Nordregio

Discussion Paper: A conceptual review on the systems perspectives on green innovation

Project	Systems perspectives on Green Innovation (GRINGO)
Programme:	Thematic Group for Green, Innovative and Resilient Regions 2021-2024
Researchers:	Mari Wøien Meijer, Alberto Giacometti & Hilma Salonen
Date:	2022-09-15

OBJ

Table of Contents

Preface

This discussion paper is the outcome of the first phase of the Systems perspectives on Green Innovation (GRINGO) project, which aims at uncovering existing bottlenecks to innovation that may impede change and the green transition, from a systemic perspective. This phase explored key concepts, their application, and their theoretical and policy traditions. The second phase will consist of an empirical study through sectoral case studies in the Nordic countries. This discussion paper is meant as an open invitation to discuss the conceptual and theoretical foundations and the empirical approaches for studying green innovation. This should help us tailor the design of the methodological approach to study it empirically.

In its action plan, the Nordic Council of Ministers states that it "will support knowledge and innovation and make it easier for companies throughout the Nordic Region to take full advantage of the development opportunities created by the green, technological, and digital transformation and the growing bioeconomy." Furthermore, one of the goals in the Regional Sector Action Plan is to Investigate smart specialisation strategies in the Nordic Region and their potential in enabling the green transition. This research project, carried out by Nordregio on behalf of the Nordic Thematic Group for Green, Innovative and Resilient Regions 2021-2024, contributes towards these goals.

To uncover the bottlenecks preventing industries or sectors to undergo green transitions, we investigate the link between agency and innovation. Particularly, the role of different agents and actors in driving transition processes, and the way in which policies and framework conditions impact green transition changes in sectors/businesses across the Nordic Region. The point of departure will be businesses, and their role as change agents in the broader context of the green transition in specific innovative sectors. The policies and framework conditions may refer to e.g., national, and regional innovation policies such as smart specialisation strategies and regulations, but also to opportunity spaces for innovation, and individual action.

Key project objectives:

A. To understand the role of businesses as change agents in green transitions.

B. To understand how systems and place-based innovation policies influence transformative processes within sectors.

C. To understand bottlenecks to innovative change needs to be addressed to facilitate green transitions in three different sectors determined later.

Introduction

This paper is written in the context of the GRINGO project which explores the role of different agents in green innovation. It conceptualizes the terms 'systems', 'innovation' and 'green' and reviews them in the context of 'green transition'. We begin by considering 'systems' through the lens of innovation and its different manifestations, and then expand upon place-based innovation, tapping into the vast contributions of economic geography literature in innovation studies, as well as innovation-based green transition of economic and social systems as understood within transition literature. These different interpretations of innovation offer us insight into how policies have been framed and changed over time. Interpretations have evolved from understanding innovation mainly as an economic driver, to acknowledging its systemic nature, finally, transcending purely economic aspirations to include social goals. We conclude with an overview of the current policy climate surrounding green transitions, which emerges from this expected potential of innovation policy in addressing the complex societal and environmental challenges of today. This ambition is translated into transformative innovation policies and missions-oriented innovation policies. This paper will serve as the baseline for upcoming empirical work.

Innovation systems theory

Nelson and Rosenberg (1993, p. 4) define innovation as the new processes and product designs that businesses have mastered and put into practice, or that otherwise are commercialised. Cooke et al (1997) critique this definition as too narrow, especially as it only considers *productive* companies, and argue for a broader understanding of innovation. Innovation, they argue, implies a wider systemic concept, which comprises the ways in which actors, organisations and behaviour connect, and the relationship between these. Moreover, they argue that "systemic innovation [...] implies the loose coupling of subsystems" (Cooke, Gomez Uranga, & Extebarria, 1997), which essentially mean that a system of innovation is a system that encapsulates a myriad of other smaller systems, and does not exist on its own. Moreover, innovation systems are "open, dynamic, and social" (Carayannis, Samara, & Bakouros, 2015, p. 107), and should not be considered separate from the interaction occurring between people. In this way, the use of 'systems' should be taken as explaining interactivity between actors, rather than solely as some form of linear knowledge transfer (Carayannis, Samara, & Bakouros, 2015; Lundvall, 1992 [2010]).

Innovation policy and economic development

At the end of the 20th century, Nelson and Winter (1977) conceptualised innovation policy as being forged on two premises: The first rests on the unquestionable premise that "technological advance has been a powerful instrument of human progress" and the second, more presumptuous premise, was that policy makers and key actors have sufficient knowledge to guide technology towards achieving "high priority objectives" in the future (Nelson & Winter, 1977, p. 38). However, then, as now, the situation is more complex. The same authors argue that "the key policy problem will be to augment or redesign institutions rather than to achieve particular resource allocation per se" (Nelson & Winter, 1977, p. 40). In 1977, Nelson and Winter recognise that innovation is not one thing, and both varies and is rather complex within each economic sector. Innovation, Nelson, and Winter write, is uncertain in an essential way, and that the "explicit recognition of uncertainty is important in thinking about policy" (Nelson & Winter, 1977, p. 47). Furthermore, Schumpeter writes in 1942:

> *"Every piece of business strategy acquires its true significance only against the background of that process and within the situation created by it. It must be seen in its role in the perennial gale of creative destruction; it cannot be understood irrespective of it or, in fact, on the hypothesis that there is a perennial lull"* (Schumpeter, 1942: 73)

The Austrian-German economist, Joseph Schumpeter, laid the foundation for modern theories of business and entrepreneurship in the early to mid-20th Century. His work can be divided in two: *Theory of Economic Development* (1934) and his later work *Capitalism, Socialism and Democracy* (1942). The first theory is concerned with an increasingly 'widening' understanding of innovation and innovative activity, whereby the entry in a new industry was characterised by relative (technological) ease, and where entrepreneurs challenged established businesses within the industry, with their new ideas, processes, or products in a process of constant disruption (Schumpeter 1934 in Malerba & Orsenigo, 1995). By 1942, Schumpeter had 'deepened' his theory of innovation (Malerba & Orsenigo, 1995), launching the term 'creative destruction' aided by capitalism, whereby

> *"the process of industrial mutation that incessantly revolutionizes the economic structure from within, incessantly destroying the old one, incessantly creating a new one. This process of Creative Destruction is the essential fact about capitalism. It is what capitalism consists in and what every capitalist concern has got to live in."* (Schumpeter, 1942 (2010), p. 73).

Based on their empirical results, Malerba & Orsenigo (1995) argue that there is support for this 'deeper' understanding of innovation as set out by Schumpeter in 1942, especially when seen in light of innovation patterns in advanced economies in the 1990s, though the nature of innovation activities varies across technologies, and therefore the dominant technological regime. Moreover, *stability* is emerging as a "feature of the patterns of innovative activity", as technological performance continues to be reliant on "a stable group of innovators", generally in larger businesses. This, Malerba & Orsenigo (1995) write, has implications for the theoretical analysis and policy writing, as it begs greater emphasis on the necessary analysis of innovation activities as they unfold in a dynamic context. Regarding policy, they contain that policymakers should primarily be concerned with creating conditions for the aforementioned 'stable group of innovators' – i.e., stability – as a crucial compliment to policies concerning innovation in new, but smaller businesses.

A theory of innovation and the subsequent institutional policy development must therefore understand the nature of innovation as evolutionary, and against the structural backdrop within which it dwells, as well as having significant room for organisational complexity, according to these authors (Nelson & Winter, 1977; Schumpeter, 1942 (2010)). For innovation, it is essential that the present time, institutions, and organisation for which (and within which) policy is developed, are considered necessary tenets of knowledge for understanding and creating appropriate innovation policy instruments. If capitalism, and innovation as the force driving economic growth forward, are inherently evolutionary, as first identified by Karl Marx, policy and institutions must follow: "Capitalism, then, is by nature a form or method of economic change and not only never is but never can be stationary" (Schumpeter, 1942 (2010), p. 73). Moreover, capitalism is not merely conditioned within social and natural environments, but also comes from inventions, radical innovation, public sector innovation as well as innovation in goods and services (Schumpeter, 1942).

Innovation systems

The 'innovation systems' concept stems from the assumption that "innovations do not originate as isolated, discrete phenomena, but are generated by means of the interaction of a number of entities or actors/agents" (Saviotti, 1997, s. 180). In relation to emerging policies such as the European Union's smart specialisation strategies, Asheim (2019) further notes that limiting the understanding of 'entrepreneurial discovery' as a public-private effort ignores "the systemic nature of innovation as interactive learning involving a number of stakeholders". These actors and their interactions, Saviotti (1997: 180) writes, conserve certain features over time and in many cases behave as a whole. This, applies to national, regional, sectoral, or technological innovation systems. Regardless of the level of

aggregation, be it country, region, industrial sector, or technology, the key consideration under the systems approach "is that innovations are generated not only by individuals, organisations, and institutions, but by their, often complex, patterns of interactions" (Saviotti, 1997, s. 180).

Asheim and Coenen (2006, p. 166) claim that a systems approach to innovation sheds the understanding that "innovations are carried out through a network of various actors underpinned by an institutional framework". Saviotti (1997) critiques traditional growth theories for being largely a-institutional and emphasises that "institutional and organisational configurations are important determinants of economic development and growth" (Saviotti, 1997: 180). Therefore, Saviotti concludes that the "historical specificity and the institutional nature of national systems of innovation cannot be predicted or explained by traditional economic theories" (Saviotti 1997:180). Like Nelson and Winter observed (1977), the role of normative institutions matters for innovation policy development, and with regards to innovation systems, they are tightly interlinked through time, context, and the agents that carry innovation systems forward.

Space and place in innovation theory

The spatial role and dimension in innovation has been discussed in literature for years (Porter M. , 1998; Asheim & Coenen, 2005; Audrecht & Feldman, 1996; Freeman, 1995). With the increased pace of globalisation however, the role of geography in innovation has been questioned. Globalisation has played a significant role for evening out the world by means of free trade, and better access to products, services, and potential new collaborative partners (Friedman, 2005). Seen from a technological and sectoral/industrial systems lens, Carlsson and Stankiewicz (1991) wrote in the early 1990s that innovation is essentially place-less. Friedman followed this argument and stated that globalisation means the "end of geography as we know it" and ultimately leads to "the death of distance". This has been heavily debated since (Rodríguez-Pose & Crescenzi, 2008).

In their paper *On the nature, function and composition of technological systems*, Carlsson & Stankiewicz (1991) write that a country's development potential, as part of a wider technological system, is reflected in its economic growth – closely tying innovation theory to economic growth theories. **Technological systems of innovation** are defined as "a network of agents interacting in a specific *economic/industrial area* under a particular *institutional infrastructure* or set of infrastructures and involved in the generation, diffusion, and utilization of technology" (Carlsson & Stankiewicz, 1991, p. 111). They are defined by knowledge and competence rather than by goods and services, and by technology and its techno-industrial area, rather than by national borders. Technological systems bring with them institutional infrastructures; a regime/organisation that "support, stimulate and regulate the process of innovation and diffusion of technology" (1991, p. 109). By institutional structures, Carlsson & Stankiewicz mean "the normative structures which promote stable patterns of social interactions/transactions necessary for the performance of vital societal functions. Institutions reduce social uncertainty and prevent or mitigate conflicts between different value systems (...) Crucial for the survival and effectiveness of institutions is their legitimacy" (1991, p. 109). Although technological systems are conceptualised independently from geographical boundaries, they are nevertheless characterised in relation to economic systems, formal and informal institutions, networks, and proximity, which in turn are largely place bound.

Technological systems of innovation are closely linked to **sectoral systems of innovation**. A sectoral system of innovation is also a network of agents, but agents operating within specific technological areas, and in a specific institutional context (Carlsson & Stankiewicz, 1991). Moreover, Breschi and Malerba (1997) write that in sectoral systems of innovation, clusters of firms and industries are involved in the generation and diffusion of technologies, and that the knowledge flows between these actors and learning from the new technologies employed are at play. The relationships between and

across industries are important factors for the analysis of sectoral innovation systems (Carayannis, Samara, & Bakouros, 2015).

Boschma (2005) corroborates both Carlsson and Stankiewicz' (1991) and Breschi and Malerba's (1997) arguments to some extent, when looking at the role of cognitive proximity vis à vis geographical proximity. His argument is that as tacit knowledge knows no distance, it may be transmitted by other means than geographical location (Boschma, 2005). In this line, geographical proximity has a stronger, complimentary role when it comes to strengthening and building institutional or social proximity. The assumption is that if there is cognitive proximity, i.e., shared ideas and understandings, geography plays a minor role (ibid). By 'proximity' Boschma refers to the ability to understand, adopt, and adapt, to identify novelty, interpret, and exploit new knowledge. Boschma's five proximity dimensions are: geographical proximity; cognitive proximity; organisational proximity; social proximity; and institutional proximity. Boschma argues that too much and too little 'proximity' is harmful to learning and innovation and that effective interactive learning and innovations require an absorptive capacity in businesses and institutions demonstrating openness to new ideas (Boschma, 2005). These proximities are mutually reinforcing, when it comes to 'learning' as part of economic development (Hansen, 2015).

Audrecht and Feldman (1996) maintain that location matters, especially when it comes to transmitting tacit knowledge versus transmitting information, which in turn may explain why some industries have clustered geographically. Rodríguez-Pose and Crescenzi (2008) further argue that although rapid technological development is supporting the idea of the death of distance, globalisation implies changes, opportunities, and threats and "not all territories across the world have the same capacity and tools to make the world an even playing field" (Rodríguez-Pose and Crescenzi, 2008, p. 372). Moreover, it is primarily in metropolitan areas that these different proximities (social, institutional, cognitive, organisational, and geographical) coalesce (Rodríguez-Pose and Crescenzi, 2008). Considering globalisation, the death of distance and the capacity of a 'flatter world' only really work from a generalised macro-perspective, and not in the more granulated details of regional and local development: "Paradoxically," Porter writes "the enduring competitive advantages in a global economy lie increasingly in local things – knowledge, relationships, and motivation that distant rivals cannot match" (Porter M. , 1998). Moreover, the role of proximity in terms of mutual understanding and absorptive capacity among and between actors to find novel niches matters (Boschma, 2005). Geographical dimensions still play a key role in economic analysis, as key social institutions develop within the national, regional, and local space (Freeman, 1995). However, as we have seen, the transmittance of ideas and technology are not dependent upon these defined boundaries. This is particularly interesting in terms of the turn towards global quests for solving grand social challenges. We will discuss this later in this paper.

National innovation systems came around as a response to questions on the role of 'home ground' in relation to globalisation (Cooke, Gomez Uranga, & Extebarria, 1997). Freeman (1995) investigated this in relation to transnational and multinational companies. He writes that even if you cannot ignore the role of 'global' demands, there are still a vast number of products and services where the local, regional, and national institutions, climate and preferences play a key role. Moreover, these institutions, often considered a hampering factor in relation to innovation, are also the source of change. As Freeman points out, the role of the nation, or the state to be more accurate, has been around for centuries (1995). Friedrich List (1854) commented on the industrial catch up between Germany and the United Kingdom in the 19th century, showing that learning from others by adopting and adapting good practices, relying on reverse engineering, and creating training and education systems to support change in many instances was supported by the German government – as the

government was the only actor, and still often *is* the only actor, that can afford to fund massive social changes. Considering the grand societal challenges that the global society is currently facing, this role of the state may still seem to ring true. Or at least, the state plays a key role in the policy design premises on which grand societal challenges are meant to be addressed.

Another interesting question arising from this is the role of the region. More specifically, "whether the organisation of innovation within nations [is] evolving in new ways" (Cooke, Gomez Uranga, & Extebarria, 1997) and the extent to which the national level is the appropriate lens from which to analyse innovation, and the role of globalisation. However, it is equally interesting to investigate the role of the region in addressing grand social challenges and e.g., green transition through innovation**.** This requires an understanding of what **regional innovation systems** (RIS) are. According to Cooke et al. (1997), a regional innovation system defines the ways in which innovation subsystems are connected. This is particularly interesting when looking at innovation processes, as the complexity and non-linearity of such connections underpins national systems a lower level (Freeman, 1995; Cooke, Gomez Uranga, & Extebarria, 1997).

Considering the aspect of learning, Asheim & Coenen (2005) conceptualised region innovation systems as "regional clusters surrounded by supporting knowledge organisations through regional governance" (Asheim & Coenen, 2005, p. 11). They write that "in a globalising economy characterised by vertical disintegration and distributed knowledge bases, the important perspective ought to be the interdependences between regions and nations, where the deciding criteria must be the location of core activities (and not the whole value chain as such) and the relative importance of their connections to regional knowledge infrastructures" (Asheim & Coenen, 2005, p. 13).

Looking at the linkages between regional innovation systems and clusters, Asheim and Coenen (2005) view regions as sites for innovation and competitiveness in the globalising economy. They draw on the common rationale that territorial agglomeration provides the best context for an innovation-based globalising economy because of localised learning processes and 'sticky' knowledge grounded in social interaction (Asheim and Coenen 2005, p. 1174). At the same time, the authors acknowledge RIS to be embedded in national and global systems. In their words: "interacting knowledge generation and exploitation subsystems [are] linked to global, national, and other regional systems" (ibid. p. 1174).

This connects to the research focus in Cooke et al. (1997) through knowledge infrastructures and its surrounding features. For Cooke et al (1997), "strengthening of regional level capacities" for promoting learning and innovation is crucial, as the key features of a regional innovation system is centred upon financial capacity, productive culture (embeddedness) and institutionalised learning (access to knowledge), without which regional knowledge infrastructures cannot be supported. However, it must be differentiated, and literature on regional innovation systems have built a significant empirical evidence-based against *'one-size-fits-all'* models (Asheim & Coenen, 2005).

According to Grillitsch and Hansen (2019), the interlinkages between innovation and economic geography studies have contributed to an increase in understanding on 1) the spatial embeddedness of innovation processes, and 2) how innovation systems approaches can inform regional policy to assist industry development. A basic assumption is that preconditions for innovation and new industry development vary in different regions. Based on this, Grillitsch and Hansen (2019) note that literature increasingly focuses on the potential for differentiated pathways of innovation in different types of regions.

Grillitsch and Hansen (2019) write that the regional innovation systems approach has added to the substantial empirical evidence on regional differences. This has evolved into a proposal of regional

typologies, which distinguishes between peripheral regions, specialized regions, and metropolitan regions; each of them with their "specific challenges and opportunities for regional development" (ibid). Regional typologies have been grounded on (1) actors and governance; (2) the strengths in radical versus incremental innovations; and (3) RIS failures (ibid). The authors note that RIS failures has been the central argument for proposing new industrial path development (Grillitsch & Hansen, 2019).

The difference in innovation capacity between regional typologies lies mainly on the underlying preconditions and support systems for innovation and entrepreneurship (Grillitsch & Hansen, 2019). These are, for instance, the available knowledge generated by universities, research institutes and the possibility to apply or 'exploit' it in economic activity by industries and economic sectors. This often happens through intermediaries such as technological parks and incubators. Thus, besides human capital and networks, other preconditions are necessary in turning knowledge into innovations applicable in markets or in practice generally, such as knowledge intermediaries and entrepreneurial capital, which refers to both competence in business models and access to risk capital. Finally, the social and institutional contexts play a substantial role in shaping entrepreneurial activity (ibid.).

Metropolitan regions most often host a number of universities and a diversity of education programmes and training opportunities. The scale and diversity of knowledge and entrepreneurship allow for the development of multiple related and unrelated industrial specialisations. Specialised regions, instead, often experience some form of positive or negative 'lock-in', which is a self-reinforcing cycle stemming from their strong legacy and dependency on one or a few interrelated industrial activities, where support systems, knowledge and resources are concentrated in few sectors (Grillitsch & Hansen, 2019). On the one hand, this may strengthen their competitive advantage, while on the other hand, weaken their position and ability to adapt when technologies or demand changes. Peripheral regions instead have not reached a critical mass of high value creation and knowledge intensive activities to be considered specialised in any particular industry. In some cases, support systems may even be available, such as universities, but they may not sufficiently trigger industrial development in the region. It may also be the case that innovative businesses are present in peripheral regions but rely on knowledge and networks outside the region (ibid.).

In conclusion, we cannot easily separate between spatial sensitivity and spatial blindness; in many ways, innovation and innovation systems are too complex for compartmentalisation. A strict separation between the two would only shed light on certain aspects of the innovation system, depending on our analytical starting point (structure-agency).

Structure-Agency: Institutions, the public sector and entrepreneurs in innovation policy and theory

The literature on innovation systems generally contributes to the understanding of how innovations occur through networks rather than individuals, as well as highlighting the relevance of institutional frameworks. In this way place-based approaches take the territorial unit rather than the sector as the "lens through which to observe the ways in which different sectors or even clusters interact with the regional governance and innovation support infrastructures as well as the national and global levels" (Cooke et al 1997 p 476). Considering clusters and sectors, and their interaction in place-based (or place-less) settings thus illuminates the role of different agents. Sotarauta & Suvinen (2021) suggest that to study and understand the different types of agency, we inevitably need to learn how they

interlink, what "roles they play in relation to each other" – even outside a geographically bound space, as sectors and clusters do not necessarily rely on the same preconditions for development.

Agents and structures

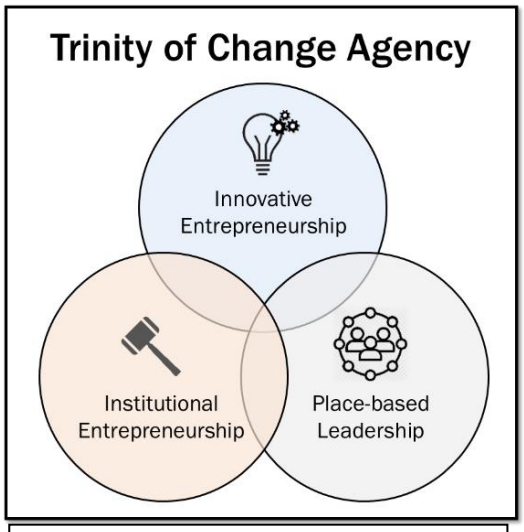
The underlying theoretical discourse in social and political sciences is split between those who argue that structures drive change and those who argue that agency (actors) is the change maker. Söderholm (2020) emphasises that the focus should be on the role of national and local framework conditions (structure), and not only on "individual heroes" (agency) (Söderholm, 2020, p. 9). Giddens' structuration theory provides a more nuanced view by arguing that one cannot be understood without the other (Giddens, 1991). Understanding Giddens' dualism of structures and agency, Jessop (2001) suggests that each should be bracketed to understand the emergence of structures and agency by analysing the position of structures and agents in relation to each other: by bracketing action in relation to structure, and structure in relation to action. This would further point to the modalities of power. The dynamics between modalities of power is crucial for understanding how e.g., policies (structures) and industries or businesses (agents) influence each other.

From the perspective of path development studies, Grillitsch and Sotarauta (2020) critique the "fundamental theoretical debate on structure and agency" and argue that the "blind spot is the role of agency and its relation to structure". They note that both the evolutionary tradition in economic geography, and studies stemming from the institutional theory provide little insight into the micro-level processes that are at work in shaping new development paths (Grillitsch and Sotarauta 2020). Therefore, the authors claim that there is a need to build an evidence base to shed understanding of "what actors do to create and exploit opportunities in given contexts, why they do so in some places and not in others, and why the effects of such efforts differ between apparently similar places". To address this gap, Grillitsch and Sotarauta (2020) suggest a conceptual framework in a more holistic approach to analyse of agency and new regional economic development paths. This framework explains interactions between a wider range of intentional and unintentional actions better and relies on. They argue that there are three types of agency at play in regional path development. These include (Grillitsch & Sotarauta 2020):

I. **Schumpeterian innovative entrepreneurship** whereby *entrepreneurship* is a key instigator of change by triggering industrial and economic transformation.

II. **Institutional entrepreneurship** demonstrating how institutional theory plays a role in explaining how new growth paths necessitate institutional change as they require opportunities and risk-taking institutional entrepreneurship. This is a *second type of transformative agency*.

III. **Place-based leadership** inspired by the border leadership literature but conceived within the framework of city and regional development literature. New paths are not constructed in a vacuum but respond to the nature and exploit of multiple actors. Place-based leadership is crucial for the organisation and pooling of competences to achieve individual objectives and broad-based (regional) goals.



Source: Grillitsch, M. (2021) Lecture in Policy for Green Growth and System Innovation, Lund University

This 'trinity of change agency', as Grillitsch & Sotarauta (2020) argue, better explains how "the three types of agency – separately and in combination – contribute to the emergence of regional growth paths". Therefore, the argument is not centred only on whether structures influence agents or vice versa, but how agents drive transformative change from multiple directions, in a more or less chaotic process that leads to innovation or change in the whole ecosystem.

Entrepreneurs and agency

Schumpeter's theory of entrepreneurship has laid the foundation for understanding creative labour and opportunity recognition. His take on innovation is necessary to understand his writings on entrepreneurship. In Schumpeter's early writings, entrepreneurs were the only relevant and true economic change agent; the 'personification of innovation' (Hagedoorn, 1996). Schumpeter's early understanding of the entrepreneur as both an irrational and rational agent in search of new opportunities, still stands up to scrutiny to some extent. As Sotarauta and Suvinen (2021) write, "entrepreneurs have the will to realise something new to 'map unknown terrain, to move where no-one dared venture before". For Schumpeter, entrepreneurship is, in essence, creative labour (Hagedoorn, 1996).

In Schumpeter's later writings, the entrepreneur as the sole change-agent; the "heroic creative labour of a single individual" (Hagedoorn, 1996, p. 891), disappears. This may be connected to the altered notion of innovation as an increasingly automatised and routinised process due to the emergence of 'trained specialists' (ibid). In this depersonalisation process, entrepreneurial activities are increasingly attributed to businesses engaged in co-operative development, whether internally or with external partners. Innovation is seen as a solely endogenous factor in this process, whereas inventions are happening exogenously. The ability to commercialise inventions becomes the main output. Innovative entrepreneurs, whether understood as single individuals or as businesses, engage in the search for new economic opportunities even if these entail risks (Sotarauta and Suvinen, 2021), exploiting both existing and new ones. In this way, Hagedoorn (1996) writes, "entrepreneurship is not a magic phenomenon or a *deus ex machina* but primarily an endogenous factor that combines the application of innovative capabilities based on tacit knowledge [and] firm specific skills and organisational learning" (Hagedoorn, 1996, pp. 893). It is driven by "(…) competition, change, learning, climate, communications, processes, social interaction between individuals and other external factors" Carayannis et al (2015) writes, pointing to Schumpeter's later writings on entrepreneurship as skills possessed in a larger, co-operative structure.

Entrepreneurship and innovation processes are by nature hard to define, as they are inheretly based on uncertainty and the ability to creatively exploit ideas. However, the pursuit of finding a distrinctive theory of entrepreneurship is still ongoing. According to Phan (2004, p. 617) this search for a cohesive theory is much due to the "phenomenological nature of extant work", which seem to be tied to our present understanding of entrepreneurship as closely tied to entrepreneur pshycologies, network economics and innovation. These prevailing understandings of entrepreneurship are also often tied to context, whether organisational or sociological, or as a typology of certain behavioural patterns (Phan, 2004).

Yet, the idea of what and who an entrepreneur is very much dependent on our language, interpretation of the world and the way we frame 'entrepreneur'. Capturing *who* entrepreneurs are cannot be separated from the context in which they operate (Ramoglou, Gartner, & Tsang, 2020). Due to the constantly changing contexts it is clear that a theory of entrepreneurship must consider external factos (e.g., institutional structures and context, culture, the political economy etc.; Carayannis et al, 2015). Moreover, the identity of an entrepreneur is, is entirely the wrong question

as it presupposes an individual trait, or even specific genetics in some cases, and neglects that "entrepreneurs exercise a widely held human potential" (Ramoglou, Gartner, & Tsang, 2020, p. 4). As previsouly stated: entrepreneurship is creative labour.

Entrepreneurship is, according to Ramoglou et al., tied to human agency: humans do not simply spontaneously respond to external triggers, but rather exercise their agency when responding (2020, p. 3). When refraining from conflating the factual (i.e. outcome) from a conceptual (i.e. language and semantic) understanding of entrepreneurs, it is clear that entrepreneurs are those that exercise their agency at the right time. They do not harbour 'deeply held secrets', but are simply able to reframe old ideas in new ways wihtin their context: "worldviews are not rooted in genes, but in grammar", as Ramoglou et al contains (2020, p. 4). Moreover, it may happen on a variety of levels, perhaps even leading to the need to understand innovaiton and agency through a multilevel analysis (Phan, 2004).

The way entrepreneurship is understood and conceptualised in policy and practice impacts entrepreneurs' ability to act. According to Sotarauta and Suvinen (2021), entrepreneurs require certain preconditions, such as capital, well-functioning capital markets, legal arrangements, and skilled labour. This may require framing policy making strategically, beyond fixing 'market failures' and resource allocation by setting a direction in which co-creation and co-shaping the economy is done in tandem with key market actors. This is what Grillitsch and Sotarauta (2020) refer to as the second type of agency – institutional entrepreneurship – which entails moulding institutions to become risk-taking and opportunity oriented with the intentional objective of influencing new industrial development or path creation.

But even here, the framing of opportunities plays a central role, and connecting back to the importance of context: institutional infrastructures certainly matter. Entrepreneurial discoveries, and enabling them, depend on the ability of actors to work together on optimising both formal and informal institutions (Sotarauta & Suvinen, 2021). Seeing this in light of the structure-agency debate, it is clear that change agents are needed both to enable and ensure change in a constantly and mutually reinforcing mechanism. It is systemic.

Institutions and the rules of the game

According to Rodriguez-Pose (2013), analyses of institutions "abandon the more rationalistic 'game-theoretic' approach of the new institutional economics and embrace a position in which institutions not only shape, but also are shaped by the environment" (2013, p. 1037). Although institutions share common features across territories, they are to a significant extent place specific (ibid.). Institutions are commonly understood as "the rules of the game in a society; and more formally, as the humanly devised constraints that shape human interaction" (Rodríguez-Pose, 2013; North, 1990). In other words, the interplay between formal (rules, laws, and organisation) and the informal (norms, values, routines) institutions, as well as path dependencies, that generate a distinct institutional environment in a particular territory (Gertler, 1997; Rodríguez-Pose, 2013). Path dependency and 'lock in' are often seen in relation to innovation capacities: here, historical institutionalism (i.e., sequences and time) comes to pass, as innovation is seen to be recreated in the same framework whence it came (Wøien Meijer & Peters, 2021). History is full of examples of path dependencies, path creation and path disruptions (Lema, Nordensvärd, Urban, & Lüktenhorst, 2014).

Rodriguez-Pose (2013) further adds that place-based institutional arrangements often work better at local and regional scales than the national scale, as the latter can 'be too distant and detached' to mobilise actors and organisations effectively. Development strategies and innovation policy need to be tailored to regions' distinct contexts and institutional arrangements to ensure legitimacy.

Institutional legitimacy however depends on the ability of institutions to work as a 'glue for collective action' through their ability to 'reduce uncertainty and transaction costs' (Boschma, 2005, p. 68). This

requires striking the balance of institutional proximity: the "enabling and constraining mechanism effecting knowledge transfer, interactive learning and innovation" (Boschma, 2005, p. 68). Too much proximity may cause inertia due to too few new ideas and a lack of novelty, while too little proximity develops silos: lack of social cohesion and common values between actors, and weak formal institutions. Cooke et al. (1997) adhere to the same principles: "innovation and learning are closely interlinked. There can be no change without previous learning (…)" (Cooke, Gomez Uranga, & Extebarria, 1997, p. 485). For Rodríguez-Pose and Crescenzi (2008): "Local innovative activities not only allow better local economic performance but also produce localized knowledge spillovers whose beneficial effects depend not only on proximity relationships but also on the presence of local institutions (or social filters) enabling their absorption and translation into further economic growth (2008, p. 383).

In the context of change agency, Rodriguez-Pose (2013) argues that both "formal and informal institutions help territories to adjust and react to change, generating a degree of 'adaptive efficiency' that highlights the willingness and capacity of local actors to adopt new knowledge and to engage in innovative and creative activities" (2013, p. 1039). He adds that institutions are a key factor in determining the learning capacity of a region and thereby its ability to adapt to changes (Morgan, 1997 in Rodriguez-Pose, 2013). However, Rodriguez-Pose (2013) notes contradictions and challenges in building institutional arrangements, as there is seemingly no clear agreement which informal and formal institutions are more relevant in driving economic development, nor a way to measure it. What is clear however, is that mutual understanding is key to ensure 'adaptive efficiency' and change. Redesigning or augmenting institutions beyond resource allocation (Nelson & Winter, 1977) to ensure their ability to respond to the evolving nature of innovation (Carayannis, Samara, & Bakouros, 2015), however, remains a problem.

Institutional innovation in the public sector

Three main periods can be distinguished in the literature on the role of the public sector in innovation (Kattel, 2015, pp. 9-19). First is the *Schumpeterian period,* where "innovations and the public sector are related to a larger theory of how evolutionary change takes place in societies" (Kattel, 2015, pp. 9-19). Second is the *organisational-theory period*, where similarities between innovation occurring in the public sector and in private companies are discerned (usually found in early organisational theory (Wilson, 1989; Kattel, 2015). Finally, the *autochthonous-theory* period concerning the trend to "disassociate public and private-sector innovations" (Kattel, 2015, pp. 9-19), returns to the origins.

However, the role of the public sector in innovation, and by extension vis á vis markets, has been widely debated throughout history. In economic theory, the Austrian and Chicago schools of thought placed much emphasis on rational choice and the role of the consumer, embracing monetarism and rejecting Keynesianism, also in macroeconomics. However, if considering markets, capitalism, and competitiveness, it is difficult not to involve the role of the state. Porter (1990) writes in his article *The Competitve Advantage of Nations* that "national prosperity is created, not inhereted" and furthermore that in an increasingly globalised world, nations, or rather countries, have become more important – not less (Porter M. E., 1990, p. 74). As the accumulation of knowledge continues to drive competitive advantage, it has become clear that the fundamental structures of a society and country, such as culture and values, institutional structure, history and economics contribute to competitiveness (Porter M. E., The Competitive Advantage of Nations, 1990). Moreover, "the home nation takes on growing significance because it is the source of the skills and technology that underpin competitive advantage" (Porter, 1990, p. 79).

In more recent years, the state's role in correcting market failures has re-emerged in the debate. There is a host of literature on market failure and the role of the state in correcting them, to minimise the

negative externalities of market failures. Considering the role of state interference in economics, the state is often viewed as a false life support, or as a source of "institutional drag". However, Mariana Mazzucato (2020) argues that we cannot reduce the role of the state into a patchwork of bandages covering market failures. Rather, it ensures that the institutional framework creates a favourable environment by reducing the risk of market failures, by taking the hits in a rather 'risky bump landscape' of innovation and economic growth.

In her book *The Entrepreneurial State*, Mazzucato attempts "to debunk this idea that the private sector has all this risk-taking embedded in it; there are many private companies that do not take risks and are perfectly happy with the status quo" (Mazzucato M. , 2013). She proposes building entrepreneurial ecosystems, thus redefining the relations between public and private sector. This requires public sector innovation, releasing bureaucratic culture from its inflexible organisational structures and their subsequent inertia. Civil servants may be trained to frame policy more strategically, beyond just fixing 'market failures', setting a direction of co-creating and co-shaping the economy together with market actors. This approach is what Grillitsch and Sotarauta (2020) refer to as the second type of agency – institutional entrepreneurship – which entails moulding institutions to become risk-taking and opportunity oriented with the intentional objective of influencing new industrial development or path creation. Mazzucato (2020) criticises, however, that currently, the environment for risk taking within bureaucratic structures is very low, perhaps due to a relatively risk-averse public sector. An emerging policy practice centred on pre-emptive considerations, where learning through mistakes is not encouraged, an impeding development, may be to blame. This is arguably impeding development. Mazzucato (2021) furthermore argues that the public sector must invest in its own capabilities, not to succumb to so-called 'brochurism', in which the 'sexiest brochure' or PowerPoint-presentation produced by for-profit consultancies take precedence, so that facts and expert knowledge matters less than looks. This more strategic or entrepreneurial role of institutions, as considered necessary by Mazzucato (2013; 2021) and Grillitsch and Sotarauta (2020) to establish institutions as a driving force for change with the help of transformative and mission-oriented innovation policies. Seeing it from an entrepreneurial lens, Sotarauta and Suvinen make it abundantly clear that "by definition, institutional entrepreneurs work to change the rules of the game" (Sotarauta & Suvinen 2021).

At sub-national levels, increased pressure falls upon regional actors and governance structures through S3, and other grand policy goals, emphasising the importance of continuously developing institutions (Morgan, 2017). Investigating whether governance structures have changed since the introduction of S3, and how policies reflect the increased focus on green technologies is topical. Exploring them informs us of existing policy feedback-loops and institutional thickness, the role of partnerships, and whether regions involved are 'learning' and adapting to an evolving regional innovation system. Moreover, taking the region as a starting point reinforces the relevance of a spatial dimension in innovation policy.

Innovation policy and transitions in innovation systems

For decades, innovation policy served as a sub-category of economic policy, driving businesses and organisations to become more innovative (Freeman, 1995). However, in the current policy climate innovation is moving beyond this rather one-dimensional conceptualisation. This is particularly evident in the development of the EU-wide concept of smart specialisation (see e.g., Foray, 2014). Smart specialisation goes beyond the mere consideration of innovation in businesses and organisations and focuses on collaboration, competitive advantages within regions, and the overall levelling of the innovative playing field in Europe at large. Innovation, Freeman explained in 1995, must be seen in relation to employment and economic growth, as innovation has an impact on both.

Smart specialisation (S3) is in many ways the European Union's response to 'new industrial innovation policies' (Asheim B. , 2019; Radosevic, 2017). This 'new industrial policy' brings new approaches to the ways in which industrial innovation develop; whereby 'discovery processes' for new specialisations seek economic diversification and path creation. Policy making is then an endogenous process based on the acknowledgement that no-one possesses a full overview of the economy (Asheim, 2019). The new industrial policy, expressed through S3, aims to fulfil the EU's 2020 objectives of a smart, inclusive, and sustainable economy (Asheim, 2019), hence receiving European Regional Development Funds ex-ante.

Beyond economic development, however, the policy and academic debate increasingly focuses on the potential for innovation policy in solving societal challenges. According to Grillitsch et al. (2019), "the orientation towards grand societal challenges can be seen as a new wave or paradigm for innovation policy". This will be addressed in more depth further on.

Transition in innovation systems theory

Transitions help understand the complexity of systems innovations, encompassing not only the emergence of new technologies but the necessary changes in "markets, user practices, policy and cultural discourses as well as governing institutions (Coenen et al., 2012: 968). I Innovations that require changes – or transformation - in the interlinked social and technical systems are referred to as '*socio-technical transitions'.*

Four different schools of thought have contributed to transition studies literature, including: strategic niche management (Kemp, Schot, & Hoogma, 1998) transition management (Rotmans, Kemp, & van Asselt, 2001; Loorbach, 2007), which can be seen as precursors of the multi-level perspective approach (Geels F. , 2002; Geels & Schot, 2007) , as well as the technological innovation systems (Bergek, et al., 2008; Hekkert et al., 2007; Hekkert et al. 2020), with their sectoral/industrial (Breschi & Malerba, 1997; Carlsson & Stankiewicz, 1991) and territorial (Asheim & Isaksen, 1997; Lundvall, 1992 [2010]) variants. All these branches coincide on that change in complex *sociotechnical systems* is channelled through *sociotechnical transitions* (Cedergren et al. 2022)

Coenen et al., (2012, p. 968), stress that transition analyses are particularly useful in addressing the "structure-agency duality via evolutionary long-term trajectories of socio-technical change." Literature on innovation systems in relation to sustainability transitions has generally centred around emerging new technologies; whereas literature on the multi-level perspective has, instead, "oriented toward reconstructing historical processes of sectoral change" (Coenen, Benneworth, & Truffer, 2012, p. 968)). Both traditions, Coenen et al. (2012) argue, have largely overlooked the geographical dimension and the socio-spatial dynamics in which transitions occur. However, the more recent shift towards the transformative capacity of innovation, and innovation policy, has established new bridges between innovation studies and economic geography (Grillitsch & Hansen, 2019).

Building from a multi-level perspective approach, Geels' seminal paper published in 2002 introduces the idea that large-scale technological transformations result from an evolutionary - continuous - process of technology substitution that occurs at different levels (Geels F. , 2002). This process, therefore, results in the shift – or transition – "from one *sociotechnical regime* to another one," (Cedergren et al. 2022). The 'green transition', addressed further down, is today's prime example of a large-scale transformation, which requires not only technological innovations but an overhaul of both formal and informal institutions. Louiseau et al (2015) at the European Environmental Research Partnership suggest that the green transition requires transformations in several aspects, including organisational support; market conditions; the governance frameworks; technologies; and political will. The latter is considered crucial, without which addressing grand societal challenges is difficult.

The growing urgency towards addressing a number of societal challenges – including environmental challenges - however, has pushed policy-makers towards incorporating transition thinking, or transformative policy, into innovation and industrial policies.

Transformative Innovation Policy

According to Grillitsch et al. (2019), "the orientation towards grand societal challenges can be seen as a new wave or paradigm for innovation policy". Hekkert et al (2020) stress that for decades, innovation policy aimed simply to fix market failures, first by investing in R&D, and later by fixing failures in national innovation systems and strengthening networks. A new wave of innovation policy – *Transformative Innovation Policy (TIP)* - explicitly centres on the "mobilization of science, technology and innovation for meeting societal needs" (Grillitsch et al., 2019). Building on transition studies, and the theory on socio-technical transitions, TIP provides directionality to innovation efforts. Also referred as system innovation policy, this new approach implies system-wide transformation (ibid.).

TIP is emerging as a new generation of innovation policy approach that drives for *change*, particularly to address grand societal challenges (Grillitsch & Hansen, 2019) such as climate change, biodiversity loss, ageing population, poverty, hunger, etc. Transformative innovation policy essentially provides directionality and concentrates policy and financial efforts on innovations that offer solutions for social challenges. This represents a major shift, at least in discourse, to previous innovation policy generations which focused primarily on economic growth (Hekkert et al, 2020) A substantial example is Horizon Europe, the EU research & innovation framework programme for 2021-2027, which allocates € 95.5 billion towards five 'missions', which include some of the most pressing societal challenges of today: adaptation to climate change; climate-neutral and smart cities; soil health and food systems; healthy oceans and other waters; and cancer.

The Horizon Europe missions reveal one possible interpretation of the Mission-Oriented Innovation Policy (MOIP) approach by operationalising the principle of discovering willing problem-solvers instead of specific solutions. For example, within the mission of building climate-resilient regions, the emphasis is on inclusive governance via pooling resources and mobilising actors. This entails the co-design, co-production, and co-assessment of policies, improving access to education and information, strengthening sustainable local economies, and targeting funds. As a result, all European citizens, communities, and regions should become better prepared for climate disruptions as the innovation pathways and local transformative solutions developed in target regions and cities spread and increase in scale (European Commission, 2020a).

In sum, the Horizon Europe missions target their resources on capacity-building and creating enabling conditions under which new experiments may take seed and grow. Instead of structuring policy work based on a linear cause-effect solution, the MOIP framework defines criteria and characteristics of the end result (European Commission 2020a and 2020b, Mazzucato M. , 2019).

Proposed missions involve certain specific targets, such as supporting 200 European communities and regions and setting up 100 deep demonstrations of resilience, under climate resilience building, or establishing 100 climate-neutral cities that will transform into innovation hubs. Despite these exact numbers, evaluating the success of these missions will leave plenty of room for interpretation due to the broad criteria and characteristics of the sought end results. Emphasis on strengthening networks and engaging a wider range of stakeholders, as well as targeting financing in a more coordinated manner suggests that previous waves of innovation policy (focusing on R&D funding, fixing system failures and network building) are still active parts of new innovation policies. The Horizon missions thus entail not only developing new directions but also executing established approaches or instruments more effectively. However, the extent to which a change in directionality results in

discovering innovative policy instruments is yet to be seen. So far, Horizon Europe missions adopt a more incremental approach rather than introducing ground-breaking measures.

TIP has been closely connected to the exercise of exploring new economic pathways, or industrial path creation, which brings back the relevance of geography in innovation. Binz et al. (2016), as well as Steen and Hansen (2018, s. 191) define a new industrial development path as a "set of functionally related firms and supportive actors and institutions that are established and legitimised beyond emergence and are facing early stages of growth and developing new processes and products" (in Sotarauta & Suvinen 2021). Grillitsch and Asheim (2018) offer three alternative routes for this path, including: upgrading, diversification and emergence of new regional industrial paths. All these routes imply transformative processes but distinguish between incremental processes (upgrading) changing the fundamental structure of the local economy by establishing new industries (Emergence), and 'diversification' as a middle way, or a combination of the two.

In the context of a 'Green Transition', upgrading may imply a change in industrial paths by climbing "the hierarchy of global production networks by introducing green services and products", or by carrying "major changes in the existing industry due to the adoption of new green technologies and/or the introduction of new environmentally friendly business models (renewal)" (Sotarauta & Suvinen, 2021). As for diversification it requires a move towards "new green industries by applying existing knowledge and competencies" (ibid.). Finally, emergence implies "the creation of new green industries which do not draw on the knowledge bases of existing regional industries." (ibid.)

Societal challenges and mission-oriented-innovation policy (MOIP)

Directionality in innovation policy has ignited a heated debate in the academic sphere. The main division is between those for *mission-oriented innovation policy* (MOIP) and those for *broad based innovation policy (or Foundational Innovation Policy)*. Supporters of MOIP believe it to be an effective approach to concentrate efforts and mobilise actors into solving societal challenges, while and advocates for broad-based innovation policy argue that narrowing down the scope risks leaving out alternatives or focusing on wrong missions.

MOIP is a subtype of transformative innovation policy, as missions define the end goal of a transformative process. Mazzucato, a primary advocate of the missions approach defines MOIP as:

> *"… systemic public policies that draw on frontier knowledge to attain specific goals or 'big science deployed to meet big problems'. Missions provide a solution, an opportunity, and an approach to address the numerous challenges that people face in their daily lives"* (Mazzucato M. , 2018).

The OECD further describes them as:

> *"… a coordinated package of policy and regulatory measures tailored specifically to mobilise innovation in order to address well-defined objectives related to a social challenge, in a defined timeline"* (OECD, 2020).

Mazzucato refers to the success of policy in generating the ICT revolution and the welfare state as efforts requiring bold ambitions (missions) and strategic thinking (ibid.). She claims that the internet, biotech, nanotech, and green tech revolutions would not have happened if states would have taken an observant or passive role (Mazzucato M. , 2021). Mazzucato believes that green transition and addressing the SDGs (Sustainable Development Goals) also requires this type of approach: "it requires rethinking the tools for policymaking, whether we look at procurement policies, grants, loans, subsidies - these are all different types of levers governments have" (Mazzucato, Kattel, & Roll, 2020).

However, she believes that the way these tools are applied needs to be rethought "to foster transitions, be it the green transitions or other types of investments and activities that are required to solve the 17 SDGs" (ibid).

Mazzucato also brings forth concepts like public value and purpose to question that "if an economy has a purpose, then it has a direction, so, how do we talk about directionality of the economy?" she asks in a lecture given at the Creative Bureaucracy Festival in (2020). Public purpose links to the role of targeted public missions. Public missions do not need to pick a sector or technology, but rather concern with fostering activity in all related industries or sectors, that may require incentive support. A mission can therefore be targeted. However, "solution-picking" policies is not required for bottom-up activity across organisations or for supporting sectors in their problem solving in order to meet these public mission goals (Mazzucato, Kattel, & Roll, 2020). Although opponents of mission-oriented innovation policies claim they limit alternatives, their aim is to support the emergence of diverse ideas and technologies.

Mazzucato (2021) explains that MOIP can be operationalised by picking 'the problem' as the starting point and then supporting innovations in any sector or industry that works towards this end. This would mean for example, "turn the SDGs, these 17 broad goals, into targeted missions, like getting 90% of the plastic out of the ocean, or having 100 carbon neutral cities across Europe, or social ones, like fighting knife crime" (ibid.). Furthermore, policy instruments, such as industrial strategies, procurement, or loans and grants to stimulate bottom-up experimentation from across businesses and organisations, are shaped to solve the set problems. This differs, Mazzucato argues, from common industrial strategies that pick, for example, the top five industries to be funded.

Green transition as a policy goal/mission-oriented concept

In the context of transition literature, a 'green transition' is *just* one more example of socio-technical transitions (Cedergren et al. 2022 - forthcoming). As understood in MOIP and TIP, green transitions solve one or several 'grand societal challenges', such as climate change, biodiversity loss, eutrophication, etc. Beyond academic discourse, a green transition exists as policy goal of varying interpretations. In general, it implies moving from a non-green (unsustainable) 'present', to a green (sustainable) 'future', which inevitably requires changes in the social, economic, and institutional systems.

At the core of green transition as a policy goal lies a "green economy", which Jacobs (1991) conceptualises as "an economic context in which prosperity and social equality increase while pressures on the environment and ecological damage simultaneously decrease" (in Cedergren, et al. 2022 - forthcoming). In relation to development or industrial policy, we may speak of green path development. UNEP (2011: 16) describes green path development as "industrial development around products, solutions or technologies that 'reduce carbon emissions and pollution, enhance energy, and resource efficiency, and prevent the loss of biodiversity and ecosystem services'" (in Sotarauta & Suvinen, 2021). The European Green Deal, which is the EU's new 'growth strategy', is set to accelerate/trigger a green transition and transform "the Union into a modern, resource-efficient and competitive economy", that is characterised by climate neutrality and reduced pollution, competitive economy and green technology, and sustainable industry and transport. (European Commission)

Setting aside policy ambitions, the concept of 'green', is a highly dynamic concept that may be altered in a few years (Tanner, o.a., 2019). Moreover, framing 'green' in terms of traditional exponential 'growth' leading to resource depletion and waste production while linking it with human well-being and economic development is no longer sustainable (Altenburg & Rodrik, 2017). The concept of green transition is often linked with the concept of 'green growth', whereas innovation is understood in

terms of economic development. Green growth is the capacity to create sustainable growth through innovation for new and improved services, processes, and goods, writes Annala & Teräs in 2017. Ambec (2017) furthermore states that when the three preconditions are fulfilled, green growth leads to economic competitiveness. These conditions are: the ease of facilitating patent and technology transfers in industrial policy, high levels of technological absorption capacities in industries, and finally, flexibility in green innovation policy instruments such as e.g., taxation policies (Ambec, 2017, p. 47). However, they are highly context specific and dependent, depending on the role of public policies and financial infrastructure, and more over on the role that 'proximity' plays in driving industrial green transitions (Altenburg & Pegels, 2012)

Conceptualising 'green' in the framework of the existing economic system can therefore be limiting (Wøien Meijer & Peters, 2021). According to Altenburg and Rodrik (2017), radical new techno-institutional systems are necessary. The commitment to Agenda 2030 and the SDGs have transformative power, but goal conflict may result in 'halfway solutions' if there is no guidance on how to balance conflicting issues (e.g., housing vs. area protection). New policy foundations, such as the SDGs, may in turn reform both the formal and informal institutional structures, if given the chance (Wøien Meijer & Peters, 2021).

As structuration theory frames, under these conditions agents and structures may influencing each other, bringing society forward. As Asheim (2019) notes, new industrial innovation policies are generally built on the assumption that "no single agent has a total overview of the economy". Therefore, to study innovation in green transitions, we need to examine change agency and identify where change initiates, who/what triggers it, and who leads the process of path creation.

Methodological Framework

Conceptual framework

Ontological foundation: Structure-agency – Coleman's Boat

We use Coleman's boat (Figure 1) to guide our interpretation of macro-micro-macro interlinkages – in other words, how structures (macro-level) influence agency (micro-level) in a mutually reinforcing way (Coleman, 1986; Giddens, 1991). This helps us ground our theory of change agency, by understanding social change and change processes as dependent on both changing institutions, and changing values, visions, and attitudes. In relation to sustainable development, for example, macro may refer to the threats of climate change. This in turn conditions micro level attitudes, leading to individual action, the development of the SDGs or other climate action, which in turn has an impact on economic pathways and the severity of the climate crisis.

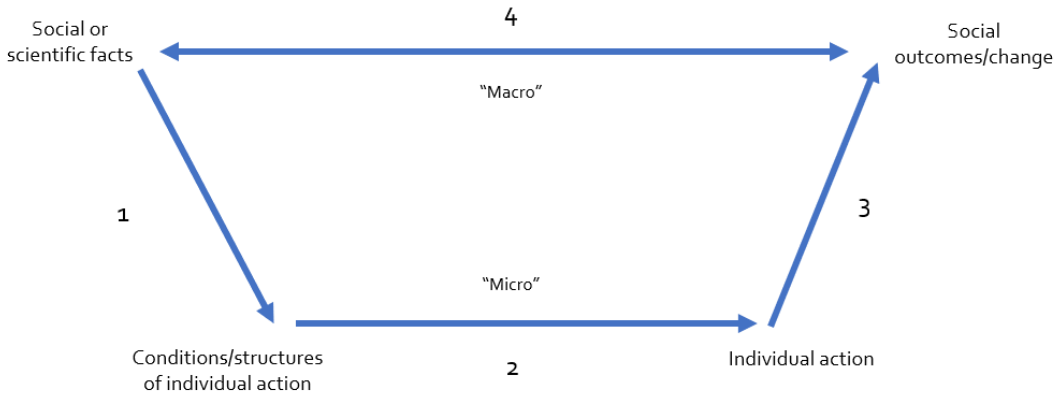


Figure 1. Coleman's Boat, authors' interpretation.

The boat explained: In relation to innovation within green *transitions*, individual actions link to system behaviour. This is partly because green transitions are catalysed by attitude and value changes, which involves trust and/or social influence. Attitudes and values affect macro-level change, which in turn influences micro-level behaviours, change, and eventually governance structures through institutional entrepreneurship. So, for example, influence type 1 (figure 1) indicates social or scientific facts, such as e.g., climate change's impact on society. Influence type 2 represents impact on the conditions/structures of individual action. Influence type 3 shows the process of individual action impacting social outcomes (Coleman, 1986, p. 1331). Finally, we would like to add a double arrow as a fourth type of influence, showing how social outcomes may impact on the development of social and scientific conditions and vice-versa on the macro scale, implying general shifts in attitudes – resulting in e.g. establishing the newfound development of problem-solving mission-oriented policies to solve grand social challenges.

The limitation of the methodology based on Coleman's Boat includes risks common to all qualitative methods, i.e. the lack of tangible, empirical results and the need to carefully review the credibility of results at every stage of analysis. While we acknowledge this limitation, we ground our conceptual framework on Coleman's Boat. Although the directionality and causality of influence tends not to be linear but complex, Coleman's boat helps to simplify and visualise how transformative action (individual level) and policies (structural level) influence and strengthen/weaken each other. This is observable in, for example, social issues today (see e.g., civil rights movement, women's rights etc.). The interlinkages between agency and structures are charging transformations, while the institutionalisation of norms and values are driving green transitions and manifesting in individual action and policy change.

Conceptual framework: Trinity of change agency

Having established how we conceptualise our ontological basis of social change in the relationship between structure-agency, we take a closer look at how this may work within the framework of innovation. Building on Grillitsch and Sotarauta's theory of Trinity of Change Agency (2020), we see how, depending on the overall social conditions, variables and outcomes might change (Figure 2). Depending on the context and actors involved, the process, directionality of influence, and outcomes of change agency vary. Moreover, this acknowledges the complex interlinkages between agency and structure in contributing to social change, or in this case, green transitions.

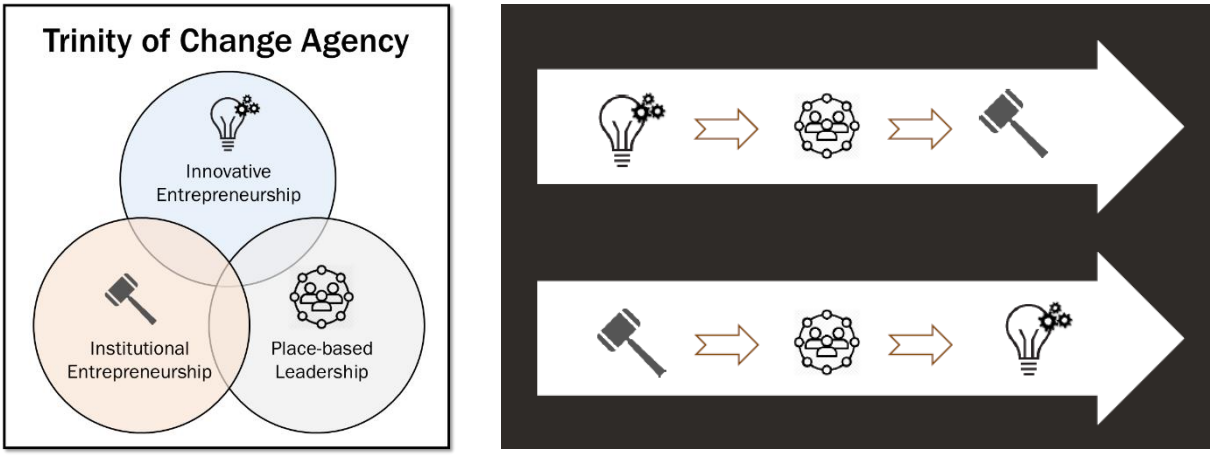


Figure 2: Trinity of Change and the role of agency in generating outcomes. Source: Grillitsch, M. (2021) Lecture in Policy for Green Growth and System Innovation, Lund University

The 'Trinity of Change Agency' does not happen in a vacuum but is surrounded by various actors who may impact change. Grillitsch and Sotarauta (2020) suggest that these three forms of agency "[...] contribute in their own way to constructing and exploiting opportunity spaces, thereby continuously forming and shaping regional growth trajectories." We furthermore follow their assumption that despite similar preconditions regions do perform differently, and that this may be rooted in what types of agency exists and their ability to exploit opportunity spaces (Grillitsch & Sotarauta, 2020).

To complement the traditional view of actors, in terms of formal role or organisation, we apply 'the roles in change agency' proposed by Sotarauta et al. (2020, p. 96), which involves both the formal and informal roles of actors in change processes and driving innovation. These include support actors, vision brokers, critics, and mentors (Table 1), in addition to core place-leaders, institutional entrepreneurs and innovative entrepreneurs (Sotarauta et al., 2020, p. 96). In our empirical study, we will consider who these actors are in relation to the sectors chosen for our case studies.

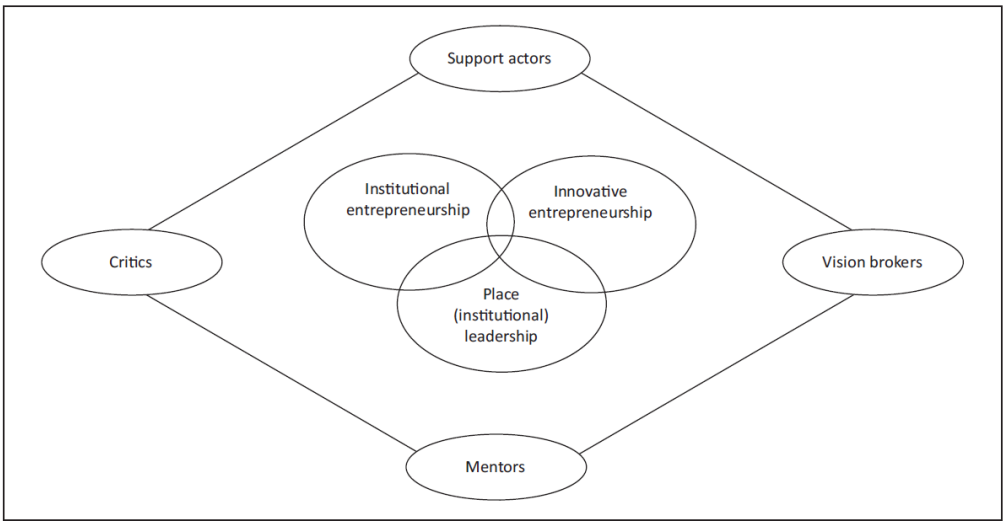


Figure 3: The roles in change agency. Source: Sotaratura et al. (2020, p. 102)

Table 1. The roles in change agency (see also, Van de Ven, 1999).

The role	Characteristics of the role (within the game metaphor)
Institutional entrepreneur	Initiates divergent institutional changes and actively participates in their implementation and is willing to take risk in doing so – *works to change the rules of the game.*
Innovative entrepreneur	Actively seeks new economic opportunities and is willing to take financial and personal risk – *exploits the existing, emerging and possible games and simultaneously changes them.*
Visionary	Breaks away from what already exists and has the imagination and the ability to see the big picture – *imagines new games.*
Support actor	Encourages change by supporting the process by loosening up facilitation, coordination and/or providing change efforts with resources – *does not play the game but helps the players and those who make/change the rules.*
Mentor	Typically, an actor who coaches and advises other actors and especially institutional entrepreneurs and leaders as well as entrepreneurs throughout the process but is not actively engaged in the change process – *teaches others to play better or to change the rules more effectively.*
Critic	Plays the role of the devil's advocate by asking cunning questions that force the other actors to re-examine their assumptions and hold them against other criteria – *does not work for the game or improve the ways it is played but indirectly helps the players to improve their game.*
Place leader	An actor having a position to assess a path development process from a more comprehensive angle than the other actors, and mobilise and pool resources, competencies and powers – *makes it all possible, provides a generic direction for a game.*

Table 1: The roles in change agency. Source: Sotarauta et al. (2020, p. 96)

Methodological approach: theoretical and empirical qualitative study and analysis.

- Desk study: literature and policy review
- Empirical study: case studies (sector-based); semi-structured interviews
- Cross-case analysis

Final remarks and next steps

Assuming a systemic nature of innovation in which no single agent has the monopoly of change, we find it relevant to use *agency* as a starting point to explore the concept of green innovation in the context of regional development. This will allow us to gain further insights into the role and collaborative efforts, employed by actors in enabling the green transition. Finally, this will shed light on the way in which the green transition may come to fruition through the complexity of actor-structure interactions.

This discussion paper serves as the foundation for the empirical studies that will be conducted in sectors deemed most interesting for the ongoing transformative process. This paper is also aimed as an open invitation for a broader discussion amongst academics and policy experts.

References

Altenburg, R., & Rodrik, D. (2017). GREEN INDUSTRIAL POLICY: Accelerating structural change towards wealthy green economies. In T. Altenburg, & C. Assmann, *Green Industrial Policy: Concept, Policies, Country Experiences.* (pp. 2-20). Geneva : United Nations Environmental Program.

Altenburg, T., & Pegels, A. (2012). Sustainability-oriented innovation systems - managing the green transformation. *Innovation and Development, 2*(1), 5-22.

Ambec, S. (2017). Gaining competitive advantage with green policy. *Green Industrial Policy - Concept, policies and country experiences*, 38-50.

Annala, K., & Teräs, J. (2017). *Synthesis report.* Nordic working group for green growth – innovation and entrepreneurship 2013-2016. Stockholm: Nordregio. Retrieved from http://norden.diva-portal.org/smash/get/diva2:1092495/FULLTEXT01.pdf

Asheim, B. (2019). Smart specialisation, innovation policy and regional innovation systems: what about new path development in less innovative regions? *The European Journal of Social Science Research, 32*(1).

Asheim, B. T., & Coenen, L. (2005). Contextualizing Regional Innovation Systems in a Globalizing Learning Economy: On Knowledge Bases and Institutional Frameworks. *Paper no. 2005/5*.

Asheim, B. T., & Coenen, L. (2006). Contextualising regional innovation systems in a globalising learning economy: On knowledge bases and institutional frameworks. *The Journal of Technology Transfer, 31*(1).

Asheim, B. T., & Isaksen, A. (1997). Location, Agglomeration and Innovation: Towards Regional Innovation Systems in Norway. *European Planning Studies, 5*(3).

Audrecht, D. B., & Feldman, M. P. (1996). R&D Spillovers and the Geography of Innovation and Production. *The American Economic Review, 86*(3), 630-640.

Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., & Rickne, A. (2008). Analyzing the Functional Dynamics of Technological Innovation Systems: A Scheme of Analysis. *Research Policy, 37*(3).

Binz, C., Truffer, B., & Coenen, L. (2016). Path creation as a process of resource alignment and anchoring – industry formation for onsite water recycling in Beijing. *Economic Geography, 92*(2), 172–200.

Boschma, R. (2005). Proximity and innovation: a critical assessment. *Regional Studies, 39*(1), 61-74.

Breschi, S., & Malerba, F. (1997). Sectoral Innovation Systems: Technological Regimes, Schumpeterian Dynamics, and Spatial Boundaries. *Systems of Innovation: Technologies, Institutions and Organizations, 1*, 130-156.

Breschi, S., & Malerba, F. (1997). Sectoral systems of innovaiton: technological regimes, Schumpeterian dynamics and spatial boundaries. In C. (. Edquist, *Systems of Innovation.* London: Pinter.

Carayannis, E. G., Samara, E. T., & Bakouros, Y. L. (2015). *Innovation and Entrepreneurship: Theory, Policy and Practice.* New York: Springer.

Carlsson, B., & Stankiewicz, R. (1991). On the nature, function and composition. *Journal of Evoluationary Economics, 1*, 93-118.

Cedergren, E., Sanchéz Gassen, N (2022 *'Just Green Transition' – key concepts and implications in the Nordic region.* 'Not Just A Green Transition'-project. Stockholm: Nordregio.

Coenen, L., Benneworth, P., & Truffer, B. (2012). Toward a spatial perspective on sustainability transitions. *Research Policy*, 968-979.

Coleman, J. (1986). Social theory, social research, and a theory of action. *American journal of Sociology, 91*(1), 1309-1335.

Cooke, P., Gomez Uranga, M., & Extebarria, G. (1997). Regional innovation systems: Institutional and organisational. *Research Policy, 26*, 475-491.

European Commission . (s.f.). (D. Reform, Productor) Recuperado el 25 de 1 de 2022, de https://ec.europa.eu/reform-support/what-we-do/green-transition_en

European Commission. (2020a). *Proposed Mission: A Climate Resilient Europe Prepare Europe for climate disruptions and accelerate the transformation to a climate resilient and just Europe by 2030.*

European Commission. (2020b). *Proposed Mission: 100 Climate-neutral Cities by 2030 – by and for the Citizens.* Report of the Mission Board for climate-neutral and smart cities.

Freeman, C. (1995). The 'national system of innovation' in historical perspective. *Cambridge Journal of Economics, 19*, 5-24.

Geels, F. (2002). Technological Transitions as Evolutionary Reconfiguration Processes: A Multi-Level Perspective and a Case-Study. *Research Policy, 31*.

Geels, F., & Schot, J. (2007). Typology of Sociotechnical Transition Pathways. *Research Policy, 36*(3).

Gertler, M. (1997). The invention of regional culture. In R. Lee, & J. Willis, *Geographies of Economies* (pp. 47–58). London: Arnold.

Giddens, A. (1991). Structuration theory: past, present and the future. In C. Bryant, & D. Jary, *Giddens' theory of structuration: A critical appreciation* (pp. 201 - 221). London: Routeledge.

Giddens, A. (1991). Structuration theory: past, present and the future. In C. Bryant, & D. Jary, *Giddens' theory of structuration: A critical appreciation* (pp. 201-221). London: Routeledge.

Grillitsch , M., & Asheim, B. (2018). Place-based innovation policy for industrial diversification in regions. *European Planning Studies, 26*(8), 1638-1662.

Grillitsch, M., & Hansen, T. (2019). Green industry development. *European Planning Studies,, 27:11*, 2163-2183. doi:10.1080/09654313.2019.1648385

Grillitsch, M., & Sotarauta, M. (2020). Trinity of change agency, regional development paths and opportunity spaces. *Progress in Human Geography, 44*(4).

Grillitsch, M., Hansen, T., Coenen, L., Miörner, J., & Moodysson, J. (2019). Innovation policy for system-wide transformation: The case of strategic innovation programmes (SIPs) in Sweden. *Research Policy, 48*(4), 1048-1061. Obtenido de https://doi.org/10.1016/j.respol.2018.10.004

Hagedoorn, J. (1996). Innovation and Entrepreneurship: Schumpeter Revisited. *Industrial and Corporate Change, 3*(3).

Hansen, T. (2015). Substitution or overlap? The relations between geographical and non-spatial proximity dimensions in collaborative innovation projects. *Regional Studies, 49*(10).

Hekkert, M. P., Janssen, M. J., Wesseling, J., & Negro, S. O. (2020). Mission-Oriented Innovation Systems. *Environmental Innovation and Societal Transitions, 34*.

Hekkert, M., Suurs, R., Negro, S. O., Kuhlman, S., & Smits, R. (2007). Functions of Innovation Systems: A New Approach for Analysing Technological Change. *Technological Forecasting and Social Change, 74*(4).

Jessop, B. (2001). Institutional re(turns) and the strategic-relational approach. *Environment and Planning A., 33*, 1213 – 1235. doi:10.1068/a32183

Kattel, R. (2015). What would Max Weber Say about Public-Sector Innovation? *NISPAcee Journal of Public Administration and Policy, 8*(1), 9-19. Retrieved from https://doi.org/10.1515/nispa-2015-0001

Kemp, R., Schot, J., & Hoogma, R. (1998). Regime Shifts to Sustainability through Processes of Niche Formation: The Approach of Strategic Niche Management. *Technology Analysis & Strategic Management, 10*(2).

Lema, R., Nordensvärd, J., Urban, F., & Lüktenhorst, W. (2014). Innovation Paths in Wind Power - Insights from Denmark and Germany. *Discussion Paper*.

Loorbach, D. (2007). *Transition Management New Mode of Governance for Sustainable Development Transitiemanagement.* PhD Thesis. Rotterdam: Erasmus Universiteit Rotterdam.

Louiseau, et al. (2015). Implementing the green economy in a European context: Lessons learned from theories, concepts and case studies. *Partnership for European Enviromental Research*.

Lundvall, B.-Å. (1992 [2010]). *National Systems of Innovation: Toward a Theory of Innovation and Interactive Learning.* (Vol. Second Edition). Anthem Press.

Malerba, F., & Orsenigo, L. (1995). Schumpeterian patterns of innovation. *Cambridge Journal of Economics, 19*, 47-65.

Mazzucato, M. (2013). *The Entrepreneurial State: Debunking Public vs. Private Sector Myths* (Vol. 1st Edition). London: Anthem Press.

Mazzucato, M. (2018). *Mission-Oriented Research & Innovation in the European Union: A problem-solving approach to fuel innovation-led growth.* European Commission: DG for Research and Innovation. Luxemburg: Publications Office of the European Union.

Mazzucato, M. (2019). *Governing Missions in the European Union.* European Commission.

Mazzucato, M. (2021, Aug 21). Mission Economy: A Moonshot Guide to Changing Capitalism. Youtube. Retrieved from https://www.youtube.com/watch?v=-uTNPSCaMmU

Mazzucato, M., Kattel, R., & Roll, K. (2020, Oct 1). Innovation, Public Policy and Public Value: New Masters in Public Administration. *Creative Buraucracy Festival*. Retrieved from https://www.youtube.com/watch?v=GMuTR1aemRs

Morgan, K. (1997). The Learning Region: Institutions, Innovation and Regional Renewal. Regional. *Regional Studies, 31*, 491-503.

Morgan, K. (2017). Nurturing novelty: Regional innovation policy in the age of smart specialisation, Environment and Planning. *Politics and Space, 35*(4).

Nelson, R., & Rosenberg, N. (1993). Technical innovation and national systems. In R. Nelson, *National innovation systems: A comparative analysis* (pp. 3-21). New York Oxford: Oxford University Press.

Nelson, R., & Winter, S. G. (1977). In serarch of a useful theory of innovation. *Research Policy, 6*, 36-76.

North, D. (1990). *Institutions, Institutional Change and Economic Performance.* New York: Cambridge University Press.

OECD. (2020). *Mission-Oriented Innovation: Tackling society's grand challenges*. Retrieved from OPSI - Observatory of Public Sector Innovation: https://oecd-opsi.org/projects/mission-oriented-innovation/#:~:text=What%20is%20mission%2Doriented%20innovation%3F&text=A%20mission%2Doriented%20innovation%20policy,challenge%2C%20in%20a%20defined%20timeframe.

Phan, P. (2004). Entrepreneurship theory: Possibilites and future directions. *Journal of Business Venturing*, 617-620. doi:DOI: 10.1016/j.jbusvent.2003.09.001

Porter, M. (1998). Clusters and the new economics of competition. *Harvard Business Review, 76*(6), 77-90.

Porter, M. E. (1990). The Competitive Advantage of Nations. *Harvard Business Review, March+April*, 74-91.

Porter, M. E. (2000). Location, Competition, and Economic Development: Local Clusters in a Global Economy. *ECONOMIC DEVELOPMENT QUARTERLY, 14*(1), 15-34.

Radosevic, S. (2017). Assessing EU Smart Specialisation Policy in a Comparative perspective. In S. e. Radosevic, *Advances in the Theory and Practice of Smart Specialisation,* (pp. 2-36). Amsterdam: Elsevier Science Publishers.

Ramoglou, S., Gartner, W. B., & Tsang, E. W. (2020). "Who is an entrepreneur?" is (still) the wrong question. *Journal of Business Venturing Insights*.

Ramström, G. (2018). Coleman's boat revisited. Causal sequences and the micro-macro link. *Sociological Theory, 36*(4), 386-391.

Rodríguez-Pose, A. (2013). Do Institutions Matter for Regional Development? *Regional Studies, 47*(7).

Rodríguez-Pose, A., & Crescenzi, R. (2008). Mountains in a flat world: why proximity still matters for the location of economic activity. *Cambridge Journal of Regions, Economy and Society, 1*(3), 371-388.

Rotmans, J., Kemp, R., & van Asselt, M. (2001). More Evolution than Revolution: Transition Management in Public Policy. *Foresight, 3*(1).

Saviotti, P. (1997). Innovation Systems and Evolutionary Theories. En C. Edquist, *Systems of Innovation: Technologies, Institutions and Organisations* (págs. 180-199). Routledge.

Schumpeter, J. A. (1942 (2010)). *Capitalism, Socialism and Democracy.* New York, London: Routeledge.

Sotarauta, M., & Suvinen, N. (2021). The many roles of change agency in the game of green path development of the North. *European Urban and Regional Studies, 28*(2).

Steen, M., & Hansen, G. (2018). Barriers to path creation: the case of offshore wind power in Norway. Economic Geography. *94*(2), 188–210.

Söderholm, P. (2020). The green economy transition: the challenges of technological change for sustainability. *Sustainable Earth, 30*(6). doi:10.1186/s42055-020-00029-y

Tanner, A., Lourenco, F., Moro, M., Iversen, E., Østergaard, C., & Park, E. (2019). *Regional Distribution of Green Growth Patents in four Nordic Countries: Denmark, Finland, Norway and Sweden.* Technical University of Denmark. Obtenido de https://backend.orbit.dtu.dk/ws/portalfiles/portal/167481794/gonst_wp3_report_distribution_of_green_patents_2019.pd

Tödtling, F., & Trippl, M. (2005). One size fits all?: Towards a differentiated regional innovation policy approach. *Research policy, 34*(8).

Wilson, J. (1989). *Bureaucracy: What Government Agencies Do and why they Do it.* New York: Basic Books.

Wøien Meijer, M., & Peters, O. (2021). Nordic Industrial Green Transition: A literature review. *NORCE Samfunn, Report no. 20/2021*.