path may be helpful for understanding to what degree a financial system needs to transform itself. Addressing these relational issues among the intermediaries, markets and infrastructure of the financial system also depends on the structure of the financial system as the next section shows.

5.3 Structural: Examine origins and interconnectedness of financial systems

The structural dimension relates to a country's national financial system. Why this focus? The evolution of a country's financial system influences its ability to drive radical economic shifts and determines the pace and scale of future development (Schumpeter, 1942; Gerschenkron, 1962). The structural dimension incorporates the degree to which the national finance system is interconnected with the global financial system, which determines its vulnerability to financial crises originating in other jurisdictions (Aziakpono, 2006). The structural dimension also requires consideration of the cultural influences from which financial systems originate and the forces that shape their evolution (Naidoo, 2019; Urban et al., 2019). For example, the dominant model for financial systems are British or American banking systems, with differentiated approaches in the Middle East and Asian countries (Urban et al., 2019). Given these factors, the structural dimension has significant influences how the financial system responds to sustainability transition processes. This means that any structural impediments or advantages of a country's financial system may either inhibit or promote transition processes.

The impediments or advantages of the financial system affect the diversity of financial innovations available for structuring and financing projects and programmes (Pathania & Bose, 2014; Polzin et al., 2017; Naidoo, 2019; Urban et al., 2019). Financial innovations can arise in two ways. Firstly, existing intermediaries in the financial system collaborate to create new financial instruments, and secondly, new government policies encourage the creation of new financial innovations (Pathania and Bose, 2014). For example, financial instruments with longer durations needed for renewable energy investment may not be accessible due to the structure of the national financial system (Polzin et al., 2017). Financial innovations within current systems are biased towards debt (Turner, 2016; Polzin et al., 2017), which influences how investment decisions are made, what is financed and by whom (either public and private). The debt bias amplifies the need for new innovative non-debt-based instruments and models for exchanging and deploying financial resources, such as crowd-funding platforms (Ansart & Monvoisin, 2017). The Paris Climate Agreement and SDGs are interdependent meaning responding to the environmental *and* social dimensions of sustainability. It requires consistent and

integrated financial systems to support the shift to new sustainable paths, which influences how the financial system supports this process. For example, as mentioned in Section 4, the narrative related to green growth and its associated reward expectation requires reflection. Since transition processes require contextual experimentation, alternative learning-by-doing mechanisms, digital platforms and community finance arrangements may be within the realm of possibility for creating a diverse financial system that is accessible and relevant for the demands of transition processes.

Structural limitations further influence facilitating equitable access to finance for participating in the transition process, which impacts how the directional changes unfold, the systems-impact achieved and heightens social contestation. For example, structural limitations in Ghana's finance system inhibit access to finance for renewable energy project developers, as there is limited project development and entrepreneurial finance available (Beggs, 2018). While, poor access to finance for vulnerable groups and small to medium sized firms place may inhibit a just and equitable transition from materialising in South Africa (Naidoo, 2019). The structural limitations, therefore, require open engagement among the drivers of change to consider openly how the financial system can be reoriented to the purpose of sustaining the new sustainable economic path. While practice-based research through the UNEP Inquiry, the UK Green Finance Strategy and ECHLEG is promising, they presently lack independent academic consideration. Falcone et al. (2016) observe that the financial system reforms are mainly led by developed countries with limited evidence of engagement by developing countries. For example, whose vision of a sustainable financial system is emerging? How is the vision constructed to include broader social dimensions? How does the vision relate to the demands of sustainability transition processes? What dimensions are being included or excluded, and why?

Systems innovation and co-evolution are inherent in sustainability transitions processes (Geels, 2010), implying that stagnant and rigid financial systems are not compatible with transition processes. This has broad implications. Importantly, it sets a new challenge for finance, including and going beyond the Schumpeterian goal of achieving radical changes in the economy. The challenge is to direct the financial system towards supporting environmental and social sustainability which requires consistent and integrated approaches to maintain this direction. The added challenge for the financial system is time.

5.4 Temporal: Instil a sense of action

The realities of the sustainability and climate breakdown drive sustainability transitions processes. Schmitz (2015) raises concern about the slow pace of sustainability transitions (which he calls green transformations). Sovacool (2016) studying the rate of past energy transition provokes debates on the temporal dynamics of transitions: need they be lengthy and protracted processes, or should we be asking what it will take to accelerate? Fouquet (2016) acknowledges this provocation, adding that “transitions are not inevitable and depend on a series of actors and forces to create new paths”. Stern (2018) offers further support for accelerated transitions by calling increased pace and scale of public policies that respond to the sustainability and climate breakdown. Brown and Granoff (2018) recognise that responding to climate requires alternate temporal framings, they ask: how does a focus on the longer term shift the debate on climate finance?

The debates are timely. The IPCC Special Report reflects the real-world drivers for accelerated transitions, offering evidence of environmental and social crisis unless urgent actions are taken (IPCC, 2018). These debates need to be extended into academic and empirical research on relating the financial system to sustainability transitions - what will it take to deliver finance urgently and at scale? What type of funding and governance models are needed to do so? What does this imply for public and private investment strategies? What type of governance arrangements and financing models can support accelerated transitions? What role can central banks play in ensuring that the financial system moves at the required pace and scale?

The temporality of the sustainability and climate breakdown adds a sense of urgency to the dimensions discussed so far in this section, which leads to questions about the qualitative dimensions of developing the response of the financial system. This is explored in the next section.

5.5 Qualitative: Embrace new qualities for finance

References to the quality of finance relate to the reluctance of investment managers to invest over the longer term (Knafo and Dutta, 2016). Calls for reorienting finance towards qualitative dimensions first emerged in the aftermath of the 2008 crisis with calls for patient capital. Such patient capital enables a shift away from the short termism of investment allocations and financialisation (finance investing in finance), and moving towards long term gains (Mazzucato, 2013). Since transition processes are iterative and experimental, patient capital is essential for learning by doing, which is implied in the contextual experimental characteristic, described in Section 4. While patient capital is a useful starting point for more qualitative dimensions for finance, the demands placed on the

financial system imply new qualities for finance are necessary. This paper, therefore, proposes additional qualities for the financial system to support sustainability transitions processes. These are consistency, pragmatism, responsiveness, inclusivity and adaptability, justified as follows:

- a) *Consistency*: To address the directional shift of finance towards sustainability and away from unsustainable options. This quality also derives from the Paris Agreement (UN, 2015a) for finance flows to be consistent with sustainability transition processes and for integration per the SDGs (UN, 2015b, c). The tensions associated with contextual experimentation and contested described in Section 4 also lend support for this quality, which implies that despite the difficult choices to be made, responding to the sustainability and climate breakdown will always be prioritised.
- b) *Pragmatism*: To address the real-world temporal dimensions, new business and funding models for accelerated access to finance is essential. This includes reducing the lag effects associated with developing and implementing projects over protracted time periods due to governance delays. This quality is derived from the real-world context of transitions highlighted by various authors (Stern, 2018; Sovacool; 2016; Geels et al., 2017).
- c) *Responsiveness*: To address the characteristics of new drivers of change, and experimentation, to ensure access for resources that enables learning by doing, as many of the temporal-related responses may be linked to uncertainty and significant variability. This relates to temporality and the need for accelerated transition processes, accounting for the real-world urgency to reduce greenhouse gas emissions, increase resilience and address crisis situations such as losses due to habitat destruction and the vulnerability of displaced people.
- d) *Inclusivity*: To ensure new coalitions participate equitably in the transition process to mitigate the challenge of social inequalities in the economy (Vergragt, 2013; Witt, 2013) and those linked to transition processes. For example, a sustainability transition can be underway and simultaneously be contributing towards growing social inequalities.
- e) *Adaptability*: To accommodate experimentation, learning by doing and iterative decision processes. This quality argues for more adaptive approaches to investment decision-making whereby a social mechanism is instilled to influence the behaviour of financiers (Hall et al., 2016) The quality of adaptability also addresses the co-existence of creative and destructive processes. Central banks and regulators are concerned about maintaining stable and secure financial systems

to facilitate economic development and avert financial crises. This means a specific role for central banks and regulators on information disclosures and risk management strategies to reduce and manage the uncertainties linked to sustainability transition processes and the climate breakdown (Campiglio et al., 2018; Battiston et al., 2017; Stolbova et al., 2018). Alternative debates are emerging that focusing on stability and managing financial risks is a defensive approach; whereas, central banks could offer incentives to the financial system to support green investment (Tooze, 2019).

Reorienting the financial system's focus towards qualitative issues requires deep reflection on the underlying theories and assumptions that drive the investment behaviours, cultures and incentives of financial institutions (Lagoarde-Segot, 2015; Diaz-Rainey et al., 2016), as discussed in the next section.

5.6 Theoretical: Update theory to prepare future generations

The theoretical dimension represents investing in the education of future generations who will be the bankers and policymakers leading the transformed systems of the future. They will need to maintain the direction of sustainability transitions and sustain the systems transformations through their future decisions.

Finance as an academic discipline resides within economic studies, where growing criticisms among scholars and students questions its ability to address real-world challenges of sustainability and climate breakdown (Orléan; 2014; Lagoarde-Segot 2015; Raworth, 2017). Early conceptions of finance connect to real economic growth and human well-being, however finance evolved mainly along quantitative approaches (Raworth, 2017). Embedding sustainability into the field of finance requires qualitative approaches and new methodologies to engage on. For example, Lagoarde-Segot (2018) notes that the emergence of sustainable finance requires qualitative approaches are incompatible with orthodox financial models. The mismatched approaches create an epistemological challenge for conceptual and empirical research. Further, some authors argue that the theories on which financial models are based have no theoretical basis for embedding environmental and social objectives, despite there being framings of sustainable finance (Lagoarde-Segot and Paraque, 2017). These epistemological challenges lend urgency to evaluating and interrogating the underlying assumptions of financial innovations and initiatives claiming to support sustainability transitions.

The mutual lack of the conceptualisation within the sustainability transitions and finance field to raises questions for both the pace and depth of sustainability transitions in the short term. For example,

how do financial theories lock-in changes that the financial system is prepared to make, rather than the changes it is required to make? The poor conceptual development of finance and sustainability transitions also means empirical research on financial innovations and reforms is limited by current framings of finance and sustainability transitions. The short-term risk is that sustainability transition processes may be constrained by a financial system that is guided by financial theories incompatible with sustainability transitions. Rethinking the field of finance is, therefore, essential for long-term systems transformation aligned with responding in a consistent and integrated manner to the sustainability and climate breakdown.

The sustainability transitions field positions finance in a neutral tone. It assigns a background role to finance as a function inherent user practices and as one of the resources critical for advancing transition processes — such positioning masks the broader and multi-layered complexity of the political dimensions of the financial system. Developing new framings for finance in the sustainability transitions field is therefore critical. Such framings should focus on developing heuristics that can examine the causal linkages between how the response by the financial system inhibits or promotes sustainability transitions. Research on finance in the sustainability transitions field tends to apply the MLP as a core heuristic, which frames finance as a resource and function. While the MLP is useful for reflecting the process of transitions it is limited in explaining the causality of transition processes (Svensson and Nikoleris, 2018; Sorrell 2018). Causality is essential to answering questions such as that posed by Köhler et al. (2019) on how financial capital restricts or promotes sustainability transitions. This implies broadening the heuristics of the sustainability transitions field towards studying causal linkages.

Independently evaluating practice-based policy research that claims to advance transition processes is also essential because the seeds of the financial systems response are planted through these initiatives. While no guarantees of success exist, the future generation of policymakers and bankers will either benefit from or have to unravel misdirected and poorly-conceived approaches.

Although new reorientations and conceptual developments may only take effect over time, the efforts on the theoretical dimension are critical for educating and laying the foundations for future generations of bankers, policymakers, entrepreneurs and consumers. Sustainability transitions is not only about creating the new economic path. It relates to sustaining it by putting in place measures that ensure there is no reverting to unsustainable economic options or investment behaviours. Academia has an important role to play in this way, through the power of ideas and education.

5.7 Implications for future research relating financial systems and sustainability transitions

The discussion in this Section 5 invites interdisciplinary approaches to further relate financial systems and sustainability transition. The implications for future research extend beyond the subject matter of the paper, which started with identifying possibilities for relating financial systems and sustainability transitions. A recurrent theme stands out in the critical emergent literature on finance and sustainability - the need for explicit assumptions (Section 3.5). Specifically, the relevance and validity of the assumptions of orthodox economic theories to societal challenges (Orl an, 2014; Raworth, 2016; Mazzucato, 2018) and the epistemological assumptions of finance that make embedding sustainability difficult (Aspinall et al., 2015; Lagoarde-Segot, 2016; Diaz-Rianey, 2017). For STR, the research highlights the limitations of the tacit assumptions informing the sustainability transitions field such as accepting the orthodox view of capitalism (Swilling, 2013; Feola, 2019) and the assumptions underlying the ontological foundations of sustainability transitions and the MLP heuristic (Svensson and Nikoleris, 2018; Sorrell, 2018).

Why focus on assumptions? In any change context, explicit assumptions help to articulate expectations and generate effective responses where possible, which enhances the rate, scale and pace of the change process (Stern, 2018). Assumptions contain the underlying elements of that which we accept unthinkingly (Feola, 2019). This means that the design of solutions then embodies the unquestioned and silent assumptions about the cause and effect of the problem. The solutions, in turn, influences, how future conceptual, empirical and policy-making processes unfold. While theory cannot solve the problems of sustainability and climate breakdown, implicit assumptions informing theory-policy-practice exchanges may indeed accelerate the breakdown. This may, in turn, lead to misdirected and misaligned transition processes and locking-in fault-lines that would then require unravelling in future, if at all possible.

Therefore, the paper encourages advancing STR research to openly examine the assumptions about the problem and the emerging solutions. Feola (2019: 7) describes STR scholars as “not only researchers but also change actors in society”. More specifically, a change actor studying the process of responding to sustainability and climate breakdown. This means that the process of theory and policy research and development in STR carries a duty of care and responsibility towards present and future generations. It requires continually reflecting on *what is the nature of the problem(s)? What implicit assumptions underpin our ideas and solutions concerning such problems? How may the assumptions we hold be problematic in future?* By making assumptions visible, we allow space for ourselves, current and future generations of scholars to engage critically. The call to STR scholars is

especially critical for relating financial systems to sustainability transitions, where research is limited and conceptually, finance is not adequately located to facilitate the study of causality. Developing causal linkages between financial systems and sustainability transitions is essential for understanding how finance and financial systems inhibit or advance transition processes.

6. CONCLUDING REMARKS

Without financial systems, sustainability transitions will struggle to materialise – the role it plays extends beyond financing the new sustainable economic state. The availability of finance is not a constraint for sustainability transitions as over U\$112 trillion (PwC, 2017) is currently circulating in the global economy that can be potentially be deployed towards the breakdown. Hence, the calls for the financial system to have consistent and integrated finance flows, as contained in the Paris Agreement, the SDGs and the Addis Ababa Action Agenda.

In this paper, the possibilities for relating financial systems and sustainability transitions are considered, which is necessary due to the nascent research and underdeveloped conceptualisations. The scoping review shows the challenges in relating financial systems and STR, largely due to limited cross-engagement between orthodox and critical research between finance and sustainability transitions literature.

“If you don’t know where you going, any road will take you there.”¹²

In Section 4, the paper argues that relating financial systems to sustainability transitions begins with understanding the nature of the transition process – which is akin to asking, what is the nature of the problem being solved? By taking this approach, it opens the road to formulating the initial demands that the transition process places on the financial system. The demands represent explicit assumptions for the financial system to engage with, from which conceptual and empirical research and policy development can advance. One of the characteristics of sustainability transitions is navigating a contested social context. Making the demands on the financial system explicit may facilitate consensus-building around the problem, around which the drivers of change may engage. Explicit demands also serve as a point of reference for situating and critically evaluating the response of the financial system relative to such demands. The ability to evaluate the responses of the financial system is presently lacking in the STR.

¹² Extract from George Harrison’s song “Any Road”.

In Section 5, the paper reflects on the initial dimensions for designing a response to the demands of transition processes. The process is complicated – it requires reflecting on political, relational, temporal, structural, qualitative and theoretical dimensions – mainly because embedded in each dimension are implicit assumptions framing finance and the financial system. No presumptions exist about the financial system having to transform to be compatible with a new sustainable economy. If such a transformation is indeed required, then the depth of the transformation process matters. The paper presents initial insights for considering the depth of response required from the financial system to meet the demands. It is also useful for engaging on the extent to which the financial system can respond.

The paper invites scholars and policymakers to reflect further on the explicit demands that transitions place on the financial system, the process of designing solutions and how to evaluate such solutions. Responding to sustainability and climate breakdown requires accelerating rapid and radical changes. However, in our haste, we may overlook the dangerous assumptions that created the breakdown in the first place and find ourselves at a point in the future back at the same place.

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SUPPLEMENTAL INFORMATION

Scoping review of 2013 Special Issue of EIST Volume 6: The financial crisis of 2009 and its effects on sustainability transitions

Authors	Main arguments	Main recommendations
Antal & Van den Bergh, 2013	The dominant framing of growth as an imperative in the economy system is problematic. The structure of the financial-economic relationships is biased to debt, financial returns meaning that the financial system is not fit for purpose.	The structure of the financial system requires re-assessment to facilitate different choices in the allocation of capital, i.e. move investment into sustainable options.
Loorbach & Huffenreuter, 2013	The article argues that the framing of green growth upholds the dominant imperative of growth, which is not helpful as it masks the systemic problems of the incumbent economic system which inevitably led to the unsustainable development pathways.	There is a need to address the underlying deep systemic problems of economic-financial systems, because any policy decisions in support of sustainability transitions is made against the dominant framing of growth.
Foxon, 2013	<p>The financial crisis shows the inability of mainstream economic theories to reflect an adequate understanding of how economies work, which has highlighted through the work of ecological economic disciplines and results in poor and inadequate policy decisions being made. The author proposes that a new economic pathway framed as 'Complexity Economics' which incorporates four schools of economic thought into mainstream economics to create a dynamic and open economic system:</p> <ul style="list-style-type: none"> i) ecological economics to reframe main goal of government to promote economic growth; ii) behavioural economics to factor in the bounded rationality and bias of human actions; iii) institutional economics to recognise the institutional complexities of banks and financial regulation which are 	<p>By blending mainstream economics with the four schools of thought, a dynamic and open economic system is possible with agents having the ability to learn and adapt over time, interacting across different networks with feedbacks and interactions.</p> <p>The fragments of a new economics for sustainability exists, but is not yet coherently developed into an alternate framework. The fragmentation is not helpful for current policymaking because dominant economic theories fail to offer policy insights for modern day challenges.</p>

Authors	Main arguments	Main recommendations
	<p>currently absent in economic models and disregarded in policy making;</p> <p>iv) evolutionary economics to acknowledge the dynamic processes that shape technological and institutional changes, rather than the use of equilibrium models, which dominates mainstream economics.</p>	
Vergragt, 2013	<p>The real crisis beyond the 2009 financial crisis is that of social inequalities, as societies with large income disparities perpetuates consumerism and support is needed from social groups with the political will to build a strong social movement. The author argues that having access to decent work, moderate to low income growth and better quality of life would be an antidote to creating future financial crisis. The ‘wicked problem’ is the pursuit of growth and a consumerist</p>	<p>Building strong social movements is necessary to address social inequalities in a radical way that works with movements such as the Rethinking Economics. The ecologically oriented and energy efficient technologies are the hope of green growth proponents, and this will lead to rebound effects and disappointing social effects. This means raising questions whether the radical societal shifts are deep enough to address transition concerns.</p>
Perez, 2013	<p>Financial crisis are a natural part of economic cycles and recur over history, offering opportunities to unleash a golden age that promotes new green innovations and prospects for green growth.</p>	<p>Realising the potential depends on conditions for such green growth to be installed, such as government intervention, reorienting and directing global finance towards new opportunities, and regulation to limit the casino effect of finance.</p>
Geels, 2013	<p>The paper attempts to expand the discussion beyond environment, incorporating financial crisis and shift emphasis towards diffusion and take-off of technologies rather than emergence. The author argues that i) financial-economic crisis reflects deep cultural problems, such as debt-biased economies, growth obsessions, and resource exploitation; ii) crisis is an essential part of long term change, which means that current crisis could be the installation of a ‘green wave’; iii) framing green growth as opportunities and rewards is problematic rather than as the costs of responding to deep cultural problems. The paper further</p>	<p>Frames the finance challenges for transitions during its take-off phase, because transitions are non-linear processes that move forward and backward, with periods of stagnation, as being:</p> <ul style="list-style-type: none"> i) mobilising large sums of money, which depends on financial-economic conditions, investor confidence and financial regulations. ii) changes in policy and institutional frameworks, with private actors having no incentive to address

Authors	Main arguments	Main recommendations
	<p>argues that financial-economic and sustainability crisis have different time frames, causes and solutions, which will compete for political attention.</p>	<p>societal problems heightens the role of government.</p> <p>iii) achieving public support and legitimacy for the changes emerging from the crisis, which could be mapped across an 'issues lifecycle'.</p>
<p>Swilling, 2013</p>	<p>The financial crisis reflects the ebb and flow of systems dynamics, where the long wave theories are useful for reflection. The paper attributes the persistence of economic-crisis to 'blocked transitions' caused by the failure to dislodge the hegemonic role of finance capital and break carbon-lock in. The paper critiques long wave theory, and sees its danger as techno-economic determinism where innovations do all the acting, and socio-political institutions do the reacting.</p> <p>The paper argues that finance capital will not voluntarily drive a green technology revolution, because i) massive build-up of unspent cash in several major economies, and ii) sustainability commitments of large investors is undermined by short termism of capital markets, which makes long term funding unavailable.</p>	<p>Transitions are only possible if three conditions are in place</p> <p>i) finance capital has been disciplined</p> <p>ii) productive capital has to lead digitising of production and consumption</p> <p>iii) finance capital drives acceleration of installation of green technologies as a response to growing ecological crisis.</p> <p>The paper proposes a framework to balance the act-react imbalance between technology and socio-political institutions, by adding socio-metabolic transitions, technological revolutions and long term global development cycles. These collective insights are necessary to reorient the technology storyline to transitions, towards the cause of the crisis in the first place, i.e. the sustainable use of material and energy flows.</p>
<p>Witt, 2013</p>	<p>The paper argues that the financial crisis is only financial on the surface, which is veil for a growth crisis. There is need to rethink growth expectations and political priorities, as the prospects of warning and less growth diverts attention away from sustainability transitions. Despite the financial reforms related to the crisis that have been made, the narrative of green growth and its investment opportunities are not helpful. Such narratives mask the systemic problems of unsustainable production and consumption patterns and social inequalities.</p>	<p>Engaging the broader public in discourse and introducing policies that promote a less expansionary mindset would be useful, though raising a political question – whether if the public prepared with such an understanding would vote for transition policies likely to negatively affect economic growth? The primary challenge being the future of employment as in transition context unemployment problems arise. These may be addressed either through reducing labour supply, or creating</p>

Authors	Main arguments	Main recommendations
		new jobs – the latter is the preferred option for a just and equitable transition.
Van der Ploeg and Withagen, 2013	Boosting green growth in a global economic crisis may be possible through government intervention and policies. Crisis expose the inefficiencies of a system, and offer potential for redirecting and engaging in new venues.	To stimulate green growth, appropriate price signals (e.g. carbon taxes), and stimulating innovations is essential including strategies for leaving fossil fuel resources unexploited.
O’Riordan, 2013	Identifies four failures arising from the financial crisis – i) to anticipate tipping points, ii) over-optimism of the corporate sector, iii) immorality of the market, iv) undermining of democracy by oligarchs of power.	

Source: Author summary

REFERENCES

- Alkemade, F., Hekkert, M.P., Negro, S.O., 2011. Transition policy and innovation policy: friends or foes? *Environmental Innovation and Societal Transitions* 1, 125–129.
- Ahlström, H., 2019. Policy Hotspots for Sustainability: Changes in the EU Regulation of Sustainable Business and Finance. *Sustainability*. Vol 11 (2) 499
- Ansart, S. & Monvoisin, V., 2017. The new monetary and financial initiatives: Finance regaining its position as servant of the economy. *Research in International Business and Finance*. 39 750-760.
- Antal, M., & Van Den Bergh, J.C.J.M., 2013. Macroeconomics, financial crisis and the environment: strategies for a sustainability transition. *Environmental Innovation Societal Transitions*. 6 47–6
- Aspinall, N., Jones, S., McNeil, E.H., Werner, R.A., & Zalk, T., 2015. Sustainability and the financial system Review of literature 2015. Presented to Institute and Faculty of Actuaries. London.
- Avelino, F., 2009. Empowerment and the challenge of applying transition management to ongoing projects. *Policy Sciences*. Vol 42 (4) 369-390.
- Aziakpono, M., 2006. Financial integration amongst the SACU countries: evidence from interest rate pass-through analysis. *Studies in Economics and Econometrics*. Vol 30 (2) 1-23.
- Battiston S., Caldarelli G., D'Errico M., 2016. The Financial System as a Nexus of Interconnected Networks. In: Garas A. (eds) *Interconnected Networks. Understanding Complex Systems*. Springer.
- Beggs, J., 2018. Access to domestic financial systems and the renewable energy transition: An analysis of Ghana's energy system 2011-2017. University of Sussex. (unpublished Masters' thesis)
- Berkhout, F., Smith, A., Stirling, A., 2004. Socio-technological regimes and transition contexts in: Elzen, B., Geels, F.W., Green, K. (Eds.), *System Innovation and the Transition to Sustainability: Theory, Evidence and Policy*. Edward Elgar. Cheltenham.
- Bergman, N., 2018. Impacts of the Fossil Fuel Divestment Movement: Effects on Finance, Policy and Public Discourse. *Sustainability* 2018, Vol. 10.
- Bhattacharya, A., Meltzer, J., Oppenheim, J., Qureshi, M.Z., Stern, N., 2016. *Delivering on Sustainable Infrastructure for Better Development and Better Climate*. The Brookings Institution.
- Bidmon, C.M., & Knab, S.F., 2018. The three roles of business models in societal transitions: New linkages between business models and transitions research. *Journal of Cleaner Production*. 178 903-916.
- Bouma, J.J., Jeucken. M. and Klinkers, L., 2001. *Sustainable Banking. The Greening of Finance*. Greenleaf Publishing. United Kingdom.
- Bronfenbrenner, U., 1979. *The Ecology of human development: Experiments by nature and design*. Harvard University Press. Cambridge MA.
- Brooks, C., Fenton, E., & Schopohl, L., 2018. Why does research in finance have so little impact? *Critical Perspectives on Accounting*. (Article in press).
- Brown, D., 2018. Business models for residential retrofit in the UK: A critical assessment of five key archetypes. *Energy Efficiency*. Vol 11 (6) 1497-1517.
- Brown, J., & Granoff, I., 2018. *Deep decarbonisation by 2050: Rethinking the role of climate finance*. Climate Policy Initiative and Climate Works Foundation.
- Caldecott, B., 2017. Introduction to special issue: Stranded Assets and the environment. *Journal of Sustainable Finance and Investment*. Vol 7 (1) 1-13
- Campiglio, E., Dafermos, Y., Monnin, P., Ryan-Collins, J., Schotten, G., Tanaka, M., 2018. Climate Change Challenges for central banks and financial regulators. *Nature Climate Change*. Vol.8
- Carney, M. 2018. A Transition in Thinking and Action. Speech at the International Climate Risk Conference for Supervisors. De Nederlandsche Bank. Bank of England.
- Carney, M. 2019. Enable, Empower, Ensure: A New Finance for the New Economy. Speech at the Lord Mayor's Banquet for Bankers and Merchants of the City of London at the Mansion House. Bank of England. London.
- CBI (Climate Bonds Initiative), 2018. *Bonds and Climate Change. The State of the Market 2018*. https://www.climatebonds.net/files/reports/cbi_sotm_2018_final_01h-web.pdf

- Clayton, A., Spinardi, G., and Williams, R., 1999. *Policies for Cleaner Technology*. Earthscan. London
- Crockett, A., 2011. What financial system for the 21st century? Jacobsson lecture. Bank of International Settlements. Basel.
- De Carvalho Ferreira, M.C., Sobreiro, V.A., Kimura, H., and de Moraes Barboza, F.L., 2016. A systematic review of literature about finance and sustainability. *Journal of Sustainable Finance and Investment*. Vol 125 (1) 13-21.
- Diaz-Rianey, I., Robertson, B., & Wilson, C., 2016. *Stranded Research? Leading finance journals are silent on climate change*. University of Otago. New Zealand.
- Dosi, G., 1982. Technological Paradigms and Technological Trajectories. *Research Policy* (11) 147-162.
- EC (European Commission High-Level Expert Group on Sustainable Finance), 2018. *Financing a Sustainable European Economy: Final Report*. European Union. Brussels.
- Edmondson, D., Kern, F., & Rogge, K., 2018. The co-evolution of policy mixes and socio-technical systems: Towards a conceptual framework of policy mix feedback in sustainability transitions. *Research Policy*.
- Falcone, P.M., Morone, P., & Sica, E., 2018. Greening of the financial system and fuelling a sustainability transition: A discursive approach to assess landscape pressures on the Italian financial system. *Technological Forecasting and Social Change*. 127 23-37.
- Farla, J., Markard, J., Raven, R., & Coenen, L., 2012. Sustainability transitions in the making: A closer look at actors, strategies and resources. *Technological forecasting and social change*, 79(6), 991-998.
- Farmer, J., Gallegati, M., and Hommes, C., 2012. A complex systems approach to constructing better models for managing financial markets and the economy. *European Physical Journal*. 214 (1) 295-324.
- Feola, G., 2019. Capitalism in sustainability transitions research: Time for a critical turn? *Environmental Innovation and Societal Transitions*. (Open access)
- Fouquet, R., 2016. Historical energy transitions: Speed, prices and systems transformation. *Energy Research and Social Science*. 22 7-12.
- Foxon, T.J., Stringer, L.C., and Reed, M.S., 2008. Governing long-term social-ecological change: What can the resilience and transitions approaches learn from each other? Paper prepared for the 2008 Berlin Conference, Long Term Policies Governing Socio-Ecological Change. Berlin.
- Foxon, T.J., 2011. A co-evolutionary framework for analysing a transition to a sustainable low carbon economy. *Ecological Economics*. Vol 70.
- Foxon, T.J., 2013a. Transition pathways for a UK low carbon electricity future. *Energy Policy* 52.
- Foxon, T.J., 2013b. Responding to the financial crisis: Need for new economics. *Environmental Innovation and Societal Transitions*. Vol 6 126-128.
- Foxon, T.J., 2015. Rationale for policy interventions in sustainability transitions. Conference paper for 6th International Sustainability Transitions Conference. SPRU.
- Foxon, T.J., 2018. *Energy and Economic Growth: Why we need a new pathway to prosperity*. Routledge. London.
- Fullwiller, S., 2016. "Sustainable Finance" in *Routledge Handbook of Social and Sustainable Finance* ed. Lehner, O.M. Routledge Handbooks Online.
- Geddes, A., Schmidt, T., & Steffen, B., 2018. The multiple roles of state investment banks in low-carbon energy finance: An analysis of Australia, the UK and Germany. *Energy Policy*. 115 158-170.
- Geels, F.W., 2002. Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Research Policy*, 31(8), pp.1257–1274.
- Geels, F.W., 2004. From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Research Policy*. Vol 33.
- Geels, F.W., 2011. The multi-level perspective on sustainability transitions: responses to seven criticisms. *Environmental Innovation and Societal Transitions*. (1), 24–40.
- Geels, F.W., 2010. Ontologies, socio-technical transitions (to sustainability) and the multi-level perspective. *Research Policy*. 39 (4) 495-510.

- Geels, F.W., 2013. The impact of the financial-economic crisis on sustainability transitions: Financial investment, governance and public discourse. *Environmental Innovation and Societal Transitions*. 6 67-95.
- Geels, F.W., Sovacool, B.K., Schwanen, T., and Sorrell, S., (2017). Sociotechnical transitions for deep decarbonisation. *Science* Vol 357., Issue 6357, 1242-1244
- Geels, F. W. and J. Schot (2007). Typology of sociotechnical transition pathways. *Research Policy*. 36(3): 399-417.
- Gerschenkron, A., 1962. *Economic Backwardness in Historical Perspective: A book of essays*. Harvard University Press. Cambridge, MA.
- Gevorkyan, A., Flaherty, M., Heine, D., Mazzucato, M., Radpour, S., and Semmler, W., 2016. *Financing Climate Policies through Carbon Taxation and Climate Bonds – Theory and Empirics*. New School of Economics.
- Goodall, A.H. 2008. Why Have the Leading Journals in Management (and Other Social Sciences) Failed to Respond to Climate Change? *Journal of Management Inquiry*. Vol 17 (4) 408-420.
- Gower, R., Pearce, C., and Raworth, K., 2012. Left behind by the G20: How inequality and environmental degradation threaten to exclude poor people from the benefits of economic growth. *Oxfam Policy and Practice: Agriculture, Food and Land*. Vol. 12 (1) 35-80
- Gramsci, A., 1971. *Selections from the Prison Notebooks*. Lawrence and Wishart. London.
- Granoff, I., Ryan Hogarth, J., & Miller, A., 2016. Nested barriers to low-carbon infrastructure development. *Nature Climate Change*. Vol 6 1065-1071
- Gray, R., 2010. Is Accounting for Sustainability actually accounting for sustainability .. and how would we know? An exploration of narratives of organisations and the planet. *Accounting, Organisations and Society*. Vol 35 (1) 47-62
- Griffith-Jones, S., Ocampo, J.A., and Stiglitz, A.J., 2010. *Time for a Visible Hand. Lessons from the 2008 World Financial Crisis*. Oxford University Press.
- Hafner, S., James, O., and Jones, A., 2019. A Scoping Review of Barriers to Investment in Climate Change Solutions. *Sustainability* 2019 Vol. 11 3201
- Hall, S., Foxon, T.J., & Bolton, R., 2016. Investing in low-carbon transitions: energy finance as an adaptive market. *Climate Policy*. 2-19.
- Hekkert, M.P., Suurs, R.A.A., Negro, S.O., Kuhlmann, S., Smits, R.E.H.M., 2007. Functions of innovation systems: a new approach for analysing technological change. *Technological Forecasting & Social Change* 74, 413–432.
- IPCC (Intergovernmental Panel on Climate Change), 2018. *Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty*. WMO and UNEP.
- Jacobs, M., 2012. *Green growth: Economic Theory and Political Discourse*. Centre for Climate Change Economics and Policy. Working Paper No. 108.
- Jacobs, M., & Mazzucato, M., 2016. *Rethinking Capitalism*. Wiley Blackwell. United Kingdom.
- Kemp, R., van Lente, H., 2011. The dual challenge of sustainability transitions. *Environmental Innovation and Societal Transition*. Vol 1(1) 121-124.
- Kivimaa, P., & Kern, F., 2016. Creative destruction or mere niche support? Innovation policy mixes for sustainability transitions. *Research Policy*. Vol 45 (1) 205-217.
- Knafo, S., Dutta, S.J., Lane, R., & Wyn-Jones, S., 2018. The Managerial Lineages of Neoliberalism. *New Political Economy*. 1-17
- Knafo, S., & Dutta, S., 2016. Patient capital in the age of financialised managerialism. *Socio-Economic Review*. 14 (4) 771-788.
- Köhler, J. et al. (2019) 'An agenda for sustainability transitions research: State of the art and future directions', *Environmental Innovation and Societal Transitions*. Elsevier. doi: 10.1016/J.EIST.2019.01.004.

- Köhn, D. (ed), 2012. *Greening the Financial Sector: How to Mainstream Environmental Finance in Developing Countries*. Springer.
- Labatt, S., and White, R.R., 2002. *Environmental Finance. A Guide to Environmental Risk Assessment and Financial Products*. Wiley Finance. New Jersey.
- Lagoarde-Segot, T., 2015. Diversifying finance research: From financialization to sustainability. *International Review of Financial Analysis*. 39, 1–6.
- Lagoarde-Segot, T., & Paraque, B., 2017. Sustainability and the reconstruction of academic finance. *Research in International Business and Finance*. 39 657-662.
- Lagoarde-Segot, T., 2018. Sustainable Finance. A critical realist perspective. *Research in International Business and Finance*.
- Lazarus, R.J., 2008. Super Wicked Problems and climate change: Restraining the present to liberate the future. *Cornell Law Review*. 94 1153 (2008-2009)
- Lehner, O.M., 2016. *Routledge Handbook of Social and Sustainable Finance*. Routledge Taylor and Francis Group. London and New York.
- Loorbach, D., Frantzeskaki, N., and Avelino, F., (2017). "Sustainability Transitions Research: Transforming Science and Practice for Societal Change". *Annual Review of Environment and Resources*, 2017, Vol.42, 599-626
- Loorbach, D., and Huffenreuter, R.L., 2013. Exploring the economic crisis from a transitions management perspective. *Environmental Innovation and Societal Transitions*. Vol 6 35-46.
- Louw, A., 2018. *Clean Energy Investment Trends, 2017*. Bloomberg New Energy Finance. New York.
- Mathews, J.A., 2015. *Greening of capitalism: How Asia is driving the next green transformation*. Stanford University Press. Stanford.
- Mazzucato, M., 2013. Finance, innovation and growth: Finance for creative destruction vs. destructive creation. *Industrial and Corporate Change*. 22 (4) 869-890
- Mazzucato, M., 2014. *The Entrepreneurial State: Debunking Public vs Private Sector Myths*. Anthem Press. London.
- Mazzucato, M., 2018. *The Value of Everything: Making and Taking in the Global Economy*. Allen Lane. Milton Keynes
- Mazzucato, M., & Penna, C., 2016. *Mission-oriented finance for innovation: New ideas for Investment Led Growth*. Policy Network. London.
- Mazzucato, M., & Semieniuk, G., 2018. Financing Renewable Energy: Who is financing what and why it matters. *Technological Forecasting and Social Change*. 127 8-22.
- McKibben, B., 2018. At last, divestment is hitting the fossil fuel industry where it hurts. Article in *The Guardian*: <https://www.theguardian.com/commentisfree/2018/dec/16/divestment-fossil-fuel-industry-trillions-dollars-investments-carbon>
- Mersmann, F., Wehnert, T., Gopel, A., Arens, S., & Orsolya, U., 2014. *Shifting Paradigms: Unpacking Transformation for Climate Action*. Wuppertal Institute.
- Minsky, H. 1986. *Stabilising an Unstable Economy*. Yale University Press. New Haven and London.
- Mohamed, N., 2018. *Sustainability Transitions in South Africa*. Routledge Taylor. London and New York.
- Mohamed, S., 2014. Banking and Credit Markets. In Bhorat, H., Hirsch, A., Kanbur, R., and Ncube, M., (eds), *The Oxford Companion to the Economics of South Africa* (Chapter 20). Oxford University Press. London.
- Monasterolo, I., Roventini, A., and Foxon, T.J., 2019. Uncertainty of climate policies and implications for economics and finance: An evolutionary economics approach. *Ecological Economics*. Vol 163 C 177-182.
- Naidoo, C.P., Amin, A., Jaramillo, M., & Dimsdale, T., 2014. Strategic national approaches to climate finance. *Third Generation Environmentalism (E3G)*. London.
- Naidoo, C.P., 2019. Transitioning South Africa's finance system towards sustainability. In Mohamed, N., (eds), *Sustainability Transitions in South Africa* (Chapter 6). Routledge. London.
- Nerini, F.F., Sovacool, B.K., Hughes, N., Cozzi, L., Cosgrave, M.H., Tavoni, M., Tomei, J., Zerriffi, H., and

- Milligan, B., 2019. Connecting climate action with other Sustainable Development Goals. *Nature Sustainability*.
- Newell, P., 2014. Civil Society, Corporate Accountability and the Politics of Climate Change. *Global Environmental Politics*. Vol 8 (3) 122-153.
- Orléan, A., 2014. *The Empire of Value: A New Foundation for Economics*. Translated by DeBevoise, M.B. Massachusetts Institute of Technology. Cambridge, MA.
- O'Sullivan, M., (2005). Finance and Innovation. In Fagerberg, J., Mowery, D. and Nelson, R.R. (eds.), *The Oxford Handbook of Innovation* (Chapter 6). Oxford University Press. Oxford.
- O'Riordan, T., 2013. Sustainability for Wellbeing. *Environmental Innovation and Societal Transitions*. Vol 6 24-34.
- Pathania, R., & Bose, A., 2014. An Analysis of the role of finance in energy transitions. *Journal of Sustainable Finance and Investment*. 3 266-271.
- Patenaude, G. 2011. Climate change diffusion: While the world tips, business schools lag. *Global Environmental Change*. 21 (1) 259-271.
- Perez, C., 2002. *Technological Revolutions and Financial Capital: The Dynamics of Bubbles and Golden Ages*. Edward Elgar. United Kingdom.
- Perez, C., 2013. Unleashing a golden age after the financial collapse: Drawing lessons from history. *Environmental Innovation and Societal Transitions*. 6 9-23.
- Perez, C., 2016. Capitalism, Technology and a Green Global Golden Age: The role of history in helping to shape the future. In Jacobs, M., & Mazzucato, M., 2016 (Eds) *Rethinking Capitalism* (Chapter 11). Wiley Blackwell. United Kingdom.
- Peterson, J., Pearce, P.F., Ferguson, L.A. and Langford, C.A. 2016. Understanding Scoping Reviews: Definition, purpose and process. *Journal of American Association of Nurse Practitioners*. United States.
- Polzin, F, Sanders, M., and Täube, F., 2017. A diverse and resilient financial system for investments in the energy transition. *Current Opinion in Environmental Sustainability*. 28 24-32.
- PwC, 2017. Asset and Wealth Management Revolution: Embracing Exponential Change. <https://press.pwc.com/News-releases/global-assets-under-management-set-to-rise-to--145.4-trillion-by-2025/s/e236a113-5115-4421-9c75-77191733f15f>
- Ramiah, V., and Gregoriou, G.N., 2016. *Handbook of Environmental and Sustainable Finance*. Academic Press.
- Raven, R.P.J.M., and Verbong, G.P.J., 2009. Boundary crossing innovations: case studies from the energy domain. *Technology & Society*. 31, 85–93
- Raworth, K., 2017. *Doughnut Economics: Seven Ways to Think like a 21st Century Economist*. Random House Business Books. London.
- Reinhardt, C.M., and Rogoff, K.S., 2009. *This Time is Different: Eight Centuries of Financial Folly*. Princeton University Press. Princeton and Oxford.
- Rip, A., 2006. A co-evolutionary approach to reflexive governance – and its ironies. In Voß, J.P., Bauknecht, D., & Kemp, R. (Eds.), 2006. *Reflexive governance for sustainable development*. Edward Elgar Publishing.
- Röpke, I., 2017. Sustainability and the Governance of the Financial System: What role for full reserve banking? *Environmental Policy and Governance*. Vol 27 (3) 177-192.
- Rotmans, J., Kemp, R., and Van Asselt, M., 2001. More evolution than revolution: transition management in public policy. *Foresight* 3, 15–31
- Roubini, N., and Mihm, S., 2010. *Crisis Economics. A Crash Course in the Future of Finance*. The Penguin Press.
- Ryszawska, B., 2016. Sustainability transition needs sustainable finance. *Copernician Journal of Finance and Accounting*. Vol 5 (1) 185-194.
- Safarzyńska K., and van den Bergh, J.C.J.M., 2017. Financial stability at risk due to investing rapidly in renewable energy. *Energy Policy*. Vol 108 12-20.
- Schmitz, H., 2015. Green transformation: Is there a fast track? In Scoones, I., Leach, M., & Newell, P.,

- The Politics of Green Transformations (Chapter 11). Routledge. United Kingdom.
- Seyfang, G., & Gilbert-Squires, A., 2019. Move your money? Sustainability Transitions in Regimes and Practices in the UK Retail Banking Sector. *Ecological Economics*. 156 224-235.
- Schot, J., & Steinmueller, W.E., 2018. Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy*. Vol. 47 (9) 1554-1567
- Schumpeter, J.A., 1942. *Capitalism, Socialism and Democracy*. Harper & Brothers. New York.
- Scoones, I., Newell, P., & Leach, M., 2015. The politics of green transformations. In *The Politics of Green Transformations (Chapter 1)*. Routledge. New York.
- Silveira, A., 2015. Nature of Transitions: Implications for low carbon transitions. University of Cambridge Institute for Sustainability Leadership. Working Paper Series on Just Transitions.
- Smith, A., Voß, J-P., and Grin, J., 2010. Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges. *Research Policy* Vol. 39 (4) 435
- Smith, A., & Stirling, A., 2007. Moving outside or inside? Objectification and Reflexivity in the Governance of Socio-technical Systems. *Journal of Environmental Policy and Planning*. Vol 9 351-373.
- Sorrell, S., 2018. Explaining sociotechnical transitions: A critical realist perspective. *Research Policy*. 47(7) 1267-1282.
- Sovacool, B. K., & Geels, F. W., 2016. Further reflections on the temporality of energy transitions: A response to critics. *Energy Research & Social Science*, 22, 232-237.
- Sovacool, B.K., 2016. How long will it take? Conceptualizing the temporal dynamics of energy transitions. *Energy Research & Social Science*, 13, 202-215
- Spratt, S., 2009. *Development Finance: Debates, dogmas and new directions*. Routledge. London.
- Spratt, S., 2015. Financing green transformations. In *The Politics of Green Transformations (Chapter 10)*. Routledge. New York.
- Spratt, D., and Dunlop, I., 2019. Existential climate-related security risk: A scenario approach. *Breakthrough – National Centre for Climate Restoration*.
- Stern, N., 2018. Public economics as if time matters: Climate change and the dynamics of policy. *Journal of Public Economics*.
- Stirling, A., 2006. Analysis, Participation & Power: justification and closure in participatory multi-criteria analysis. *Land Use Policy*. Vol 23.
- Stolbova, V., Monasterolo, I., & Battiston, S., 2018. A Financial Macro-Network Approach to Climate Policy Evaluation. *Ecological Economics*. 149 239-253.
- Sun, W., Louche, C., & Perez, R., 2011. Finance and Sustainability: Exploring the Reality we are making. In *Finance and Sustainability: Towards a New Paradigm? A Post Crisis Agenda 2011*. 3-15. Emerald Group Publishing.
- Svensson, O., and Nikoleris, A., 2018. Structure Reconsidered: Towards new foundations of explanation transitions theory. *Research Policy*. Vol 47 (2) 462-473.
- Swilling, M. and Annecke, E., 2006. *Just transitions: explorations of sustainability in an unfair world*. UCT Press. South Africa.
- Swilling, M., 2013. Economic Crisis, long waves, and the sustainability transition: An African Perspective. *Environmental Innovation and Societal Transitions*. 6 96-115.
- Tooze, A., 2019. Why Central Banks Need to Step Up on Global Warning. *Foreign Policy*.
- Turner, A., 2016. *Between Debt and the Devil: Money, credit and fixing global finance*. Princeton University Press. Princeton and Oxford.
- UN (United Nations), 1972. *Declaration of the United Nations Conference on the Human Environment*. United Nations.
- UN (United Nations Framework Convention on Climate Change), 2015a. *The Paris Agreement*. United Nations.
- UN (United Nations), 2015b. *The 2030 Agenda for Sustainable Development*. United Nations.
- UN (United Nations), 2015c. *Addis Ababa Action Agenda of the Third International Conference on Financing for Development*. United Nations.

- UN, 2017. Roadmap for a Sustainable Financial System. UN Environment.
- UN (United Nations Environment Programme's Inquiry into the Design of a Sustainable Finance System), 2018. Making Waves: Aligning the Financial System with Sustainable Development. United Nations Environment Programme.
- Unruh, G.C., 2002. Escaping Carbon Lock-in. *Energy Policy*. Vol. 30 (4) 317-325.
- Urban, M., and Wójcik, D., 2019. Dirty Banking: Probing the gap in sustainable finance. *Sustainability (Switzerland)*. Vol 11 (6)
- Van der Ploeg, R., and Withagen, C., 2013. Green Growth, Green Paradox and the Global Economic Crisis. *Environmental Innovation and Societal Transitions*. Vol 6) 116-119.
- Vergragt, P.J., 2013. A possible way out of the combined economic-sustainability crisis. *Environmental Innovation and Societal Transitions*. 22 7-12.
- Volz, U, Bohnke, J., Eidt, V., Knierim, K., Richert., & Roeber, G., 2015. Financing the Green Transformation – How to Make Green Finance Work in Indonesia. Palgrave-Macmillan. Basingstoke.
- Voß, J.P., Smith, A., & Grin, J., 2009. Designing long term policy: rethinking transition management. *Policy Sciences*. Vol 42.
- WCED (World Commission on Environment and Development), 1987. *Our Common Future*. Oslo.
- Weber, M., & Rohracher, H., 2012. Legimitising research, technology and innovation policies for transformative change. *Research Policy*. 41 1037-1047.
- WEF (World Economic Forum), 2017. *The Global Risk Report*. 12th Edition. World Economic Forum. Geneva.
- Werner, R.A., 2014. How do banks create money, and why can other firms not do the same? An explanation for the coexistence of lending and deposit-taking. *International Review of Financial Analysis*. Vol 36 71-77
- Witt, U., 2013. The crisis behind the crisis. *Environmental Innovation and Societal Transitions*. 6 120-122.
- Wright, H., Hawkins, J., Orozco, D., and Mabey, N., 2018. Banking on reform: Aligning development banks with the Paris Climate Agreement. E3G. London.

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