‘It’s all a question of business’: investment identities, networks and decision-making in the cleantech economy.

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Abstract

Cleantech has emerged in the last decade as a major new investment area at the very cutting edge of the green economy, responding to the need for innovative new technologies to combat the impact of global environmental, climate and resource trends. Previous research has defined the discursive logics of cleantech and tracked its conceptual, sectoral and material development. This paper explores the central importance of social relations within the financial domain of the green economy by furthering our understanding of cleantech within economic geography, engaging with a broad representation of cleantech professionals to explore its nature, operational drivers and definitions, and how these interact within socio-spatial network forms of organisation. The central aim of this paper is to deepen understandings of the operation of cleantech investment by examining the decision-making processes of cleantech actors, how these are influenced by (and influence) cleantech investment networks, and the relationships between these factors and the macro-level drivers and discourses around the cleantech sector. More specifically, a relational economic geography approach is used in conjunction with other frameworks (spanning the cultural, structural and actor-network dimensions of cleantech investment) to investigate: how actors within cleantech investment define the sector; the macro- and micro-levels drivers of cleantech investment activities; and how cleantech networks form and operate to create and disseminate cleantech discourses and to generate the mutual trust and information sharing needed to secure cleantech investments. In so doing, the paper seeks to help shed greater lighter on the micro-level processes contributing to the creation and growth of cleantech investment markets as an essential catalyst and component of the green economy. Fourteen semi-structured interviews were conducted with a range of cleantech professionals in London. The paper discusses these cleantech actors, their decision-making, how they interact in social network forms of association and the vital importance to actors of understanding these networks, aligning these discussions to further our understanding of cleantech’s emergence and growth through its geographies, discourses and social network interactions.

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Introduction

Irrespective of whatever other political, social and economic reforms the green economy produces in the coming years, there is little doubt that investment (both public and private) will play a crucial role in driving forward new technologies and processes aimed at improving resource efficiency while reducing social and environmental externalities. In particular, private-sector investment in the emergent cleantech sector stands to make a significant contribution to shaping the goals and practices of the green economy. Cleantech only really emerged as an identifiable investment target around the year 2000 but since then the sector has experienced rapid and sustained growth, in overall terms and relative to other investment sectors. Like most other investment sectors, cleantech was affected by the 2008-2009 financial crisis and subsequent recessionary pressures. However, it has responded better than most, with a fall in investment of just 6.6%, compared to 19% for the oil and gas industry. Furthermore, the first half of 2011 saw the largest half-year investment record since 2000, with over US $4.7 billion invested in the sector (Knowles *et al.* 2012). However, cleantech is more than simply a burgeoning investment sector. Indeed, a Merrill Lynch report describes it as the sixth technological revolution, arguing that '[t]he current information technology age should give way to the leadership of cleantech as the energy infrastructure moves back to renewables', and that venture capital and private equity provide key sources of investment for innovative and disruptive technologies that will drive this revolution (Milunovich and Rasco 2008, p. 1).

The geographies of cleantech finance have been the subject of increasing interest among economic geographers in recent years, not least because private investment is now the largest source of capital for cleantech sub-sectors such as renewable energy (Wüstenhagen and Menichetti 2012). However, although the macro-level trends related to environmental change, resource efficiency and profitability driving investor, corporate and government interest in cleantech activities are readily identifiable, the details of how cleantech has formed and maintained its identity as an investment sector or theme, the rationalities underpinning decisions made by participants in cleantech activities, and the ways in which cleantech networks and interactions operate remain less well understood.

Traditional economic geography approaches have already provided many useful insights into the effects and material flows of cleantech investment (Mason and Harrison 2002; Montgomery 2006; Knight 2012). However, some scholars have argued that these approaches are less suited to understanding how cleantech professionals construct the logics, discourses and processes that influence the identity, scope, orientations and everyday workings of cleantech investment (Caprotti 2012a). In contrast, studies rooted in relational economic geography, cultural economy and related approaches that focus on the importance of social relations and networks in shaping economic interactions appear more suited to probing the inner workings of markets, especially when compared with the more abstract lenses of classical economics or analyses of macro trends that struggle to explain how markets are made, operate and change (Boeckler and Berndt 2012). As Leyshon (1998) notes, financial and commodity markets are palpable entities producing concrete effects but many fundamentals of their character and operations are socially constructed by myriad actors, technologies and institutions which are involved in financial and commodity networks. Leyshon argues that such networks and shared meanings are crucial for generating the trust needed for exchanges between buyers and sellers to take place. Similarly, Berndt and Boeckler (2009, p. 536) argue that: 'Markets do not simply fall out of thin air, but are continually produced and constructed socially with the help of actors who are interlinked in dense and extensive webs of social relations, [...] concrete markets cannot be separated from their social and institutional context.'

Much of the recent existing geographical research on cleantech from a relational economic geography perspective has focused on trying to understand the factors driving the growth and operations of sector and how far these can be regarded as distinctive from other branches of the financial sector. These forays have produced some useful initial insights into how cleantech is being defined and how the looseness and dynamism of definitions of cleantech are furthering its legitimacy as an investment theme. For example, Caprotti (2012a) examines the various discursive logics emphasizing environmental crisis, resource efficiency and profitability that have contributed to the emergence of cleantech as a sectoral identity. Masini and Menichetti (2012) and Wüstenhagen and Menichetti (2012), meanwhile, provide initial explorations into the behavioural factors affecting renewable energy investment. Other studies have sought to define how geography affects cleantech venture investment by considering issues such as the importance of social clusters, access to capital and physical barriers to cleantech investment (Caprotti 2013; Knight 2010), or to

position cleantech as part of a broader evolution of the global technological-financial system, alongside other sectors such as biotech (Cooke 2008).

However, this research has yet to provide a detailed picture of, firstly, how actors involved in the cleantech sector perceive the sector. Secondly, there is a need for investigation of the various factors, including but not limited to discursive logics, that have helped to consolidate cleantech as an investment target and continue to shape how cleantech networks form and day-to-day decision-making connects potential investors with prospective projects. This echoes earlier comments by Sidaway and Bryson (2002, p. 403) on the emergence of the 'emerging markets' investment category, focusing on the fact that 'despite research into money and finance… fund managers and analysts have been somewhat neglected'. They note that this is a surprising and important omission in the analysis of money and finance and that geographers are well positioned to address. Equally, as with research into other areas of investment and finance, there is a need to balance the insights gained from relational economic geography research examining the social relations and processes contributing towards the operation of economic sectors or specific networks with those gained from analyzing the broader-level trends in investment (Torrance 2009).

Accordingly, the central aim of this paper is to deepen understandings of the operation of cleantech investment by examining the decision-making processes of cleantech actors, how these are influenced by (and influence) cleantech investment networks, and the relationships between these factors and the macro-level drivers and discourses around the cleantech sector. More specifically, a relational economic geography approach is used in conjunction with other frameworks (spanning the cultural, structural and actor-network dimensions of cleantech investment) to investigate: how actors within cleantech investment define the sector; the macro- and micro-levels drivers of cleantech investment activities; and how cleantech networks form and operate to create and disseminate cleantech discourses and to generate the mutual trust and information sharing needed to secure cleantech investments. In so doing, the paper seeks to help shed greater lighter on the micro-level processes contributing to the creation and growth of cleantech investment markets as an essential catalyst and component of the green economy.

The remainder of the paper is structured as follows. In the next section we explore the growth of research on finance within geography, focusing particularly on the contribution

of relational economic geography and cultural economy approaches towards deepening understanding of the functional and spatial operation of finance markets, including cleantech. Following this, we discuss the findings from 14 semi-structured interviews conducted between June and August 2012 with cleantech and venture capital investors and other professionals and companies operating in London-based cleantech investment networks. London was selected as the focus of investigation because of its status as one of the world's leading centres of cleantech investment, while respondents were selected based on their specialist knowledge of different sub-sectors within cleantech investment markets. The main themes explored in the interviews correspond with the major research questions identified above: firstly, respondents' definitions of the cleantech sector; secondly, macro- and micro-drivers of cleantech investment; and thirdly, the inter-actor relations and networks perceived by respondents to aid the identification and completion of cleantech investments. The paper concludes by reflecting on the key insights gained from the study.

Geographies of finance and cleantech

Since the early 1990s, the geography of finance has grown from being a relatively neglected backwater of economic geography into 'a vibrant intellectual terrain that is characterized by considerable variety in terms of theoretical approaches [and] substantive research concerns' (Hall 2011, p. 234; Lee *et al.* 2009; Leyshon 1997; 1998). A significant part of this interest has stemmed from the growing importance of financial markets to the functioning of politico-economic systems and their corresponding influence on other social, cultural and political geographies, a point underlined by the finance-led global economic downturn that began in the late 2000s (Wójcik 2009). However, another contributor to the invigoration of geographical interest in the financial sector has been the growing diversity of perspectives used to probe the character and impacts of financial systems, in particular the supplementing of traditional political economy approaches focusing predominantly on analysing the uneven consequences produced by financial markets across different spatial and temporal scales (French *et al.* 2010; Pike 2006; Pike and Pollard 2010), with studies which are more culturally and socially informed in their examination of the relational geographies of finance. This emphasis has included investigations of how financial actors and intermediaries operate (both functionally and spatially) and how international financial systems are reproduced through the grounding of global financial flows in place-specific institutional spaces (Callon 2005; Clarke 2005; Hall 2011).

A core strand within geographical analyses of financial markets has centred on the spatial patterning of investment companies and their geographical links with firms seeking investment (Fritsch and Schilder 2008; Malmberg 2003; Mason and Harrison 2002; Saxenian and Savbel 2008). Studies on the spatial patterning of financial markets and how networks of capital and information operate within and across spatial scales in the global economy are by necessity intimately linked to analyses of the relational geographies of finance and investment in the sense that both of these research emphases seek to understand the factors linking capital to 'productive activities' (in the broadest sense of the term). The key difference is the level of emphasis on contractual exchanges compared with the social processes involved in the creation of particular investment categories, the sharing of knowledge, expertise and resources, and the building of trust relationships. The latter focus falls most centrally within the research area of relational economic geography. This sub-field, in existence for almost three decades at the time of writing, is focused on the need to find a middle ground between economic theories that under-socialize economic behaviour and existing sociological frameworks that over-socialize such behaviour (Granovetter 1985). Relational economic geography is therefore centred on the ways in which socio-spatial relations of actors are intertwined with processes of economic changes at various geographical scales (Yeung 2005). Thus, when seen through a relational lens, economic rationality becomes more accurately viewed as embedded within social relationships (Boggs and Rantisi 2003).

In turn, the individuals and network transactions which are part and parcel of these relationships are seen neither as mechanistic enactors of the logics of economic rationality and markets, nor as completely divorced from them. As Knox-Hayes (2009) observes in relation to the establishment of financial services for trading carbon emissions, new markets remain embedded within existing international financial markets and operate through virtual platforms, but still depend on underlying human networks that rely on 'social connectivity and proximity' (p. 768) in which 'trust and reciprocity is critical to all interactions' (p. 762). Thus, studies sensitive to relational economic geography and of the embeddedness of social networks within the 'economic' all seek to correct reductionist thinking on economics (Callon 2005; Yeung 2005), which creates a rational entity (the 'economy') to which 'non-rational' elements of non-economic life are subservient (Leyshon 1998). These approaches simultaneously seek to avoid portraying the actors involved in financial networks as being divorced from the wider contexts of economic systems. Therefore, approaches informed by relational economic geography promote the study of

financial actors, and of their interactions and the forms of association that enable interactions to take place, with an understanding of the interconnected nature of what have previously too often been described separately as the 'economic', the 'cultural', the 'political, and the 'social'. In so doing, studies along these lines attempt to open out the empirical terrain of the 'economic' to recognize how the material realities of economic activities are embedded within social and cultural contexts (Gibson and Kong 2005; Amin and Thrift 2007; Hall 2011). It is at this juncture that we situate our analysis of cleantech as a relational sector within recent iterations of the 'green economy'.

As a relatively new sector in investment markets, cleantech remains an under-explored area of geographical research into financial markets compared with the attention paid to the creation and operation of other 'environmental futures' markets. Broadly, there has been much emphasis on environmental markets dealing with carbon (Bailey and Maresh 2009; Bailey *et al.* 2011; Knox-Hayes 2009), as well as on markets focused on the commodification of a range of environmental goods and services, as is the case with wetland mitigation banking (Robertson 2004, 2006), and more marginal investment areas such as weather derivatives (Randalls 2010), in an attempt to conceptualise what has been termed the increasing financialisation of nature and the environment (Sullivan 2013) in neoliberal 'efforts to fully integrate nature into the operation of capitalism' (Knox-Hayes 2010, p. 954). In this context, cleantech has rapidly become a major focus of financial markets focused on investments into environmental technologies and services. Indeed, by 2008 the cleantech sector as a whole was valued at US$ 284 billion globally (Caprotti 2010), a dramatic emergence of a sector which barely existed as recently as 2000.

Cleantech is often framed as a technological, market-oriented and ecologically-modernizing response to issues such as climate change and renewable energy because of its primary focus on developing and commercializing resource efficient and low-impact technologies and processes rather than galvanizing changes in social attitudes and behaviours (Wüstenhagen and Menichetti 2012). However, defining what cleantech *is* and the areas of investment activity that fall into the cleantech category is far from straightforward. The Cleantech Group (2012) suggests that: 'Cleantech represents a diverse range of products, services, and processes, all intended to provide superior performance at lower costs, while greatly reducing or eliminating negative ecological impact'. However, the Foundation for Global Sustainability (2012) argues that: 'Cleantech is not an "industry" limited to certain "sectors" … it is "eco-innovation" applied to all

industry sectors.' Burtis *et al.* (2004, p. 6) nevertheless argue that: Cleantech companies 'share a common thread: they use new, innovative technology to create products and services that compete favorably on price and performance, while reducing mankind's impact on the environment'. As such, cleantech products and services are often construed as a means of competing with existing technologies, with an economic rationale first and an environmental one second (Cooke 2008; Wüstenhagen and Menichetti 2012).

Key to cleantech's emergence as a sector and as an investment category is the idea of cleantech as a cultural economic 'wrapper' and as a 'discursive logic' that interprets technologies and material realities and structures them under the banner of cleantech as a sectoral identity. Cleantech can thus be seen as 'an organising trope focused on the nexus between technology, finance, innovation and future transition pathways' (Caprotti 2012a, p. 371). However, the sector attracts substantial capital flows, and is therefore deeply active in the production of materialities, from renewable energy landscapes to new technologies of the everyday. The idea of a symbiotic relationship between discursive strategies and materialities in the creation of markets is a recurring theme in relational economic geography (Boeckler and Berndt 2012). Berndt and Boeckler (2009, p. 536), for instance, note the 'self-realization of economic thought' in their research into the sociology of markets. They argue that markets are performative in the sense that discursive logics and concepts shape actions in a way that makes them more than merely theoretical (see also Hudson 2004; Butler 2010). The economic then takes on two incarnations: 'the 'chaotic' (and immeasurable) sum of all economic activities and as a narrated, more or less coherent, subset of these activities; economic imaginaries, a coherent but selective representation of the complex social world' (Van Heur 2010, p. 431). Cleantech discourses or narratives can thus be seen as central in shaping the material reality of the sector.

In sum, previous research has made some progress in identifying the processes through which the cleantech concept is being delineated and the range of actors who have helped to mark out its discursive logics and identity as a technological revolution and a market-driven response to climate and environmental trends. Beyond this, however, limited research has been conducted on how specific actors in cleantech investment define the sector, the factors informing the analysis of cleantech investments by investors and advisors, how cleantech networks form and operate, or how these factors are shaping the development, deployment and growth of clean technologies (Clark 2005). Considerable scope remains for research on cleantech investment that goes beyond the statistical

analysis of investment deals and the mapping of investment patterns to probe *how* and *why* cleantech decisions are made and how the sector is developing. This is because '[m]arkets, and economic actors more widely, are not preformed and given, but are made up of the entwining of humans and a range of non-human actors such as technologies, theories, tools and beliefs' (Hall 2011, p. 237). Such areas of research, we argue, are vital to understanding the green economy, not least because investment, in many ways, provides the crucial motive force for the emergence and commercialisation of new technologies upon which large segments of the green economy concept depends (Caprotti 2012b). At a basic cultural economic level, the logics behind the identification of cleantech as an attractive target for investment were based on actors' definitions of cleantech, discussed in the following.

Cleantech definitions and networks

As our starting point in the analysis of the cleantech sector, we have opted to examine attempts to define the sector. Definitions proposed by our research participants show not only actors' perceptions of cleantech, but also their conceptualisation of the sector's attributes as an investment category. In part, some of the definitions we encountered reflected widely disseminated sectoral definitions published by actors central to the sector. An example of such a definition is the broad grasp of cleantech offered by Ron Pernick and Clint Wilder, two of the most active cultural and relational actors in cleantech since the inception of the sector. Indeed, Pernick was active in establishing CleanEdge Inc., the world's first cleantech research and advisory corporation, in 2000; and Wilder, a renowned business journalist who specialises in high-tech industries. In 2007 they published *The Clean Tech Revolution*, a book focusing on the growth of cleantech, and which has since been translated into seven languages, thus showing its importance in the cultural importance of cleantech definitions. In the book, the authors defined the cleantech sector in the following way:

> '*Clean tech* refers to any product, service, or process that delivers value using limited or zero nonrenewable resources and/or creates significantly less waste than conventional offerings.' (Pernick and Wilder 2007, p.2).

During the course of our research, it became clear that actors who followed a broader approach such as the one above frequently used more open definitions and felt no need to

name sub-sectors, but, importantly, highlighted a trend towards cleantech becoming 'omnipresent':

> 'At [this company], we define it really broadly. We define it as any process that can be done more efficiently, and I think that's the trend we're going to see going forward. I think you will find cleantech being present in everything that we do.' (Analyst, Cleantech Venture Capital Firm).

However, actors who leaned towards more specific definitions sought to delineate the exact areas of cleantech. Even when they referred to the broad nature of cleantech, they were at pains to name sub-sectors:

> 'We've used the definition of cleantech put forward by Cleantech LLC out of California; which is really they are about 11 segments, of which five are about energy, a couple are about mobility, and then you've got agriculture and waste management as well. So it's really anything that is making a baseline improvement on what we would call business as usual and that doesn't just limit it to your renewable energy, which is where sometimes cleantech gets left. But it's your green chemistry, it's green buildings, its enzyme-based approaches, it's substitutes for gold, copper, all of the scarce resources.' (Senior Vice President Cleantech, Energy & Sustainability, PR & Communications Consultancy).

Some participants even rejected the possibility of defining a cleantech sector. This was justified in a number of ways, from arguments about of cleantech companies being too diverse, to the choice for better-established identities for existing, specific sub-sectors:

> 'Well it doesn't mean much for me at all. I see it as an artificial label, imposed on a diverse bag of investments and I don't really understand why it's useful. So I've never really subscribed to cleantech as an idea.' (Director, Renewable Project Finance Firm).

Nonetheless, some of the participants who rejected the idea of cleantech as a technology sector employed a more nuanced definition of the sector as an investment 'theme' instead. This focus emphasizes the role of cleantech as a cultural construction in making sense of variegated environmental markets and in attracting flows of capital and investment as a

result of broader trends focused on the establishment and emergence of the green economy across a range of scalar and national contexts:

> 'Cleantech is not a sector, it's an investment theme. So I think that the thing that defines cleantech is that it's a response to certain mega-trends.' (Senior Analyst, Market Research Firm).

Thus, one notable aspect of these definitions is that cleantech can be defined as a reaction to green economy concerns, especially around issues such as the improvement of economic-environmental efficiency. This can be seen as the core definitional justification of the sector, and is one reason why salient actors argue that it is appropriate to use 'clean' rather than 'enviro' or 'green' as it distances cleantech from emotive and non-profit-driven responses that can be generated by identification with environmental, 'eco' or 'green' definitions. As the Cleantech Group (2012) argues:

> 'While greentech, or envirotech, has represented 'end-of-pipe' technology of the past (for instance, smokestack scrubbers) with limited opportunity for attractive returns, cleantech addresses the roots of ecological problems with new science, emphasizing natural approaches such as biomimicry and biology. Greentech has traditionally only represented small, regulatory-driven markets. Cleantech is driven by productivity-based purchasing, and therefore enjoys broader market economics, with greater financial upside and sustainability.'

Above all, cleantech was defined and discussed by a range of research participants as an investment target which 'made sense' not because of the potential environmental benefits of any particular cleantech technology or industrial process, but because of the potential for returns and for market-making, the latter based on a range of policy and other drivers which were in some cases couched in 'environmental' or 'green economy' justifications. As one participant noted, her clients were not 'tree huggers', but did want to differentiate themselves from other firms; they liked to be identified as cleantech as it meant being taken seriously as a business proposition, for securing investment, which would be less likely if they were to brand themselves as 'green', 'eco' or 'environmental' (Managing Director, Communications Consultancy). Moreover, as a financial analyst for renewables project finance noted,

> ‘What I’ve learnt [...] so far in finance, is that the environment isn’t ever, ever brought up really. No one particularly cares. I mean, I’m sure people are happy to be working in a sector that’s not doing bad, to some extent helping the environment. But even myself, when I get into work, I don’t try and shoot down investments or projects which I don’t think are environmentally sound enough, it’s all a question of business, at that point.’ (Financial Analyst, Project Finance Firm).

Whether cleantech is conceptualized as a definition that can solely be applied to a fixed set of sub-sectors or as a discursive logic that permeates a wider range of sectors, there is certainly a difference in how actors in each area of cleantech act and interact in the networks through which financial markets take shape. Moreover, cleantech was noted by a number of participants as having widened into newer sub-sectors, which are notable for being less capital intensive than the ‘traditional’ areas of cleantech, such as renewable power generation. Indeed, the participants quoted above were working with a range of different markets, technologies, customers, challenges and business models. However at the same time they were responding to the same macro trends and drivers. Therefore, from the definitions offered by participants, it can be said that cleantech is a ‘discursive sphere’, or an investment ‘theme’, but there is less certainty that it is an actual industrial sector. This appears to be true when considering the various sub-sectors that make up cleantech, because they do not target the same markets, or share the same suppliers or corporations, and the range of business models are frequently very different. However, it is also clear that there are strong enough cultural and discursive linkages and overlaps between these various areas to enable actors to consider them to be logically encompassed within loose definitions under the banner of ‘cleantech’:

> ‘Who is the word cleantech valid for? It’s certainly valid for people who run events, and for investors who want to put some kind of label on all these kinds of sectors, it’s a sort of filtering name at the moment, which I think over time will fall away as the sub-sectors become more developed.’ (Partner, Corporate Finance Firm).

There are, however, moments when different networks of actors around different types of investment or different technologies and sectors coalesce around particular companies and deals. In this way cleantech does exist as a space that is broader than the (currently) relatively fragmented sub-sectors that make it up. Thus, various elements (both human and non-human) can come together at different moments in both space and time, only to change later in shifting socio-technical and environmental-economic assemblages (Anderson and McFarlane 2011; Allen and Cochrane 2007; Cowen and Smith 2009; Law 1992). This captures the complex and often unstable way in which different types of finance and technologies coalesce through the alignment of cultural and economic drivers and actors in moments of cleantech investment activity, only to shift as companies seek different forms of investment, investors look at deals in other sub-sectors, advisors are brought in, or new companies and sub-sectors enter the cleantech sphere. The geography of cleantech is therefore complex, but an identification of the shifting nature of associations enables an understanding of how such conceptual geographies (for example, sectoral definitions or specific investment deals made possible through the cultural economy of cleantech) come into existence, endures over time and changes. In turn, the conceptual geographies of sectoral definition are based on relational interactions between actors, and on day-to-day decision-making at the level of individual actors, whether these are seen as individuals or corporations. It is to these relational networks that the paper now turns.

Relationality, networks and decision-making

Cleantech is constructed through the way in which it is defined and performed, as argued above. Interpersonal networks and relations are therefore a key component in attempting to analyse cleantech as an economic, cultural and social construct (Sunley 2008). In our analysis, networks and relations constitute a frame of reference through which the object of our study can be scrutinised (Latour's 2005). Having examined the relationship between the emergence of cleantech and some of its broad definitional trends and strategies, it is important to ask how these discursive, definitional strategies influence the day-to-day decision-making of investors as actors within cleantech networks seen as a 'hybrid entanglement' (Amin and Thrift 2007, p. 143) by considering the power of cultural mechanisms such as values, soft knowledge, trust and cultural metaphors, as well as by analysing the flows of material inputs and outputs such as raw materials, technologies and funding.

In a number of interviews there was an evident disconnection between identified macro-level drivers of cleantech and the factors influencing investment decision-making on an operational level. The latter were seen as virtually indistinguishable from any other investment analysis:

> 'The measures that are applied to cleantech are pretty much the same as the economic measures that are applied to any other sector. I would say that it's nice to have the additional PR for the companies. Cleantech is not a social entrepreneurial endeavour, it's just measured on cost savings or marginal improvements, just as any other sector and I think that's key to understanding it; ultimately, investments are only made if the numbers make sense.' (Head of Environmental Finance, Professional Services Firm).

This was also reflected in a distancing of cleantech investment from investment strategies that promote ethical choices, or equal weighting for environmental evaluation. Several interviewees assured us that cleantech companies were assessed on how efficiently (and profitably) they delivered technology-based improvements and ameliorations:

> 'They are certainly not foregoing profitability for ethical soundness, they are simply looking for businesses that make lots of money, and do good as well, in that order. And that's the right way to do it. And there's lots of ways to make money, where the result is clean streets, or less polluted air.' (Partner, Corporate Finance Firm).

It would be easy to conclude from such a line of argument that cleantech actors adopted a more or less 'business-as-usual' operating ethos; this would raise pertinent questions about 'greenwash' within the sector. However, this would be an oversimplification of the networked and relational realities within which investors and cleantech executives have to both define and identify cleantech and its macro drivers, and take operational decisions which are ultimately related to financial performance and an investment's future profit potential. This co-constitution of macro drivers, definitions and everyday financial and material practices constitute the shifting assemblage of cleantech, as discussed above.

Relationships between actors are of central importance to this co-constitution, and to the way cleantech business is carried out between a wide range of actors, such as venture

capital investors looking to profit through selling on their investee companies to potential buyers, to corporate finance advisors aiding cleantech innovators in attracting funding, a communications consultancy helping a cleantech company to get its message heard by the right people, or a legal firm advising a cleantech investor on mergers and acquisitions (M&A) procedures. Numerous benefits were identified by our interviewees in thinking about cleantech investments relationally: actors were keen to maintain close relationships and dense networks of interest. In part, this was because intimate knowledge of the investment landscape and of the firms and individuals active within that landscape was seen as crucial to the establishment of successful investment deals and working relationships. Furthermore, the importance of networks was highlighted through reference to the enabling of access to contacts, venture partners and expertise in individual industries and sectors. Networks were also described as essential and central to the operation of specific investment assemblages. For venture and equity investors, for example, networks enabled co-investing. In turn, co-investment networks were seen as desirable not only because of the investment opportunities they presented, but because of the potential for reducing risk to individual investment firms when co-investments were made with other investment partners. With other firms going through due diligence processes, the chances of investing in a potentially risky investment are reduced:

> 'I think the industry is quite co-operative and I think that makes more sense for the investment community. As often in cleantech, because it's a bit of a risky sector, many funds prefer to co-invest.' (Head of Environmental Finance, Professional Services Firm).

Furthermore, the more different parties within cleantech work with each other, the better the understanding they build up of what the other is looking for from a particular deal. As those bonds grow stronger, trust is built up, it speeds up the deal process, and interactions between the two actors are likely to be more successful. As one interviewee commented:

> 'That actually quite surprised me when I started, I always thought it was like stock markets where it's all anonymous, but it's not, you work on a personal level with everyone. We know one group at a bank that just do infrastructure and renewables, and we work with them every week, and that's good because we then just send them our projects, and within an hour they say 'yeah we like this, we'll take this', or 'no, we don't like this'. (Financial Analyst, Project Finance Firm).

Building on this, the scale and breadth of networks highlighted by our participants focused on the dense, intimate nature of these networks. For example, in discussing the search for potential investors for renewable energy projects, the same participant quoted above stated that: 'we only talk to around 15-20 investors, ever. If that helps give a scale to it, and that's enough to satisfy our appetite' (Financial Analyst, Project Finance Firm). This gives some indication of the scale of the relational actor network within which a single project finance firm was seen as operating:

> 'Well, there are only a limited number of investors and we probably know most of them. We met them by getting out there. But now we know where they are, we can speed up the investment process for anybody who is looking for investment. A lot of people will still go to the events and try to do it that way and a lot of people get stuck in the valley of death; now how connected are the two? As one person famously said to me, you have to eat a lot of chicken wings to find any money out there!' (Partner, Corporate Finance Firm).

Therefore, actors were deeply cognisant of the necessity for networks which were not only intimate, but effective in sharing risk, building trust, identifying drivers and investment opportunities, and facilitating the opportunities for interaction. This was seen as particularly important by actors working in an advisory capacity:

> 'The key is to have a network in the sector of the potential investors and buyers, et cetera. So it's more around what do you know of the network within a sector, than if you know all of the different technology differences between battery A and battery B. So it's important that you know all of the players.' (Head of Environmental Finance, Professional Services Firm).

Building up networks can also provide investors with access to expert knowledge to help better assess potential investments. This is particular important in an area like cleantech, which covers such a broad range of different sub-sectors that frequently have different business models, different technologies, and which is also particularly fast-paced, because it is relatively young. For example, it is important to understand the difference between different polymers used in wind turbine blade construction even at the prototype stage, as it may critically affect how an investment will perform. This may differ greatly from the

challenges presented, for example, in assessing an investment in an energy efficiency software company, or a water filtration company. Investment firms aimed to build up their expertise regarding specific cleantech sub-sectors. As one participant noted:

> 'We have a really great venture partner network. And they are ex-industry guys; so we're pretty confident through our network that we can get to the right person to give us feedback on a particular opportunity. Surrounding yourself with those kinds of people is pretty important.' (Analyst, Venture Capital Firm).

As well as technical expertise and expert knowledge, the role of professional service firms was seen as central to the functioning of investment networks in the cleantech sector. As noted by previous studies (Wray 2012; Mason and Harrison 2002), this is especially true of venture capital and private equity, where investors often take an active and face-to-face role in assisting the management of the company. Several research participants identified the key role of service and advisory firms in mediating relational connections between actors in heterogeneous networks:

> 'We get our message out there to corporate finance houses, law firms, because that helps deal flow. You need to engage with companies and watch them grow, you need to surround yourself with people who have experience. And of course, the most important aspect is deal flow; you don't get access to the deals unless you do.' (Analyst, Venture Capital Firm).

Finally, relationships in the cleantech space can be seen as identity-forming. It is through engaging with other actors in cleantech networks that individuals and companies develop their reputation and identity within the cleantech sector. This is significant because this is a key way in which the legitimacy is established. Through building associations with other actors, engaging in repeated relations of transactions and exchange, a cleantech firm strengthens its own status and the discursive logics that contribute to its identity. Moreover, the act of collaborating or advising strengthens the ties between actors, in a way that will enable them to improve the way in which they do business in the future. It is however important to note that cleantech is a fast-moving, dynamic economic environment with new companies and new sectors emerging and evolving, so these ties within actor-networks do not serve to entrench or stagnate cleantech, but to allow companies and individuals to work together in efficient ways that are mutually beneficial

and open to rapid change and adaptation. Repeated interactions (building embedded relations) act as a conduit to resources that may not otherwise be accessible (Uzzi 1999). It can be seen that there is a cultural and social context surrounding the financial activity of cleantech created through events, meetings, understanding of synergistic and shared goals, and trust built up through business track records. The challenges of cleantech, as it often involves companies that face significant technology as well as market risk, mean that co-investment is important as it increases the amount of due diligence undertaken, and it allows investors access to a wide geographical scope of expertise and support for companies to help them enter new markets, for example.

Overall, participants identified the importance of networks of contacts for co-investing, obtaining technical expertise for assessing companies, and finance and legal expertise to speed up deal flow. However, as several scholars of relational economic geography and the cultural economy have argued, there is a need to balance the benefits of adopting culturally-nuanced theoretical frameworks with appropriate consideration of the 'embeddedness' of networks of actors within cultural, political, territorial and institutional contexts (James 2005, in Sunley 2008, p.10). It is therefore important to balance the significance of relations, connections, and networking with the influence of identified drivers and macro-trends, and prevailing economic conditions, whilst not narrowing the focus of the "relational" element of the analysis too much.

What this means in the scope of this study is that while it may be true that cleantech investors are not thinking about saving the planet every time they walk into the office, it is not possible to completely separate day-to-day operational decision-making from extra-organisational drivers and macro-trends. Indeed, we argue that cultural practices of relationality and network-building intersect with broader economic, policy and other drivers in co-constituting cleantech as a sector and investment direction. As one of our respondents stated:

> 'At the company level, the ones doing the most in this are doing it for one of two reasons; either they believe that it is the way they will deliver sustainable value in the future, so they look at their consumers who are becoming more alert to these issues, and looking for a way to build reputation, to lock on the consumer to their brand long-term. Or they're doing it because their board sat down and has done serious risk assessment of what climate change means for us, and they are trying

> to reduce their exposure long-term to cost spikes which are going to come when resources really do get scarce.' (Senior Vice President Cleantech, Energy & Sustainability, PR & Communications Consultancy)

More broadly, it is also true that although cleantech venture capital and private equity actors *respond* to these macro drivers, due to its relative size as an economic sector, cleantech is not in a position to set agendas. It can, however, play a vital role in developing innovative solutions to broader issues seen as drivers, and it is in this context that discursive constructions of cleantech intersect with technological and economic materialities.

Concluding remarks

The broad range of processes that characterise the emergence of new economic identities and sectors have been largely implicit in existing research and have often been left within the wider 'black box' of wider socio-economic change, understood as taking place as a matter of course. Indeed, such processes have, in many cases, been regarded as constrained to a single dimension (economic, technological, political and so on) where change can be seen to be taking place, and their deeper complexities and multifaceted nature have not always been rigorously investigated. It is in this context that the theoretical frameworks offered by relational economic geography and by studies into the cultural economy offer assistance in understanding the complex, shifting, and sometimes elusive and contested character and workings of phenomena within economic geographies such as sectoral emergence and change (Bathelt and Glückler 2003; Bosco 2006; Gibson and Kong 2005).

Through our analysis of relationality and of the perceptions of specific investment actors within the cleantech sector in London, we have highlighted the relationships and co-constitution of micro and macro-level drivers and specific contexts contributing to the advancement of cleantech as a sector and investment theme. What has emerged in particular from our research is the importance of relational networks of investment and cognate actors in establishing and performing the identities of specific sectors of the economy, according to shifting and evolving cultural-economic logics. A key corollary of this is the assumption that can be made about economic trajectories in specific sectors. Specifically, this paper has opened up the potential of identifying relational, cultural change processes through which actors' agency is expressed: the implication of this is that

the ‘economic’ sphere is, at any point in time, ‘up for grabs’ and open to endogenous or exogenous influences. This connects to wider, contemporary concerns about the extent to which transitional environmental-economic strategies can be designed and enacted in the construction of green economic futures and trajectories.

This paper has focused on the pivotal role of relational networks of actors in performing, enabling and contesting sectoral identities and processes of emergence. Networks allow cleantech actors to understand the market drivers and the decision-making logics of potential investors, technology firms, and buyers. All of the above factors help to create identities and relations of trust, give legitimacy to cleantech discourses and generate the essential conditions for mutually beneficial economic activity. The study has developed our understanding by establishing how those actors who are active participants define cleantech, and what factors influence its development. It is thus key for further research to focus not just on networks and highly visible actors within relational networks, but also on the broader range of discursive actors who may not be directly involved in investment decision-making but who, through their discursive and network influences, may exert subtler but still significant impacts on sectoral emergence. These actors may include professional service firms such as market research corporations, law and advisory firms, financial journalists, sectoral media coverage and financial news outlets, and other parts of relational networks which can be investigated in the online sphere through forums and blogs, and through online investment platforms. In this context, the cultural economic network which plays a part in sectoral emergence can be seen as comprised of an extensive and diverse range of actors that includes, but is certainly not limited to, investment and industry executives. As mentioned above, this also leaves open the possibility of investigating the targeted involvement of other actors or relational mechanisms within existing and evolving networks in attempts to influence green economy development trajectories.

This study thus highlights the importance of focusing on economic *networks*, and their roles, scale and composition in enabling the development and workings of an emergent sector such as cleantech. Our research has underlined the importance of networks not simply in terms of their emergent and evolving nature. Rather, our focus on the cleantech sector has uncovered the central importance of relational networks for those same actors who are part of the network: in this light, the network can be seen not as a simple expression of economic organization and cultural economic activity, but as the central

interface through which actors can achieve specific goals and in so doing, perform the emergence of a sector which encompasses but surpasses the firm-specific or individual economic identity of any one actor. The implications for research in economic geography are multiple, as it opens up the possibility of interdisciplinary links with other social science approaches which have tackled the question of the formation and functioning of social networks and their broader role in both enabling and shaping social life.

Finally, our study reveals cleantech's predominant framing as a neo-liberal, market-driven sector that provides tangible expression of broader trends towards 'market environmentalism' (Bailey 2007; Bakker 2005) as a currently hegemonic development pathway towards a 'green economy'. Indeed, the development of the sector can be seen to be operationalized across a variety of scales, from the individual investor decision-making scale, to broader policy drivers at a national or even global scale. These multi-scalar drivers operate on a scalar spectrum which ranges from corporate sustainability strategies, to institutional investors' influence on sectoral development, to governmental regulatory incentives or directional policies, to global concerns around decarbonisation and the establishment of an as-yet loosely defined 'green economy'. However, it is clear that central to an understanding of the emergence of cleantech is an understanding of how networks, relationality and multi-scalar drivers interact in the co-constitution of economic sectors driven by environmental finance. In this sense, the paper concludes with two related points. The first is that neoliberal market environmentalism is, without question, the dominant discourse within relational networks performing the emergence of new sectors of the green economy, such as cleantech. The second is that our focus on the importance of networks and relationality depicts a more diffuse distribution of agency than is perhaps commonly allowed for in discussions of the development and dominance of neoliberal market environmentalism. This second point is particularly important because if key aspects of the green economy are relational and performed rather than prescribed and prefigured, they are also open to change.

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