

**Title**

David, Goliath and Schumpeter: questioning mechanisms of value accrual in the context of clean energy technology transfer

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**Abstract**

Investment in new energy technologies is inadequate relative to the timescale on which greenhouse emissions need to be reduced. This raises questions concerning the level of commitment of the energy majors to low carbon energy supply. We bring firm-level theory of value creation together with a critical perspective of Schumpeterian concepts, to set out propositions and a theoretical basis for the study of 'value hoarding' in the context of energy technology diffusion. Using clean energy technology transfer as an example of potential technology benefit, and focusing specifically on biofuels, we draw on studies of clean energy patenting to discuss how value creation may in principle be impeded by corporate patent strategy and how this may be researched empirically.

**Keywords**

Value creation; biofuels; patent strategy; intellectual property; innovation; technology transfer.

## Introduction

This paper connects theories of firm-level value creation with policy debates relating to the downstream consequences in terms of international technology transfer for climate change mitigation, particularly for renewable energy. Our underlying premise is that global financial, economic and environmental crises require different ways of thinking, different ways of acting and different ways of doing capitalism. In particular, in terms of the environmental impact of contemporary economic systems, the prospect of a number of discontinuous, large scale, interconnected environmental and climatic changes this century demands a rapid shift towards more sustainable practices (Lenton et al, 2008). Deploying new, low carbon energy technologies internationally is one of the more important of these shifts (IPCC, 2011).

Patenting has potentially an important role to play in clean technology development. The number of international patent applications filed in the EU relating to climate change mitigation technology, relative to GDP, more than doubled between 2000 and 2007 (EC, 2011). Yet while this is viewed positively at policy levels, policy influence over incumbent energy firms and supply cartels, particularly in terms of encouraging new entrants and renewable energy technology innovation, is far from straightforward. Challenges include the need to co-ordinate the phase-in of low carbon sources with the phase out of so-called 'brown' sources (Verbruggen and Lauber 2009). The scale of the required deployment of low carbon energy technology for a nation such as the UK is huge, but the level of contemporary investment in particularly renewable energy technology by the incumbents is modest: contrast, for example, BP's \$8bn investment in low carbon energy technology<sup>1</sup> over 2005-15 with its single year operating revenue in

2010 of \$267bn, or its \$20bn compensation fund for the Deepwater Horizon oil leak (BP, 2011a,b).

Here we are concerned with a further problem, but one that at this stage is a hypothesis rather than empirically supported: the possibility that multinational companies (MNCs) in the energy sector may have operated intellectual property right strategies that are hindering the transition to lower carbon economies, by acquiring intellectual property rights that are either deliberately unused or that are used in such a way as to block the use of low carbon energy technology owned by others. We emphasise that we do not have evidence of this – but then neither do there appear to be any assessments of whether, or the extent to which, this is actually taking place.

Rather, this paper lays a basis for study of such a possibility. The possibility is neither fanciful nor dependent on assumptions of conspiracy. It is known that patents are used strategically to block competitors (Hall and Ziedonis, 2001; Ziedonis, 2004; Giuri et al, 2007); that some of this activity can be regarded as aggressive – including by so-called patent ‘trolls’ (Sandburg, 2001) - and that the social cost of not using a patent increases in proportion to its scope (Giuri et al, 2007). It is also known that there is a strong temporal aspect to the societal value of patents and a need to balance the benefits to first and subsequent generations of developers (Scotchmer, 1991). Acquiring knowledge that is not used may have the function of blocking others’ actions, but it also enables a firm to be ready for its future use, when an opportunity presents itself or, a specific likelihood in the clean energy sector, the policy environment becomes more consistently and vigorously supportive.

Overall, perceptions of the value to society of different levels of stringency for patent law have fluctuated over the years (Mazzolini and Nelson, 1998). A common narrative, though, is one in which the small firm or inventor battles against a large company in defence of his or her intellectual contribution (Chien, 2009). While acknowledging that the reality is doubtless more complex than any of the common patent litigation narratives, of which ‘David v. Goliath’ is but one (ibid), it is this possibility that we address by setting out a rationale, supporting theory, propositions, methods for further investigation and exploratory discussion. In this way, we aim to lay the basis for study of what we term as ‘value hoarding’, constructing a conceptual challenge to the myth that there is necessarily a positive association between innovation, patent filing and societal benefit through new value creation. Drawing on Schumpeter’s principles of Creative Accumulation and Creative Destruction in conjunction with Bruyat’s (1993) and Bruyat and Julien’s (2001) theory of new value creation through entrepreneurship, we develop a theoretical basis for investigating trends in value accrual and use. We apply this to the case of clean energy technology transfer, which we argue to be of urgent importance, using secondary material as a precursor to further, primary data analysis. Thus we lay the theoretical groundwork for empirical investigation.

Although authors such as Ball and Kesan (2009) and Chien (2009) have examined firm size in relation to patent litigation, and although there have been major surveys of corporate use and non-use of patents (Guiri et al, 2007), defensive and offensive patent practices appear to be untheorised in terms of value creation by the entrepreneur and related studies in the clean energy sector are scant. What is needed is systematic study that traces the genesis and use of individual patents. In our case study sector of biofuels, the European Patent Office lists some 771 patents with ‘biofuels’ in their title, offering

an entry point for such work. Our purpose here, though, is primarily theoretical and conceptual. We aim to provide a theoretical basis for such empirical work: to provide a rationale for propositions relating to value-hoarding, particularly in terms of small-large firm relationships. While we discuss some of the possibilities in terms of biofuels and technology transfer, drawing on previous work (Jorma and Bell, 2009; UNEP, EPO and ICTSD, 2010), we leave new empirics for another stage.

In terms of reasons for our focus on the relationship of smaller and larger firms (the precise definition of which is deliberately left open here), firstly smaller firms have been repeatedly shown to be in many ways more successful sources of innovation, highly personalised in their values provision and more often pioneers of radical innovations than their larger counterparts (Alsos, Isaksen & Ljunggren 2006, Kirchhoff, Newbert, Iftekhhar & Armington 2007). Small firms have also been credited with making a fundamental contribution to local, regional and national economies due to their net contribution to employment and job creation (Curran 2000, Parker 2001, Phelps 1996, Reynolds, Hay & Camp 1999, Michael & Pearce II 2009), taking over a social role as recipients for labour released due to rationalisation, scaling down and decentralisation amongst larger businesses, management buy-outs, and the introduction of new technologies (Council of Europe 1994, Curran & Storey 1994). Thus while we could have restricted our discussion to IPRs held by firms of unspecified size, organisational size does seem to be an important variable (albeit but one among many) in both innovation and in realising societal benefit in addition to private benefit from technological innovation.

Secondly, in so far as IPRs play a critical role as a mediator of societal value, so they often also figure highly in the relationships between smaller and larger firms. Fundamentally, IPRs mediate the realisation of value through the allocation of ownership. Yet, as Michael & Pearce (2009) observe, the relationship of small and large firms, particularly multinationals in innovation generally, and in relation to IPRs specifically, is ambiguous. McDonald (2003, p. 136) expresses it thus in relation to one particular sector: “the patent system is not equally suited to all; it suits the pharmaceutical industry very well indeed, and most small firms (SMEs) very badly”. Similarly, critical voices such as Lahti (2007) and McDonald (2003) have suggested that MNC purchasing power, dominant market positions and socio-economic, political and technological dominance exert a variety of pressures on stakeholders, particularly SMEs operating in globalized commodity markets. Of course there are also contrary views: commentators such as Alan Rugman (1996) have argued strongly that multinationals make a significant contribution to world welfare and are of a non-exploitative nature.

We consider developing country technology transfer for greenhouse gas emissions mitigation as a strong case of societal value creation. IPR in the pharmaceutical sector, specifically generic drug production, might be a similar case. While related arguments would apply to patent strategy in, for example, the consumer electronics sector, the societal benefits potentially foregone might be more debateable.

With this rationale in mind, the paper is structured as follows: first we review selected aspects of the small-large firm relationship and discuss the Schumpeterian concepts of Creative Destruction (CD) and Creative Accumulation (CA) and their relevance to

innovation, Schumpeter being perhaps most classically and reverently associated with the field of technology innovation. We then critically investigate conceptions of value creation, proposing a model based on Bruyat (1993) and Bruyat and Julien's (2001) conceptualisation of entrepreneurship as value creation. The latter follows Gartner's (1985) four variable model of the entrepreneur, the organisation, the process of firm creation and his/her interactions with the environment, enabling a complete picture of the firm's development (Anderson et al. 2007). Thereafter, we review ways in which patents may be used strategically to secure value within the firm in ways that limit wider societal benefit, particularly in relation to international technology transfer. Through this process, we develop propositions that arise from the discussion, which we then consider in relation to technology transfer in the biofuel sector. Finally, we discuss methodological considerations applicable across sectors, for subsequent empirical work.

### **Innovation and small-large firm relationships**

As Schumpeter (1950) observed, clustered MNCs share certain elements of collective capitalism. They invest heavily in global R&D and marketing, but they also represent power in markets and politics. These resources are concentrated geographically. Drawing on Dunning (1993), Eden, Levitas & Martinez (1997) observed that by the 1980s, over 80% of all R&D expenditure occurred in five countries: the US, Japan, France, the UK and Germany. This is, however, a highly dynamic and competitive context: on the current trends, China is set to overtake the EU by 2014 in terms of absolute R&D expenditure (EC, 2011). While EU total research investment rose by 50% between 1995 and 2008, in China it rose by 855% (ibid).

Despite on-going shifts in the global economic power balance, the firms involved collectively influence (if not determine) the rules of the game in the global economy (Lahti 2007). In economic terms, it is only growth firms and successful start-ups that pose countervailing power (ibid). Whether or not such firms are actually more innovative than larger incumbents is unclear. Adams and Brock (1986) estimated that small firms produce some four times as many innovations per R&D dollar as middle-sized firms and 24 times as many large firms. Damanpour (2010), however, integrating empirical studies of the associations of firm size and market competition with product and process innovations, did not find evidence of substantial differences in the strength of the influence of either firm size or competition on the two innovation types (ibid).

As pointed out by Kenney (1986), the relationship between entrepreneurial small firms and multinationals is full of such contradictions: relationships between the two are often perceived as marriages of convenience, often (but of course not always) with smaller firms owning technology of interest to larger firms. Nonetheless, in general, larger companies need new products to keep their marketing portfolio full and acquisition of small firms or rights to their innovations offers one way of meeting this need. Aware of this, small firms tend to pursue their own agendas in their dealings with their larger counterparts, aiming to give as little as possible and to build their own in-house skills whilst working with large firms (Keeney, ibid). The small firm strategy is often to sell marketing rights and entertain different contracts with large firms, thus ensuring independence and flexibility (ibid). Large companies can be useful partners for entrepreneurs, as the former have access to world-class technologies (Markusen & Venables 1997, Lööf 2009), as well as relatively efficient marketing channels and logistics with a global reach.

Given the above ambiguities in the relationship between innovation and firms of radically different size, a return to theory is merited when thinking about the relationship between value creation, firm size and societal benefit. Below we revisit classical Schumpeterian concepts and later theoretical developments, setting the scene for what we see as a more contemporary and perhaps less stylized account of the dynamics involved.

### **Creative Destruction and Creative Accumulation revisited**

Schumpeter advocated two approaches to the innovative process: *Creative Destruction* (CD) and *Creative Accumulation* (CA). The first focuses on the role of new entrepreneurs entering market niches, introducing new ideas and challenging existing firms through a process of *Creative Destruction* (Prozess der kreativen Zerstörung), considered the engine of economic progress (Schumpeter, 1912). CD can ex post be observed as economic discontinuity, which then becomes the entrepreneurial momentum ex ante to introduce innovations and to earn monopoly profits, on condition that an entrepreneur is early enough in identifying market opportunities (Lahti 2007).

Nelson and Winter (1982) and Winter (1984) further developed Schumpeterian ideas into Schumpeter Mark I and Schumpeter Mark II technological regimes. Mark I focuses on the key role of new firms in innovative activities, i.e. CD; Mark II focuses on the role played by large and established firms, i.e. CA. As Aghion & Howitt (1992, 1998) point out, CD is a micro-economic process in nature, with important macro-economic implications. In particular, small, new, innovative firms, highly personalised in their

values provision, are classically viewed as a key source of innovations (Lahti, 2010; Alsos, Isaksen & Ljunggren 2006; Kirchoff et al 2007).

In terms of Schumpeter's theoretical developments, CA came later (1942) and related to the role of large firms as engines for economic growth via the accumulation of non-transferable knowledge in specific technological areas and markets (Patel & Zavodov 2010, p. 79). As expressed by Freeman and Soete (1987, in Soete and ter Weel, 1999), the idea is that in large firms there is a strong positive feedback loop from successful innovation to increased R&D capability and activity, setting up a feedback loop that in turn reinforces market concentration.

CA is thus associated with a number of processes of institutionalised innovation by large firms (Filipetti, Frenz & Archibugi, 2009). When entrepreneurs engaged in processes of CD expose their innovations to the market, large firms may legally appropriate a major part of that intellectual property and add to their own proprietary knowledge stock. This is assisted by the use of near-monopoly power, substantial in-house R&D departments and networks of partners such as research universities and private and public research institutes (Filipetti et al, 2009; Lahti, 2010). Internal and financial resources allow the larger firms to recruit the competencies required to embed externally developed generic knowledge into the development of new products and services internally (Filipetti et al, 2009). Moreover, utilising scale economies and monopoly power, large firms are able to create high barriers to entry of new entrants (Scherer & Ross, 1990), impact upon industry life cycles (Klepper, 1996) and market structure (Agarwal et al, 2002).

Both concepts – CD and CA are thus the opposite ends of a continuum (Filipett, Frenz & Archibugi 2009). Figure 1 provides a stylised, Schumpeterian approach to value creation as being a function of CD and CA, in relation to innovation and IPR, specifically patenting. Both the processes of CA and CD are thus conceived of as being socially beneficial.

< Figure 1 >

### **Schumpeterian logic and Bruyat's theory of value creation**

This brief rehearsal of one aspect of Schumpeterian thought provides a context for considering the process of value creation, for which purpose we use a perspective provided by Bruyat & Julien (2001). The latter extended Bruyat (1993) to define entrepreneurship as concerning the relationship between the individual and value creation (“l’objet scientifique étudié dans le champ de l’entrepreneurship est la dialogique individu/creation de valeur”) (Bruyat 1993, p. 57). Bruyat’s concept is in turn based on Gartner’s (1985) four-variable model for entrepreneurship, comprising the individual, the process, the environment and the enterprise. Bruyat’s approach suggests that new value is created in terms of more or less intense change in the environment directly related to the entrepreneurial process (Verstraete & Fayolle 2005). In other words, Bruyat argued that at the heart of the entrepreneurial process we find the act of value creation, as a result of the interaction between the individual and his/her environment. As Bruyat & Julien (2001) elaborate, at the beginning of the process we have:

The Individual (I) => New value creation (NVC)

where the individual defines himself or herself in relation to the structure, i.e. the organisation that is being created. Hence the individual is both constrained and created by the object that (s)he constructs.

Bruyat & Julien (2001) concluded that:

The Individual (I)  $\Leftrightarrow$  New value creation (NVC)

indicating the dialogic between the two entities who form a system. Following Boulding (1956), Bruyat & Julien (2001) concluded that the entrepreneurial system is a *type 9* system, meaning that it is capable of learning and creating and that it has intention. The system as such is also open and interacts with its own environment, as shown in Figure 2. Similar to Gartner's (1985) conception, this model is comprised of four key aspects: the individual, the object created (i.e. the organisation and/or an innovation), the environment and the process. The key difference between Gartner and Bruyat & Julien (2001) is that in the latter's conception, the individual and the object created are part of a dialectic and are thus at the heart of the theory, which assumes that the entrepreneurial value creation process leads to Schumpeter's CD. Figure 2 shows the entrepreneurial process following Bruyat & Julien (2001).

<Figure 2>

Taking this initial model further, we propose, based on this initial conceptualisation of Bruyat & Julien's (2001) theory of the relationship between the individual, the

enterprise, the entrepreneurial process and its environment, a theoretical understanding for the relationship between the entrepreneurial individual (I) involved in new value creation (NVC) which leads through a process of CD to (radical) innovation. However, this process, which is potentially favourable for society, can be impeded by the process of CA, as the act of value creation takes place not in a vacuum but in a particular context or environment involving in practice agents such as MNCs, government subsidies, university and other research laboratories and a wide range of stakeholders who seek to influence the system in their interests, as shown in Figure 3. In this respect our conception of value creation through innovation corresponds with Filipetti et al (2009), who argue that CD and CA are not exclusive, but rather interrelated processes.

<Figure 3>

### **Critical views of patenting**

Thus far, we have extended the classical account of innovation by bringing this together with an account of value creation processes that emphasises the complexity in the relationships of firms and their environments. In this section we add to this account of complexity by introducing what might be termed the ‘critical’ literature on patent strategy. By ‘critical’ is here meant work that questions the relationship between patenting, innovation and societal welfare, be this conceptually or empirically.

As with innovation generally, there is a widespread assumption that patenting is a socially positive activity. Yet patenting clearly also has private value. Moreover, use of patenting as a competitive, strategic tool, rather than simply a defensive one, has a long

history. Hart (2001), for example, identifies a cyclical salience to technological innovation in US anti-trust law over 1890-2000, referring to Woodrow Wilson's critique in 1912 of the practice of purchasing patents that then remain unused. More recently, Dosi et al (2006) question whether IPR mechanisms have any positive relationship at all to innovation - and perhaps a negative relationship - suggesting that factors such as the technological paradigm and firm characteristics and capabilities have more of a bearing on innovation rates.

As Macdonald (2004) comments, while the patent is nominally supposed to be a means to the end of protecting IPR, it has become much more than this, arguably since the 1982 inauguration of the Court of Appeals for the Federal Circuit (CAFC) in the United States, a specialist patent court, in authority just below the Supreme Court (ibid). Macdonald takes the view that the patent has become an end in itself, with strategic value independent of innovation, supported by a technology-push myth of a linear innovation process in which R&D is at a chronologically early point in the chain, rather than the more complex, contemporary actuality. Macdonald (ibid) also refers to the way in which small firms and developing countries have had little power in the development of the global patent system (ibid).

Examining patent behaviour in more detail, Blind et al (2009) identify and distinguish two strategic approaches to the use of patents by German companies, namely offensive and defensive patenting. Drawing on Arundel and Patel (2003), Blind et al (2009) refer to offensive patenting as describing a situation in which a firm is already earning a return from an innovation, which it later patents in order to hinder or block another firm planning to patent a similar but not identical innovation. In comparison, defensive

patenting relates to a situation in which a firm patents its innovation to prevent another firm patenting that same innovation, even though it has not needed the patent, up to that point, in order to earn a return (ibid).

Offensive patenting may involve building a web of patents that are not used directly for IPR purposes, but which serve to protect another patent (ibid). Such blocking of others' attempts to patent and/or sell their own, closely related products (Cohen et al, 2000), by patenting around a product, is also referred to as creating a patent thicket, cluster or bracket (Rivette and Kline, 2000). Associated activities have been termed blitzkrieging, consolidation, blanketing and flooding, fencing and surrounding, by patent harvesting and ramping up (Hall and Ham, 1999, in Macdonald, 2000). A qualitatively different strategy is patent stacking (Heller and Eisenberg, 1998). Patent stacking in combination with reach-through license agreements (RTLAs) may extend the influence of a patent holder onwards through time, in relation to subsequent innovations in which they are not directly involved. An RTLA gives a patent holder rights (e.g. to a royalty) in subsequent downstream discoveries, often in lieu of an upfront payment to use the patented innovation. Through multiple patenting around an innovation, rather than of the specific innovation only, there is a higher chance of retaining rights to a return.

### **Propositions relating to value creation and SME-MNC inter-relationships**

In the light of the above, in this section we consider the relationship between larger and smaller firms, specifically processes of value creation and the role of patenting therein. We make a number of propositions, drawing on the above and on additional literature. Arguably, CA is associated with institutionalised innovation by large firms which appropriate the intellectual property of individual entrepreneurs and protect it as a major part of their own intellectual property. However, as Soete and ter Weel 1999, p. 8). the perception of the nature of innovation processes has changed in our societies. Innovation has come to be less understood as the capability to innovate and more as the ability to discover new technological principles in terms of the systematic exploitation of “the effects produced by new combinations and use of pieces in the existing stock of knowledge” (ibid, p.8). This new understanding requires systematic access to the state-of-the-art and new procedures for disseminating information about the stock of technologies available, so that knowledge and information exchange between innovators is made possible (ibid).

As Patel & Zavodov (2010) observe, technological knowledge is generally embedded in some form of specific blueprint form such as a patent, artefact, a design, a software programme, a manuscript or composition. By design, this knowledge is often not fully shared. Our proposition (P1) reflects the premise that the concentration of patents in the ownership of a few countries and a few MNCs in particular locations is potentially antithetical to the process of sharing that knowledge with the many. Malecki (2009) emphasises the way in which knowledge and innovative activity are geographically clustered and Asheim & Gertler (2005) observe that the tendency toward spatial

concentration has become more marked over time. Yet, as Soete and ter Weel (1999, p. 2) emphasise, the capacity of an economy to benefit from technical change and innovation is finally “dependent on the dynamic efficiency with which firms and institutions can diffuse, adapt, and apply information and knowledge”. As the authors conclude, the diffusion of knowledge is key to growth (ibid). Once the contribution of an innovation is manifest as leading-edge technology, other firms are able to deploy that technology through purchase of related but different design and incumbent firms whose technology is no longer on the leading edge experience competition, i.e. the process of CD is in place. Based on this understanding we propose:

**P1: The concentration of innovative power in the hands of a few countries and a few large companies restricts knowledge access and knowledge transfer, inhibiting the process of CD and new value creating processes potentially beneficial for society**

Whereas knowledge can - theoretically - be shared freely (Malecki 2009), there are costs associated when acquiring knowledge, also referred to as information asymmetry (Patel & Zavodov 2010). According to WIPO (2008) the cost for filing a patent in two countries amounts to \$16,971, 7 countries \$59,397 and 15 countries \$119, 381; these figures include official fees, maintenance, legal and translation costs. The costs highlight the importance of economies of scale when patenting, but also the need for adequate financial resources when engaging on this path. It can be assumed that MNCs, with larger resources than small firms, will have less trouble funding patenting than young, struggling ventures. This gives rise to our second proposition:

**P2: The processes of CA and IPR accrual can accentuate the imbalance of access to financial resources of small and large firms, creating significant barriers to entry for small businesses, so impacting new value value creation potentially beneficial for society.**

Through the process of CA, the production of knowledge becomes the privileged domain of what Foray (2004) termed the “comfortable world” of standard models, with stakeholders such as R&D laboratories and universities specialising in knowledge production and in particular generic knowledge with potential for large-scale commercialisation processes (Filipetti et al, 2009) This contrasts with CD which supports the key role of small business in providing impetus for change, innovation, personalised value propositions and specific knowledge (Gibb 2000). Hence our third proposition (P3) relates to the potential tension between CD and CA as the former may inhibit small business’ potential to deliver much needed societal impetus in terms of qualitatively different value-adding activity.

**P3: The process of CA and use of IPR strategies may promote the abundance of generic, large-scale end value propositions, potentially detrimental to small business’ potential to deliver specific knowledge applicable in personalised new value creation propositions**

Creative Accumulation also promotes the geographic proximity of scientists who live in the regions occupied by multinationals that are best buyers of the new, scientific knowledge. The triad of New York, London and Tokyo that dominate global financial services is an example of permanent clusters (Sassen 1991). Such settling strategies have both macro and micro-economic implications in terms of infrastructure available,

pricing of housing and quality of life and again clustering of knowledge in the hands of a few. Thus we propose the following:

**P4: CA and IPR promote the geographic proximity of scientists, thus clustering intellectual knowledge and new value-adding activities in a few, mostly developed country locations.**

As Lahti (2007) points out, knowledge is the core of the global economy and as such “knowledge represents the capabilities of individuals or social groups associated with meaning and understanding, as well as the abilities to organise, interpret and assess information while information is knowledge reduced to messages that can be transmitted to decision agents” (Dasgupta, Partha & David 1994). Knowledge is concentrated in the hands of a few multinationals in a limited number of locations and is associated with established power dynamics. Hence MacDonald (2004) refers to US policy-maker concern regarding the relationship of economic strength to maintain national security and military might (MacDonald 1990). In particular in the 1980s, high technology and associated patents were considered as key to keeping American technology American. The pharmaceutical industry was quick to use this opportunity to establish a monopoly, rather than the diffusion of information that, as MacDonald (2004) suggests, may have benefited foreign companies and thus jeopardised US innovation, competitiveness and security (Merges 1988, in Macdonald 2004). As Macdonald (2004, 146) critically notes in this regard: “some companies now have no activity beyond collecting patents in the hope of obstructing the innovation of other companies”. We propose:

**P5: The process of CA and IPR systems are used by large companies to monopolise information channels to influence established power dynamics in their interest. This may lead to interrupted/incomplete knowledge transmission to different decision-makers and the general public, so retarding new value creation activities and potentially impeding societal benefit.**

MNCs collaborate with the most successful universities and research laboratories to access the latest technology and knowledge Dicken (2003). Yet the increased propensity of universities to patent inventions has reduced spill-overs from research, as universities benefit more directly from in-house innovation (Cooke et al, 2007). Increasingly, universities forge formal and informal ties with companies, yet to date the focus has been on large firm relationships. US universities are particularly successful in filing patents( see for instance California University with 364 patent filings in 2007, followed by MIT with 175 filings, Columbia with 114 and Texas System with 95 filings (WIPO, 2008)). In 5<sup>th</sup> position we find Osaka University with 91 filings and Tokyo University with 67 filings in 10<sup>th</sup> position (ibid). The same data as of 2007 reveals the complete absence of European universities. We propose the following:

**P6: The process of CA and IPR systems are used by large companies to monopolise knowledge with the increasing assistance of universities due to their privileged relationship, so potentially obstructing new value creation processes and their societal application.**

The European Commission (2007) found that many service sector innovations do not necessarily meet the requirements for protection through patenting, that twice as many industrial as service firms applied for a patent and that more industrial than service firms apply for a trademark. One reason for this may be the mismatch between the type of knowledge generated by universities and research institutes and the knowledge needed by the services sector. Such knowledge can only exceptionally be synthesized and transferred in a codified manner, something that is easier for technological knowledge (European Commission 2007). As a result, the European Commission (2007) asked for a complete rethink of European innovation policy in line with the changing socio-economic, political, technological and environmental circumstances, with particular focus on innovation in services, seen as a main enabler for the creation of the knowledge-based economy and hence a priority for Europe. This gives us our seventh proposition.

**P7: The process of CA and the accumulation of intellectual capital in the hands of a few multinationals and in a number of selected countries run counter to the European Union goal of creating a knowledge-based economy based on new value creating activities (CD) available for every citizen.**

As Ahlstrom (2010) advocates, disruptive innovation helps firms and economies grow through the creation of new business and the development of new product markets, i.e. in Schumpeterian terms ‘new economic space’, an idea later further developed in Kim and Mauborgne’s (2005) Blue Ocean Strategy. Arguably, small firms’ innovative capacity, also for disruptive innovation, enables them to create ‘uncontested market space’ - ie. blue oceans. We suggest:

**P8: CD leads to the design of ‘new economic space’ through small businesses, with the latter being a promoter of new value creation and related value creation processes.**

In the remainder of the paper we discuss issues arising from these propositions in relation to a specific example of the use of IPR for societal benefit, namely technology transfer in the clean energy sector, using biofuels as a specific case.

### **Technology transfer and IPR**

Enhancing technology transfer to developing countries has been an integral part of the global climate change regime since the inception of the United Nations Framework Convention on Climate Change (UNFCCC), yet the role of IPRs has emerged as a particularly contentious issue in this context. Many developing countries and some nongovernmental organisations (NGOs) have advocated the use and expansion of the flexibilities on IP available within the WTO TRIPS Agreement, such as compulsory licensing, while many developed countries and business associations claim that only strengthened IP regimes will encourage the necessary innovation, transfer and diffusion of such technologies (UNEP et al, 2010).

In 2010, with the purpose of mapping the clean technology patent landscape, the European Patent Office (EPO) reviewed 60 million patent documents and identified 400,000 that matched one or more of 50 clean energy technology categories. The EPO also elicited 160 responses organisations regarding their IP licensing behaviour

(constituted of 47% MNCs; 7% large firms; SMEs with fewer than ten employees constituted 24% of the private company respondents; others 34%). Respondents with headquarters in Germany, the US, Japan, France and the UK amounted to 74 per cent of the total respondents and 63% of respondents focused on biomass/biofuels (UNEP et al, 2010). The study found that the leading six countries with actors innovating and patenting CETs are Japan, the United States, Germany, the Republic of Korea, the United Kingdom and France. Aside from geothermal, national (geographic) concentration in all CETs is relatively high: the top six countries account for almost 80% of all patent applications in the CETs reviewed.

Views on IPR posing barriers to technology transfer are mixed and it is clear that IPRs are only one factor in a complex situation (Roffe, 2005; Brown et al. (2008), with the capacity to assimilate, implement and develop a technology also being important (Foray, 2009). Hence Barton for ICTSD in 2007 examined companies developing solar photovoltaic (solar PV), biofuel and wind technologies in Brazil, India and China, and concluded that IPRs are unlikely to be a significant barrier to access in the immediate future. Similarly Harvey (2008) observes that most patents for CETs are not filed in least developed countries (LDCs) in any case, given their small market potential. This would leave companies in those countries free to use others' inventions. On the other hand, Hutchinson (2006) concludes that while the overall effect of strong patent protection on the transfer of technology is not clear, as demand for new energy technologies strengthens in response to climate change policy, corporate action may frustrate technology transfer through the refusal to license and the use of other kinds of restrictive business practices. In this regard, Ockwell et al. (2007), based on company case studies in India involved in CETs, found that gaining ownership of or access to IP

may be a necessary but not sufficient requirement for successful low-carbon technology transfer. Moreover Mallet et al. (2009) did find that IPRs seemed to be slowing down the rate at which Indian firms are able to develop commercial hybrid vehicle technologies without infringing existing international patents owned by industry leaders such as Toyota and General Motors.

### **Trends and prospects for biofuel patenting**

While studies of biofuel patenting specifically are very limited in number (Juma and Bell, 2009), the number of biofuel-related patents has increased substantially in recent years. Using the US as an example, between 2002–2007, 2,796 biofuel-related patents were published, with an increase of 610 per cent from 2002 to 2007 (ibid: 65). In 2007, the number of biofuel patents exceeded the combined total of solar power and wind power patents published (ibid). Categorized by ownership entity, the patents published in selected technologies in 2006–2007 were 57 per cent owned by corporate entities, 11 per cent owned by universities or other academic institutions and 32 per cent undesignated (Kamis and Joshi, 2008, in Juma and Bell, 2009:65).

As Mannan (2009) observes, a substantial number of start-up biofuel companies (by definition small businesses) are offering novel biofuel technologies. If any of these technologies become a definitive choice for a particular process, the company controlling that technology may secure greater control of the market and extend that control to other links in the commodity chain (Glenna and Cahoy, 2009: 113). There are precedents for this in the related sector of agribusiness: a small group of multinational US agribusinesses has achieved oligopolistic control of commodity value chains

through the strategies of horizontal and vertical integration Heffernan (2000; (Glenna and Cahoy, 2009).

In the agribusiness sector, value is particularly accrued by obliging annual purchase by farmers of seed and/or agro-chemicals, to maintain yields. Two companies, DuPont-Pioneer and Monsanto, account for 56% of the U.S. seed corn market and four companies account for 29% of the world market in commercial seeds (Fernandez-Cornejo, 2004 and UNCTAD, 2006 in Glenna and Cahoy, 2009). Comparing the biofuel and agribusiness sectors, Juma and Bell (2009) concluded that the biofuels industry has the potential to follow the trajectory of the agricultural biotechnology industry, with its divestitures, mergers and acquisitions leading to consolidation globally. Indeed they argue that a restrictive IPR regime for advanced biofuel technology will likely prevail, to the detriment of developing countries due to the technology being costly to obtain and difficult (inter alia) to adapt to local needs.

More generally, key issues of concern in this context include control of access to resources and imbalances in intellectual property right regimes across countries (Juma and Bell in UNCTAD, 2009). This potential for the concentration of knowledge and hence market power also applies in developed nations: in a study of the US biofuel sector, Glenna and Cahoy (2009) concluded that while patent ownership in the emerging biofuel sector is not yet as concentrated as in the agricultural biotechnology sector, such concentration is taking place nonetheless.

Juma and Bell (ibid) posit three IPR scenarios in relation to wider (particularly developing country) access to biofuel technology and a number of mechanisms by

which control over knowledge may be exerted. First is use of company and patent acquisition. For example, Jorma and Bell (2009) refer to UNCTAD's finding that although small start-up companies in the agrobiotech sector still figure prominently as acquisition targets or as licensors to the large corporations, by 2002, 95% of patents originally held by seed or small agrobiotech firms had been acquired by large chemical or multinational corporations. When a few multinational companies are backed by a broad portfolio of patents, including proprietary entitlements on key enabling technologies, this may impede access to technologies if they refuse to license (UNCTAD, 2006, in Jorma and Bell, 2009).

Secondly, highly restricted access could occur if many different patented technologies (for agricultural and industrial processes) are required for producing second generation biofuels. Generically this has been referred to as the "tragedy of the anti-commons", which, while empirically is relatively rare (Caulfield et al., 2006), may occur when multiple owners each have a right to exclude others from a scarce resource and no one actor has an effective privilege of use (Heller and Eisenberg, 1998, in Jorma and Bell, 2009).

A third mechanism for control of knowledge and hence market power may be the use of "blocking" or "hold-up", in which patent holders are unwilling to license their technologies for strategic reasons: broad patents may be filed or purchased not for the purposes of product development, but to enable "strategic use" of the patents to prevent competitors from developing products (Suppan, 2007, in Jorma and Bell, 2009). Patent lock-up may already be taking place, for example, with regard to critical enzymes in the biofuels production process (Ortiz et al., 2006, in Jorma and Bell, 2009). Patenting of

genetic material and reproduction methods is another possible route to controlling access to the best yields. For example, most of the 21 patent applications with the species 'Jatropha Curcas' in the title, listed in the European Patent Office register, relate to genetic aspects of the plant. While several applications were made by Indian companies, most of these are listed as having been withdrawn, something that merits further investigation.

### **Empirical directions**

As currently framed, the propositions are not intended as testable hypotheses. Their generality would to some extent require counter-factuals that are difficult to find. However, from each proposition, sub-questions can be derived that are more amenable to investigation. For brevity, here we deal with just one key issue, namely how value hoarding and value blocking might be observed? Firstly, and recalling our focus on *societal* value accumulation, it should be noted that these two types of private knowledge accumulation differ somewhat in their mechanisms. Value blocking is in many respects the normal purpose of a patent: patents are designed to retain value for the patent holder and, via a process of legally-mandated denial, prevent value accruing to competitors. Hence any adverse relationship between technology transfer and deployment is not an externality in the sense of being wholly outside of an intended design. Value hoarding, on the other hand, seeks to accrue value not through controlled deployment of a technology, but via non-deployment. Therefore in seeking evidence of the first we need to look more at consequences outside of the firm, while in seeking evidence of the second we need to look more within the firm.

In terms of methods, information on both value blocking and hoarding requires a combination of interviews and surveys of stakeholders in a particular sector, including expert observers, analysts and firms themselves. This raises the issue of the veracity of self-report, but survey approaches nonetheless have a precedent in the PatVal-EU survey (Giuri et. al 2007), which has assessed the prevalence of non-use of patents, licensing and use of patents to block potential competitors (Giuri et. al 2007; Hughes and Mina, 2010). The results of the survey, conducted between 2003 and 2004, and which collected information on 9,216 patents filed between 1993 and 1997 in six European countries, are closely relevant to the thesis of value hoarding. Overall, 18.7% of patents were filed primarily to block other companies. 17.4% of patents were unused but were considered to be ‘sleeping’ rather than blocking (Giuri et. al 2007; Hughes and Mina, 2010). In large firms, 21.7% of patents were reported as being filed to actively block rival R&D and 19.1% were considered sleeping (not having the effect of blocking). Medium size firms developed a relatively high percentage of patents for internal use (65.6%) and had less than half the percentage of strategically held or sleeping patents as large firms. Smaller firms reported a very low incidence of unused patents (9.6% were blocking patents and 8.8 % were sleeping). This shows the potentially non-abusive character of small to medium-sized firms and IPR, in terms of value hoarding, and the latter’s need to use the knowledge acquired inside the firm for new value adding activities. It also indicates a need for European policy makers to provide more support (including advice and finance) to small to medium-sized enterprises, to help them develop and acquire IPR for new value adding activities..

While the PatVal study sought to identify the original inventors behind the patents and to assess their mobility between firms (Giuri et al, 2007), neither the mobility pathways

of the patents themselves, nor the consequences of the use of blocking patents were within the remit of the study. It is these that we propose need closer examination and for this purpose it is the movement of patents that must be observed. It is our intention that the theoretical basis that we have laid here will assist in empirical investigation of value creation chains, particularly the movement of intellectual value between firms, including internationally.

## **Conclusions**

Current and future challenges in the global economy require a better understanding of the roles and inter-relationships of both SMEs and MNCs in value creation. We have viewed this relationship in terms of Schumpeter's concepts of creative destruction and creative accumulation, concepts that are both multidimensional and non-exclusive (Filippetti et al, 2009). To date, however, aside from Filippetti et al (ibid) there has been little work on conceptualising the link between MNCs and SMEs, innovation and the foregoing Schumpeterian logic. Our work has made a small contribution to addressing this gap in the extant literature. In setting out a conceptual model and propositions related to the way in which MNCs may frustrate or thwart the process of creative destruction by entrepreneurial market entrants, we affirm Schumpeter's awareness of the capacity for market power to stymie innovation. The biofuel sector has served as an example of a new energy sector in which patenting activity is relatively high (Jorma and Bell, 2009; UNEP, EPO and ICTSD, 2010) but in which the societal benefits are uncertain for many reasons, IPR being but one.

## **Notes**

1. This sum includes investment in biofuels, wind, solar, carbon capture and storage and ‘clean technology’ (BP, 2011a).

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Figure 1 A stylised, Schumpeterian approach to value creation as being a function of Creative Destruction (CD) and Creative Accumulation (CA)

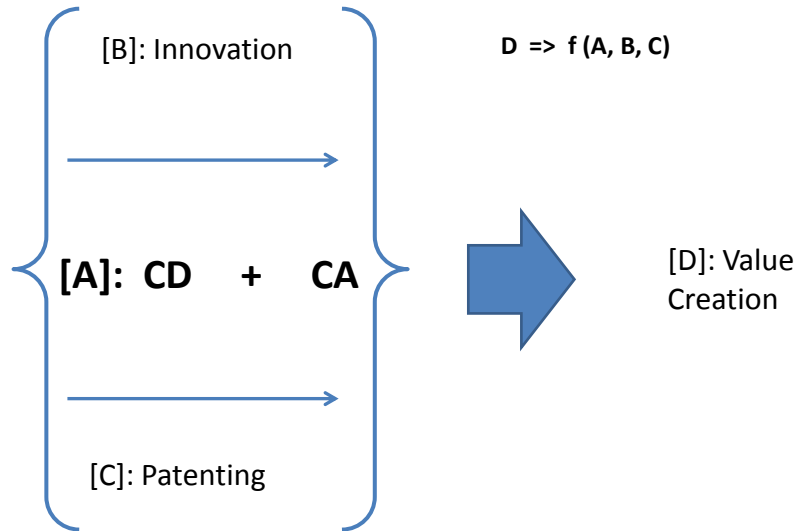


Figure 2: The entrepreneurial process located within its environment and time (after Bruyat & Julien, 2001)

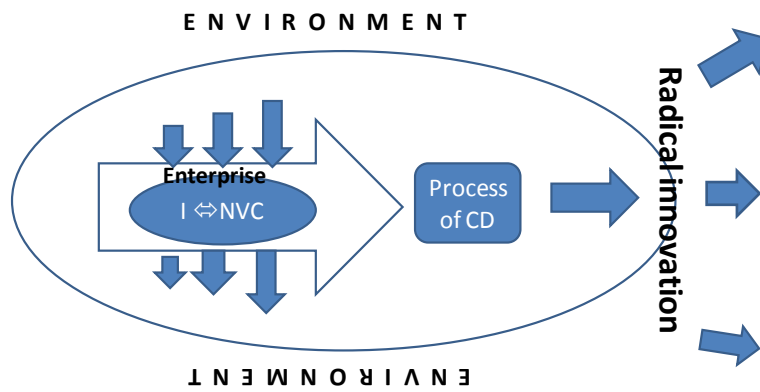
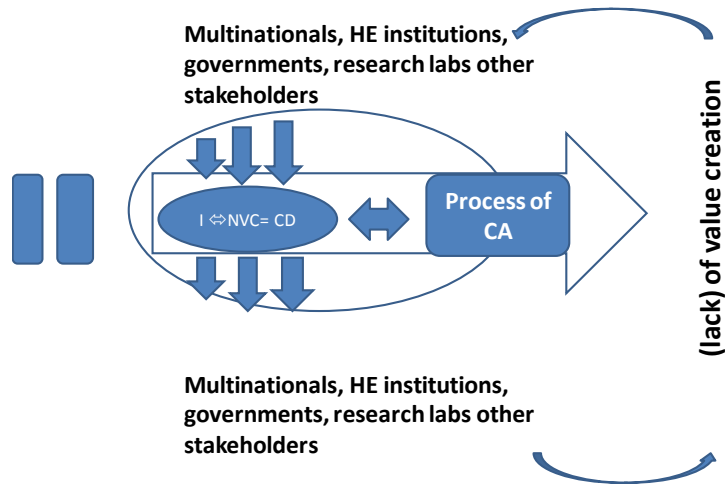


Figure 3: The relationship between value creation, CD and DA in the context of stakeholder influences



**Table 1: Propositions and related illustrations in the context of biofuel technology transfer**

Propositions	Illustrations
<p>P1: The concentration of innovative power restricts knowledge access and knowledge transfer</p>	<p>1a) IPRs have slowed down the rate at which Indian firms are able to develop commercial hybrid vehicle technologies without infringing existing international patents owned by industry leaders.</p> <p>1b) Agribusiness: a small group of large US agribusinesses has achieved oligopolistic control of commodity value chains through the strategies of horizontal and vertical integration Heffernan (2000; (Glenna and Cahoy, 2009).</p> <p>1c)=2b</p> <p>1d) A survey of 9,216 patents filed between 1993 and 1997 in six European countries showed that 18.7% of patents were filed primarily to block other companies. 17.4% of patents were unused but were considered to be ‘sleeping’ rather than blocking (Giuri et. al 2007; Hughes and Mina, 2010). In large firms, 21.7% of patents were reported as being filed to actively block rival R&amp;D and 19.1% were considered sleeping (unused but not having the effect of blocking).</p>
<p>P2 The processes of CA and IPR</p>	<p>2a) By 2002, 95% of patents originally held by</p>

<p>accentuate the imbalance of access to financial resources of small and large firms</p>	<p>seed or small agrobiotech firms had been acquired by large chemical or multinational corporations (Juma &amp; Bell 2009)</p>
<p>P3: CA, patent hoarding and stacking promote the abundance of generic, large-scale end value propositions vs small business' specific knowledge applicable in personalised new value creation propositions</p>	<p>3a) = Ia)</p> <p>3b) Two companies, DuPont-Pioneer and Monsanto, account for 56% of the U.S. seed corn market and four companies account for 29% of the world market in commercial seeds (Fernandez-Cornejo, 2004 and UNCTAD, 2006 in Glenna and Cahoy, 2009). Biouel and agribusiness sectors: Juma and Bell (2009) concluded that the biofuels industry has the potential to follow the trajectory of the agricultural biotechnology industry, with its divestitures, mergers and acquisitions leading to consolidation globally.</p>
<p>P4: CA and IPR promote the geographic proximity of scientists, thus clustering intellectual knowledge and new value-adding activities in a few, mostly developed country locations.</p>	<p>4a) Enhancing technology transfer to developing countries as integral part of the global climate change regime since the inception of the United Nations Framework Convention on Climate Change (UNFCCC), yet the role of IPRs is particularly contentious.</p> <p>4b) Leading six countries with actors innovating and patenting CETs are Japan, the United States, Germany, the Republic of Korea, the United Kingdom and France (UNEP et al. 2010)</p>

	<p>4c) Most patents for CETs are not filed in least developed countries (LDCs) (Harvey 2008).</p> <p>5) A restrictive IPR regime for advanced biofuel technology is likely to prevail, to the detriment of developing countries due to the technology being costly to obtain and difficult (inter alia) to adapt to local needs (Juma &amp; Bell 2009)</p>
<p>P5: Large companies use CA and IPR systems to monopolise information channels to influence the established power dynamics in their interest.</p>	<p>5a)=1b)</p> <p>5b)=2a)</p>
<p>P6: The process of CA and IPR systems are used by large companies to monopolise knowledge with the increasing assistance of universities due to their privileged relationship, so potentially obstructing value creation processes of lower financial worth and their societal application.</p>	<p>6a) Patents published in selected biofuel technologies in 2006–2007 were 57 per cent owned by corporate entities, 11 per cent owned by universities or other academic institutions and 32 per cent undesignated (Kamis and Joshi, 2008, in Juma and Bell, 2009:65). However the evidence for the relative balance of larger to smaller firms engaged in university collaborations is unknown at present.</p>
<p>P7: The process of CA and the accumulation of intellectual capital in the hands of a few multinationals</p>	<p>7a)=2a)</p> <p>Medium size firms developed a relatively high percentage of patents for internal use (65.6%) and</p>

<p>and in a number of selected countries run counter to the European Union goal of creating a knowledge-based economy based on new value creating activities (CD) available for every citizen.</p>	<p>had less than half the percentage of strategically held or sleeping patents as large firms. Smaller firms reported a very low incidence of unused patents (9.6% were blocking patents and 8.8 % were sleeping) (Giuri et. al 2007).</p>
<p>P8: CD leads to the design of ‘new economic space’ through small business with the latter being the promoter of new value creation and related value creation processes.</p>	<p>8a ) Smaller firms reported a very low incidence of unused patents (9.6% were blocking patents and 8.8 % were sleeping) (PatVal study) (Giuri et. al 2007).</p>