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Technoscience Rent: Toward a Theory of *Rentiership* for Technoscientific Capitalism

Kean Birch[1]

Abstract

Contemporary, technoscientific capitalism is characterized by the (re)configuration of a range of "things" (e.g., infrastructure, data, knowledge, bodies) as assets or capitalized property. Accumulation strategies have changed as a result of this assetization process. Rather than entrepreneurial strategies based on commodity production, technoscientific capitalism is increasingly underpinned by rentiership or the appropriation of value through ownership and control rights (e.g., intellectual property [IP]), monopoly conditions, and regulatory or market devices and practices (e.g., investment dispute courts, exclusivity agreements). While rentiership is often presented as a negative phenomenon (e.g., distorting markets, unearned income) in both neoclassical and Marxist political economy literatures—and much in between—in this paper, I conceptualize rentiership as a technoeconomic practice and process framed by insights from science and technology studies (STS). So, rather than a problematic "side effect" of capitalism, the concept of rentiership enables us to understand how

[1]York University, Toronto, Ontario, Canada

Corresponding Author:
Kean Birch, York University, 4700 Keele Street, Toronto, Ontario, Canada M3J 1P3.
Email: kean@yorku.ca

different forms of value extraction constitute, and are constituted by, different forms of technoscience. This allows STS to contribute a distinctive analytical approach to ongoing debates in political economy about economic rents and rent-seeking.

Keywords
assetization, rentiership, rent-seeking, technoscientific capitalism, technoscience rent, political economy of technoscience

Tractors are an unusual starting point for research in science and technology studies (STS), but one that reflects a broader set of emerging issues in technoscientific capitalism that STS scholars could pay more attention to. In an article on the *Motherboard* website, Koebler (2017) claims that farmers in the United States are purchasing black market software from Ukraine in order to hack their own tractors. The reason for this is that tractor manufacturers have made it increasingly difficult, legally speaking, for farmers to do "unauthorized repairs" on *their* tractors. I stress "their" because Wiens (2016), writing in *Wired*, claims that said tractor manufacturers are reconfiguring—or "destroying" in his terms—the very nature of ownership itself, and, by extension, capitalism as we know it. Wiens argues that tractor manufacturers are basically claiming that farmers "don't own their tractors" anymore after farmers sign license agreements in which they are forbidden to "tamper" with their tractor's software and electronics, copyrighted by the manufacturers.

This reconfiguration of ownership is an example of *rentiership* or the capture of economic rents. Generally, *economic rents* are the value that can be extracted from economic activity—broadly conceived—as the result of the ownership and control of a particular resource (or asset), primarily because of that resource's inherent *or* constructed productivity, scarcity, or quality. As a concept, economic rent is usually associated with the ownership and control of land and has its origins in eighteenth- and nineteenth-century political economy (e.g., Ricardo [1817] 2001; Marx [1894] 2010). Some classical political economists sought to defend this ownership (e.g., Thomas Malthus), although most criticized its negative effects on capital accumulation (e.g., Ricardo). Since then, and especially during the twentieth century, economic rent theory has been applied more widely to natural resources (e.g., oil), financial resources, and intangible resources such as knowledge.

Recently, economic rents and *rent-seeking* have moved to the center of public debate. A growing chorus of academics, politicians, journalists, activists, and commentators analyzing contemporary capitalism have turned to these concepts as a way to understand the implications of contemporary capitalism's increasingly technoscientific characteristics. From the pro-capitalist side, the journalist Robert Colville (2017) argues that "the structure of capitalism is increasingly tending towards monopoly . . . [and] because of the network effects involved, this tendency is particularly pronounced in tech." From the anti-capitalist side, the academic Guy Standing (2016) argues "Plutocratic corporations are patent hoovers, buying thousands of patents. It is a winner-takes-all market created by the regulatory apparatus, not market forces." Numerous people raise similar issues relevant to debates in STS, including the privatization and commercialization of basic research (Stiglitz 2014), network effects of information technology (Jacobs 2015), business models of new technology platform companies (Kaminska 2016), ownership and use of personal data (Morozov 2016), threats to competition represented by corporate concentration and monopoly in tech sectors (Mazzucato 2018), and financial technology innovation (Bregman 2017).

This raises an important question: considering its focus on science, technology, and innovation, what might STS offer this analysis of rentiership in technoscientific capitalism? Despite increasing debates about the expansion and capture of *technoscience rents* (see above), there has been limited analytical development in political economy in recent decades of the core concepts involved. An increasing number of STS scholars are engaging with "rent" as a concept (e.g., Fuller 2002, 2016; Cooper and Waldby 2014; Birch 2017a, 2017b, 2017e; McGoey 2017), so it is an opportune time to examine how these STS approaches might plug this analytical gap. A key reason that STS is well-placed to contribute to this analytical *and* normative task is because of its commitment to examining the contingency of social phenomena. Existing and often quite diverse political economy literatures, in contrast, tend to naturalize or idealize specific economic processes (e.g., "the market"—Tullock 1993) or economic logics (e.g., labor value—Harvey [1982] 1999) and characterize economic rents as a distortion or corruption of these naturalized phenomena. A major reason for STS scholars to engage in this analytical work is so that they can shape the ongoing public debates about the future of capitalism and how it is (re)configuring science, technology, and innovation (Hackett 2014; as an example, see Birch 2018b).

I start by defining technoscientific capitalism, then develop the concept of rentiership as a technoeconomic process and practice reflecting dynamics that are becoming entrenched in technoscientific capitalism. I specifically consider how STS can contribute further to the theoretical, political, and normative analysis of rentiership in technoscientific capitalism.

Technoscientific Capitalism

Contemporary capitalism is characterized by the increasing interdependence between science/innovation and markets/business. On the one, technoscience is increasingly constituted by specific forms of financing (e.g., corporate research and development spending) and financial logics (e.g., return on investment calculations), while, on the other hand, capitalism is increasingly constituted by specific forms of technoscience (e.g., disruptive and predatory innovation) and technoscientific logics (e.g., network effects). Examples range widely, including the growth in intellectual property rights (IPRs; Schwartz 2017) and the expansion of a global IPR regime (Tyfield 2008) centered on technoscientific innovation (e.g., biotechnology); the growth of start-up technology firms as vehicles for financial speculation (Mirowsk 2012; Mazzucato 2018); the increasing monetization of free, immaterial, or cognitive labor, such as user-generated content on social media like Facebook and YouTube (Arvidsson and Colleoni 2012); the development and popularity of technoeconomic platforms such as Uber, Airbnb, and Taskrabbit (Langley and Leyshon 2017); and the regular deployment of future technoscientific promises and expectations in support of public science funding as well as financial investment strategies (Beckert 2013; Birch 2017c).

Several scholars within STS and cognate fields have theorized this changing political economy of research and innovation as a specific form of *technoscientific capitalism*. For example, Lyotard (1984, 4) argued that the "nature of knowledge cannot survive unchanged" in the context of "techno-scientific capitalism," a term he developed in his subsequent work (Lyotard 1992). Since then, a number of others have addressed the interdependence of technoscience and capitalism. Much of this discussion in STS has centered on concepts like "academic capitalism," for instance.[1] People like Hackett (1990) used this term to analyze the changing culture of American universities, especially those changes resulting from the introduction of private-sector practices and expectations (e.g., profit-seeking). More recently, he has argued that:

> As the academic enterprise becomes increasingly dependent on allocations of capital from without and on the accumulation of capital within, it cedes freedom, purpose, and the ability to act as an independent moral force in society. (Hackett 2014, 637)

This observation resonates with the work of Slaughter and Rhoades (2004) and Mirowski (2011), among others. In their work, Slaughter and Rhoades (2004) outline the integration of American university research and teaching into the "new economy," from the expansion of university technology transfer activities and patenting to the "intensified commercialization of instruction, educational materials, and software/courseware" (p. 10). More broadly, Mirowski (2011) argues that the twentieth century has witnessed an evolution of regimes of technoscientific research and innovation culminating with a neoliberal and globalized "privatization regime" by century's end. Others have shown how similar trends are evident in jurisdictions outside of the United States (see Jessop 2017). First, Felt et al. (2007) argue that a "regime of economics of technoscientific promise" dominates European Union (EU) research and innovation narratives, policies, and practices, as well as the push behind the expansion of a unified IPR regime and "innovation-friendly markets" in the EU (p. 25). Second, in their *Handbook of the Political Economy of Science*, Tyfield et al. (2017) and contributors discuss an array of countries and sectors in which political-economic logics have come to shape technoscientific priorities, organization, and governance.

Perhaps the clearest exposition of technoscientific capitalism comes from the work of Sunder Rajan (2006) in his book *Biocapital*. According to Sunder Rajan, "biocapital" represents a way to theorize the "explicitly speculative nature of recent, especially technoscientific, capitalism" (pp. 121-22). He goes on to argue that technoscientific capitalism is "a speculative marketplace [which] lends itself to innovation, while innovation breeds a speculative marketplace" (p. 111). For these reasons, Styhre and Sundgren (2011) argue that Sunder Rajan is not claiming biocapital to be a distinct version of capitalism; rather, they argue that the concept reflects "capitalism pursued by other (technoscientific) means" (pp. 54-55). As the pursuit of capitalism by technoscientific means, it is crucial to examine *how* these "means" enable the realization and accumulation of capital. Accordingly, the rest of this article focuses on rentiership as the "technoeconomic means" underpinning technoscientific capitalism.

Technoscience Rent

I now consider the relevance of economic rent theory to STS debates with the aim of identifying particular forms of "technoscience rent" constitutive of technoscientific capitalism. My starting point is Haila's (1990, 277) argument that economic rent is as much a "technical-economic phenomenon" as it is a "juridical relationship" (e.g., property rights). It is, therefore, useful to broaden the conceptual applicability of economic rent from land (Ricardo [1817] 2001) to other resources and assets, especially those derived from technoscientific knowledge (Birch 2017a, 2017d). Several STS scholars have started to engage with these other resources and assets, including intangible assets like IP (e.g., Birch and Tyfield 2013; Lezaun and Montgomery 2015; Martin 2015), human capital (Cooper and Waldby 2014), business models and valuation practices (e.g., Birch 2017d; Muniesa et al. 2017), and personal data (Vezyridis and Timmons 2017).[2] This engagement with (technoscientific) resources and assets as analytical objects provides a clear rationale for considering economic rent theory from a new perspective—namely, from an STS perspective. I now outline the relevance of three conceptions of economic rents to STS: differential rents, monopoly rents, and rent-seeking.

Differential Rents and Technoscience

I start with *differential rent*. This concept goes back to the intellectual origins of economic rent theory in the work of classical political economists like David Ricardo ([1817] 2001). He defined it as follows: "Rent is that portion of produce of the earth, which is paid to the landlord for the use of the original and indestructible powers of the soil," that is, the biophysical qualities and productivity of land (e.g., soil quality, rainfall, sunshine; p. 39). Ricardo argued that different economic rents—or "differential rent"—accrue to different pieces of land depending on the aggregate prices of corn produced by said land. Conceptually, differential rent is primarily concerned with the processes of production, rather than the exchange of commodities and their prices, in that raising productivity—and thereby reducing prices—does not reduce rent (Rigi 2014). As such, Ricardo did not conceptualize rent as a determinant of price; rather, it reflected the transfer of profit from capitalist to property owner (Ward and Aalbers 2016).

Differential rent is relevant to debates about (a) "moral economies" of science (Kohler 1994) and (b) varied forms of affective, cognitive, and/or immaterial labor (Moulier Boutang 2011). First, differential rent resonates

with STS debates around the moral economy of science (e.g., Shapin 1991; Kohler 1994). According to Kohler (1994, 12), the moral economy refers to the "moral conventions" that regulate scientists, their activities, their access to equipment and materials, and their system of credit and rewards. Kohler references Shapin's (1991) earlier work on the moral economy of seventeenth-century scientists as well as Latour and Woolgar's (1979) work on credit cycles in (more recent) laboratories. With regard to Latour and Woolgar, they argued that knowledge production involves all sorts of credit, credibility, and credentials, which could be treated as differential resources—for example, citations vary widely between different researchers engendering differential effects on the capacity of those different researchers to find employment, wages, grants, awards, and so on. Second, differential rent also resonates with discussions of affective, cognitive, and immaterial labor, especially drawing on the work of autonomist Marxists (see Moulier Boutang 2011). It is possible to conceptualize what Veblen (1908) called "habits of life"—that is, humor, love, friendship, loyalty, reputation, and so on—as social resources that can be monetized and capitalized with the deployment of specific technoeconomic arrangements, leading to the capture of differential rents depending on their qualities.

In both cases, it is important to consider how human activities and labor might be considered a form of differential rent. Fuller (2002) provides a useful starting point in this regard. He argues that the need to qualify for professional standing in knowledge communities—whether academic or legal or medical, and so on—can "be seen as a form of intellectual rent that is imposed on the student" (p. 38). The relevance of differential rent to STS is probably most obvious in the analysis of the (social) status of individual researchers, institutions, or broader communities (e.g., city, nation). Status reflects the credit and credibility of social actors; for example, well-cited researchers extract rent as a result of the increasing "credit" that their higher visibility and epistemic centrality in their disciplines provides them (Fuller 2016). At the same time, their status reflects a broader system of collective labor in which other, less well-cited researchers act as "prosumers" who both produce and consume the credibility and reputation of the output of the more well-cited researchers—primarily through citation practices. The latter is important because it recognizes that knowledge production and the credit system which currently underpins it are social processes and that the "free" labor of citers is highly differentiated, similar to advertising, branding, and other immaterial processes (Arvidsson and Colleoni 2012).

Monopoly Rents and Technoscience

I now turn to *monopoly rent*. Building on Marx's ([1894] 2010) arguments in *Capital: Volume III*, Harvey ([1982] 1999) argues that there are two forms of monopoly rent: (1) monopoly rent (MR1) created by the quality of the asset (e.g., land quality) and (2) monopoly (MR2) created by the rent itself (e.g., denial of access). Analytically speaking, Haila (1990, 278) argues that monopoly rent depends on property rights and is, therefore, distinct from differential rent since the latter "was conceived as being caused by technically and ahistorically determined production differentials and as existing independently of private property on land." Consequently, monopoly rent was often associated with precapitalist economic systems (e.g., feudal ownership) and seen as dysfunctional because it was a barrier to accumulation.[3] However, Harvey and others have linked monopoly rent to finance capital, conceptualizing monopoly rent as claims on future revenues and, therefore, as endogenous to capitalism (Haila 1988, 1990). That being said, the materiality of land (and other biophysical assets) matters here since land has a recurring use, being difficult to either destroy or use up (although not impossible), meaning that it can provide (almost) indefinite future claims whereas other assets cannot (e.g., machinery).

Monopoly rent is most relevant to STS analyses of IPRs, although there are undoubtedly other relevant instances worth considering—for example, the monopoly in the production of laboratory animals used in pharmaceutical testing (Demortain 2017a, 2017b). A number of scholars have theorized IPRs in terms of monopoly rights and monopoly rents (e.g., Zeller 2008; Birch and Tyfield 2013; Cooper and Waldby 2014).[4] It is possible to consider IPRs as monopoly rent derived (1) from the qualities of an asset itself—its "quality" or "specificity"—and (2) from the denial of access to that asset (Harvey [1982] 1999; Haila 1990). However, analytically speaking, IPRs better reflect the latter definition, as property rights are a bundle of rights including rights of exclusion.[5] Legally speaking, IPRs confer monopoly rights on their owners, including the (often temporary) right to returns on their investment—this is framed as an "entrepreneurial" or "Schumpeterian" rent in mainstream economics and business literatures, representing a reward for innovation (Teece 1986, 1998, 2003; Pisano 1991). According to May (2010, 4), IPRs reflect certain "legal benefits" including "the ability to charge rent for use," as well as "the right to receive compensation for loss" and "the right to demand payment for transfer to another party through the market."

According to Zeller (2008, 98), monopoly rent is the "result of a systematic shortage of supply created by the property monopoly of the supplier of a key product [including knowledge], which encounters no direct competition from substitution goods." He goes on to argue that knowledge monopolies are distinct because:

> In contrast to the differential rent, which arises due to differently favorably located or fertile pieces of land, no information differential rent can emerge, because every enclosed information is unique and is normally used in each case for the production of specific products.

There are numerous examples of these sorts of IP monopolies relevant to STS. Research by STS scholars—and many others—have raised concerns about the limitations placed by property rights—such as patents and copyright—on access to knowledge (e.g., Drahos and Braithewaite 2002; Hope 2008; Hackett 2014; Harvie et al. 2014). Monopoly rents from copyright, for example, include subscription fees that publishers charge for access to journal articles, which is defined as "knowledge rolls and rents" by Hall (2010). These IPRs limit the use of such proprietary knowledge in finding solutions to broad social problems, since they necessitate some form of payment (e.g., license fee).

In thinking through the implications of this for STS, it is notable that intangible assets (e.g., IPRs) do not depreciate or deteriorate like most tangible assets (e.g., machines, buildings), meaning that IPRs can represent an ongoing "source of revenue" because "rights over reproduction are constantly renewed resources [i.e. assets], offering the opportunity of perpetual income (in the form of rents) with negligible renewal or transactional costs" (Hall 2010, 67). However, this raises two issues. First, future revenue claims are not implicit in the characteristics of the intangible asset itself, in that future rents are not known when an intangible asset is enclosed by IPRs. This implies that rents are constructed as part of the process of assetization, not simply inherent to an asset—that is, rents are *made*. Second, therefore, the capture of monopoly rents is a proactive process, rather than a passive process usually associated with notions of "rentier" ownership; it involves the active management, policing, enforcement, and reinforcement of property rights and their value by their holders and others (Birch 2017d).

Rent-seeking and Technoscience

Finally, I turn to the concept of *rent-seeking*. Analytically, rent-seeking draws on the work of neoclassical economists like Tullock (1967, 1993) and Krueger (1974). They developed a very specific meaning of "rent" which distinguishes it from differential and monopoly rent discussed previously. For example, according to Krueger (1974, 291):

> In many market-oriented economies, government restrictions upon economic activity are pervasive facts of life. These restrictions give rise to rents of a variety of forms, and people often compete for the rents. Sometimes, such competition is perfectly legal.

This neoclassical concept of rent-seeking is used predominantly to mean the interference of governments in the naturalized workings of a market economy, especially at the behest of some vested interest (e.g., a business seeking to shore up a monopoly position).

As a concept, rent-seeking is reflected in STS debates on "regulatory capture," especially in relation to the pharmaceutical sector. Examples include work by John Abraham and Courtney Davis on pharmaceutical regulations (e.g., Abraham 2008; Davis and Abraham 2013). These two scholars argue that the capture of regulatory agencies happens when they "regulate primarily in the interests of the industry, rather than the public interest," and it happens through active lobbying and structural changes (e.g., "revolving door" between regulators and industry; Davis and Abraham 2013, 9). Even though they do not deploy the concept of rent-seeking specifically, their arguments reflect the concept outlined by the likes of Tullock and Krueger; namely, private organizations focus on lobbying government for policy and legislative changes, rather than on their internal research and development strategies.

A more specific STS analysis of rent-seeking is contained in the work of Frohlich (2016, 4) who argues that "Regulation, including standards setting, becomes a potential site for 'rent-seeking,' where the state is 'captured' by private interests who seek third-party certification to protect their market." As this would imply, lobbying and other policy and political interventions are constitutive of particular codes, standards, regulations, and certification (Busch 2011), which end up not only imposing costs on certain parties and not others but also configuring technoscience through the necessary pursuit of compliance. For example, the already mentioned work on regulatory capture illustrates the constitutive role that regulations play in

pharmaceutical research and development programs (e.g., the pursuit of blockbuster drugs in order to ameliorate the high costs of regulatory testing). Another example is where standards and their network externalities enable certain social actors—whether that is a single firm or even whole nation—to accrue rents on the basis of their control over those standards (Teece 1998). This is a point emphasized by Jim Balsillie, ex-CEO of Blackberry, in his discussions of the national benefits reaped by the United States as the center of standards setting in information technology (Castaldo 2016).

Toward a Theory of *Rentiership* for Technoscientific Capitalism

Having applied economic rent theory to STS—as a way to illustrate its relevance to analyses of science, technology, and innovation—my aim now is to consider what STS can bring to the analysis of economic rents. I develop a theory of *rentiership* as a way to understand economic rents and rent-seeking as a social process and practice rather than a distortion of an idealized and naturalized political-economic process or logic (e.g., markets "distorted" by rent-seeking). Briefly, my argument is that rentiership involves a series of actions, knowledges, and transformations that, from an STS perspective, configure technoscience such that the realization of value from its commercialization can be analyzed as a process unfolding over several years, if not decades. Such a process of rentiership entails the "thing-ification" of knowledge—its reification—as part of the coproduction of understandings of value and valuation practices; the transformation of that "thing" into an asset as a way to organize, govern, and manage value and valuation over time; and the extraction of value (i.e., rent) through different modes of ownership and control.

Creating "Things"

A theory of rentiership built on STS approaches has to start with a conception of technoscientific knowledge production, dissemination, and use. Knowledge represents one of the basic units of analysis in STS reflecting the view that knowledge is collectively produced, constituted, and legitimated (e.g., Bloor 1976; Fuller 1988). STS analyses highlight that knowledge cannot be conceptualized as a "thing" in our (individual) heads or on the page; rather, knowledge is a social process bounded by social practices, social actors, social values, and social institutions (Fuller 1988, 2002;

Tyfield 2012). Moreover, and complicating things further, knowledge can be as much "affective" (e.g., Oikkonen 2017) as technoscientific, reflecting feelings and emotions (e.g., desires and dislikes); social values, incentives, and motivations (e.g., cultural tastes); relational states and dispositions (e.g., friendship); and much else besides.

Several autonomist Marxists have specifically theorized these various "knowledge" practices, relations, and identities as forms of "labor," even though we may not earn a wage from them. For example, Lazzarato (1997), Morini and Fumagalli (2010), and Moulier Boutang (2011) argue that contemporary capitalism is underpinned by forms of "immaterial," "affective," and "cognitive" labor. I do not want to equate different forms of (knowledge) labor as analytically equivalent. In fact, Schumpeter (1950, 25) specifically argued that rent theories based on the labor theory of value (e.g., Ricardo, Marx) make this theoretical assumption and thereby ignore the specificities of the "Services of Natural Agents." Such phrasing, reminiscent of actor-network theory, highlights the need to understand the social *and* technoeconomic relations, arrangements, and entities that constitute (different) knowledges, as well as their monetization and capitalization in distinct organizational forms and their capture through different modes of ownership and control. All of which STS scholars are well-placed to do.

Any theory of rentiership, then, necessarily starts from the position that knowledge, as collectively produced, has to be turned into a "thing"—or, reified as a technoeconomic object like a patent, or copyright, or similar IP designation that is alienable. This "thing-ification" of technoscientific (or any) knowledge follows from the distinction that Fuller (2013) makes between knowledge as a substance (*is*) and function (*does*). He argues that knowledge's function is to replace something else, although this necessarily means a *function* of something else rather than its substance. The value of knowledge, therefore, has to be understood as "determined more by the cost incurred by lacking it than the benefit received from possessing it" (Fuller 2013, 13). Consequently, the value of knowledge is better theorized in terms of "positional goods" rather than public goods as argued by numerous economists of science (see Mirowski 2011). Positional goods entail a zero-sum consumption in which the use of the good stops its use by another person, thereby sustaining the status of the first user and limiting its usefulness to other potential users. However, while this might be a useful way to think about the value of knowledge, it assumes that knowledge—really, its function—will be used up in consumption, which is not (necessarily) the case. In contrast, the transformation of knowledge into a thing—through IP designations, for example—ensures that knowledge is separated from its

function, so that it can be alienated and exist as property, which has an expected ownership life span (e.g., twenty-year patent right).

As such, thing-ification entails a dual process in which our understandings of the value of knowledge (e.g., its property status) are always necessarily coproduced with how we use knowledge (e.g., its positional status). As this would suggest, it is important to unpack property rights alongside the positional nature of knowledge (i.e., its use). This is perhaps most evident, as a process, in the ongoing political-economic transformation of academic science since the 1970s resulting from the expansion of IPRs (Mirowski 2011; Tyfield 2012; Hackett 2014). As Hope (2008, 19) notes, such IPRs are really "private regulatory tools that enable their owners to order the market by fixing prices" and, as a result, they "encourage rent-seeking via the pursuit of unproductive property rights." The legal monopoly rights conferred by IPRs transform knowledge into a "thing" (e.g., patent) and, simultaneously, enable it to be valued as such because it is then possible to value the expected future returns *and* rents. For example, Arvidsson and Colleoni (2012, 145) argue that the valuations of social media platforms like Facebook do not necessarily follow from calculations of advertising revenues, or "rational calculations as to the underlying performance of company assets," but rather from the "ability to initiate and sustain a convention that enables a rational estimate of a company's future financial performance" (e.g., continuing increases in share value). As such, rentiership entails both the understanding of value as an abstract concept—for example, as financial opportunity cost (Chiapello 2015)—and economic and legal practices that can turn these understandings into things for sale.

Turning Things into Assets

A major empirical gap in existing political-economic analyses of rent and rent-seeking is the absence of empirical detail, and even discussion, about *how* rents are made—they are simply assumed to exist as the result of "distortions" in other political-economic processes or logics. As noted above, knowledge has to be reified before it can be valued, since its value largely depends on future revenues that can be configured as rents through the transformation of a thing into an asset (Birch 2017d; Muniesa et al. 2017). Things are transformed into assets; they do not automatically take on the asset form. For example, IP (e.g., patent) is made into an asset through the application of various (technoeconomic) knowledges, practices, and so on (e.g., accounting, corporate governance), alongside juridical decisions. As such, it is possible *and* important to examine empirically *how* assets and

the economic rents they engender are made in each particular case. Understanding the transformation of things into assets—scholarship in which STS scholars are increasingly engaged—necessitates in-depth empirical research into the political-economic knowledge production, practices, and processes involved in this assetization process (see Birch and Tyfield 2013; Cooper and Waldby 2014; Lezaun and Montgomery 2015; Martin 2015; Birch 2017d; Muniesa et al. 2017; Delvenne 2017; Vedel and Irwin 2017; Vezyridis and Timmons 2017). It is exactly this sort of empirical and methodological commitment—to follow the actors (and actants), to unpack knowledge claims, and so on—for which STS is well-known. Consequently, STS provides a range of analytical and empirical tools to examine who and what is involved in the creation of assets, the knowledges, devices, and practices that turn things into assets and then how rents are extracted from assets through different modes of ownership and control.

Focusing on the process of assetization involves understanding the creation of assets, which the International Accounting Standards Board (IASB) defines as "a resource controlled by the entity as a result of past events and from which future economic benefits are expected to flow to the entity" (https://www.iasplus.com/en/standards/other/framework). As a concept, assetization defines the conversion of a thing into identifiable and alienable *property*, which has value both as a resource (i.e., input into production) and as tradable property (Birch 2017d). For example, technoscientific research can be transformed into an intangible asset as a result of IPRs (e.g., patents, copyright), organizational procedures and processes (e.g., database and software), reputation (e.g., brand), and "goodwill"—the last of these represents the value of a business as a going concern (MacKenzie 2009). Assets are interesting for a variety of reasons (Moulier Boutang 2011) but most notably in the context of rentiership for how their value and valuation are organized, governed, and managed—all of which can be unpicked through detailed STS-driven analyses (e.g., Birch 2017d; Muniesa et al. 2017; Doganova 2018).

In relation to knowledge, intangible assets—like IPRs—are often organized and governed as monopoly assets in which legal restrictions (e.g., licensing rights) inhibit the use, replication, and imitation of the underlying knowledge; as such, rentiership involves the organization of limits and exclusions on the use of a resource or its copies (Zeller 2008; May 2010; Frase 2016). This is a crucial part of assetization because knowledge can only be turned into an intangible asset through its identification and classification as a resource, which means finding ways to extract it from the freely and openly accessible knowledge "commons" (Birch et al. 2018).

According to Frase (2016), for example, a key defining feature of intangible assets (e.g., music or film copyright) is the fact that exclusion and use rights are combined with follow-through rights that are extended to the sale of their copies (e.g., CD or DVD), thereby reinforcing monopolies despite the proliferation of copies. This necessitates international standards like the IASB, as well as the legal extension and application of ownership rights to knowledge "assets" *and* their "products," whether the latter is given away for free or not. A key question to consider in this context is where the value of intangible assets then lies. As several political economists argue (e.g., Nitzan and Bichler 2009; Styhre 2015; Bryan et al. 2017), much of the value of intangible assets rests in the valuation by the asset holders (e.g., business organizations) as the result of the legal limits on the use of assets, rather than being derived from any inherent qualities of assets themselves or their exchange in markets, especially as intangible assets can be valued very differently by different people (Bryan et al. 2017). It is for this reason, among others, that STS analyses of value and valuation can provide a critically important addition to the analytical tool kit for those interested in rentiership.

The valuation of intangible assets is not a simple matter. Rather, it involves a diverse array of political-economic knowledges, practices, and actors (Birch 2017b, 2017d), all of which directly relate to the dynamic and ongoing management of the earnings, or yield, of an asset over its life span—which is how the economist Alfred Marshall ([1890] 1920) defined "quasi-rents." In technoscientific capitalism, the future earnings or yields of an asset are highly uncertain (see Hopkins [2012] on the biotech sector). In part, uncertainty results from an array of time-sensitive concerns, including the ease in developing a substitute for an asset, the threat that an asset will lose its appeal or reputation, the potential of an asset to generate a new product or service, and so forth. As a result, the capitalization of an asset has become an important valuation practice in sectors like biotech and information technology where there is a high degree of uncertainty (Doganova and Eyquem-Renault 2009; Birch 2017d; Doganova 2018).

According to Muniesa (2012) and Muniesa et al. (2017), capitalization is a technoeconomic epistemology and social practice entailing the discounting of future earnings in the present. Originally introduced in the early twentieth century, it contradicted notions of inherent value prevalent in approaches based on the labor theory of value. Today, it represents a way to calculate the value of future earnings—using a discount rate to work out their current value—and therefore the suitability of something for investment (Muniesa 2012, 2014). As such, it involves a valuation based on future

expectations rather than past work, meaning that it is constituted by a collective financial ecosystem—since valuations cannot be derived from current market exchange because value is going to be realized in the future—comprising a range of technoeconomic experts and expertise which forms part of the ongoing management and governance of value through valuation claims (e.g., stockbroker prospectuses), valuation devices (e.g., analyst reports), valuation monitoring (e.g., accountant due diligence), and so on (Birch 2017d, 2017c). Rentiership depends on this active and ongoing organization, governance, and management of value—akin to performativity claims made by Callon (1998)—meaning that it is not a passive process; it involves significant effort on the part of asset owners (or rentiers) to manage the valuation claims and decisions of investors. However, it means that managers, financiers, investors, and others can make a valuation of something that has no historical precedence (or profits), such that the time frame between technoscientific "discovery" (or, more likely, IP filing) and realization of value—which can be many years afterwards, if at all—are aligned with one another.

Capturing Economic Rents

Almost all political-economic conceptions of rent and rent-seeking are normative as much as they are analytical. As mentioned already, this is the result of idealizing and naturalizing certain political-economic processes or logics; for example, rents are often framed as distortions of markets (e.g., Tullock 1993), or as unearned income (e.g., Sayer 2015), or as a burden on the "real economy" (e.g., Mazzucato 2018). Consequently, existing political economy literature frames rent and rent-seeking almost wholly in negative terms, as something problematic that needs to be avoided. If, on the other hand, we take the axiomatic STS principle of symmetry into account (Bloor 1976), it is worth disentangling the conflation of analytical and normative assumptions underlying discussions of rent and rent-seeking by analyzing how rentiership could be negative *or* positive, although this does not mean acceding to corporate claims—for example, that "value extraction" is a form of "value creation" (Muniesa 2017). The almost universally negative perspective of economic rents and rent-seeking in the political economy literature necessarily closes down an array of social activities and subjectivities that we may actually want to support. For example, Fuller (2002, 2016) classifies academic disciplines and scholarship as examples of "epistemic rent-seeking"; however, if we treat rentiership as wholly

negative then this implies that academia and universities can—and *should*—be framed as socially problematic.

It is, then, worthwhile to theorize diversity and variety as inherent to rentiership, entailing an examination of how rentiership is enacted through different *modes of ownership and control* of diverse assets. I only discuss three modes of ownership and control here but recognize that there are more forms: (a) government fiat, (b) monopoly, and/or (c) the configuration of markets and technoscience.

The first mode of ownership and controls involves *government fiat*. In this article, I use a Polanyian lens to conceptualize economies and markets as "instituted" rather than natural or naturalistic (Polanyi 1957). From this perspective, modes of ownership based on government or quasi-government fiat include the establishment of things like entitlements, regulations, standards, and codes (Busch 2011; Frohlich 2016). Value extraction can happen in at least three ways as a result: first, the presence and absence of regulations and so on can lead to the shifting of markets from one jurisdiction to another (e.g., stem cell tourism—Sleeboom-Faulkner and Patra 2011; Rosemann 2014); second, new regulations and so on can create new markets altogether (e.g., ethanol fuel standards—Birch and Calvert 2015); and third, new regulations and so on can both curtail existing markets and open up new markets (e.g., greenhouse gas emissions—Felli 2014). I focus on the last of these since it most clearly illustrates government fiat.

A helpful example of government fiat is the introduction of carbon markets, which Felli (2014) theorizes as a form of "climate rent." Felli argues that government (or quasi-government) fiat does not create "commodities" per se, but rather legally constituted "public entitlements to emit greenhouse gases" enacted through property rights (p. 254). He goes on to call it an "administrative grant" representing a "barrier to production" which is the very thing "that makes them valuable" (p. 266). As such, this form of government fiat reflects the Marxist notions of *absolute rent* in which ownership rights are first instituted and then protected and enforced by the state, thereby providing an important underlying logic to rentiership—namely, societal rules on the ownership and control of useful assets (Ward and Aalbers 2016). Other examples of this mode of ownership and value extraction abound, including of land, of water, of culture, of oil, and so on (Andreucci et al. 2017). Traditionally framed as problematic (e.g., Tullock 1993), government fiat need not only entail negative societal impacts; however, since it is deeply implicated in the creation of new markets and the promotion of sociotechnical transitions, some of which

we may want to support such as low-carbon technologies (e.g., biofuels, electric cars; Tyfield 2017; Birch 2018a).

The second mode of ownership is *monopoly*, especially intellectual monopoly in regard to science, technology, and innovation—for example, IPRs like patents, copyright, and so on (Zeller 2008). There is an important element of government fiat here as well (Fuller 2013), but it is not necessarily a defining feature of monopoly since monopoly rents can accrue as the result of the uniqueness or rarity of an asset as well. There are at least three reasons why IPRs are better theorized as monopoly rather than government fiat. First, IPRs represent very different sociolegal "things" (e.g., patent, copyright, trade secret, trademark), which are configured in very specific ways to create specific exclusions. For example, Kang (2015) highlights the need to differentiate between types of property rights, including "use," "fruits," and "abuse" rights. Property rights do not necessarily allow owners to destroy their asset (e.g., knowledge, land, customer base), although they extend use rights to copies of the asset (cf. commodities; Frase 2016). Second, IPRs entail a specific time frame (e.g., twenty-year patent right; May 2010). Consequently, they do not represent a generic form of ownership encompassing the societal rules of the game or covering assets with (nearly) perpetual life spans (e.g., land). Third, increasingly, ownership rights, especially of assets, are governed as "investments" (in assets) through corporate mechanisms like investor dispute panels, rather than through government sanction (e.g., trade law; Dreyfuss and Frankel 2015). Alongside IPRs, other monopolies are also possible, especially those based on the unique or special quality of an asset, such as wine appellations or unique artwork (Harvey 2002). This might be pertinent to technoscientific knowledge as well, in that the uniqueness and specificity of research findings and their commercial potential are inscribed in the legal terminology of IPRs like patents (Pagano and Rossi 2017). While IP monopolies are frequently characterized as problematic (e.g., Hope 2008; Mirowski 2011), at least in some respects, this need not be the situation in all, or even most, cases. For example, growing fears about automation's impact on employment imply that we may all need to find new waged (or paying) activities in the future, one of which could be content production; however, this obviously depends on our capacity to capture value from our creative activities (e.g., film, writing, and music distributed on the Internet), which will likely entail IPRs (Keen 2015).

The final mode of ownership results from the *(re)configuration of markets and technoscience*. As noted above, the temporal nature of valuation practices—exemplified by capitalization (Muniesa et al. 2017)—

necessitates the technoeconomic configuration of organizational forms—specifically, the private business enterprise (Birch 2017d). Considering the uncertainty of technoscientific commercialization, there are obvious limitations to the financing of innovation; that is, it needs to ensure that investors *can* receive their capital back before the realization of value in production events (e.g., selling products or services; Hopkins 2012). According to Pisano (2006), for example, the long time lines involved in biopharmaceutical development mean that biotech firms often pursue research and business strategies based on monetizing knowledge in order to finance product developments. Such monetization of knowledge, however, is dependent on the configuration of knowledge markets through the reinforcement of IPRs as well as the emergence of nonperforming entities—or "patent trolls" in more poetic language—which buy IP and then engage in litigation to extract value from their property rights (Chien 2014).

As such, value extraction involves the (re)configuration of markets and technoscience, which is reflected in two examples. First, Lazonick and Tulum (2011) show that much of the financing that goes into the US biopharmaceutical sector is used to buy back shares from shareholders, and thereby increase share prices, rather than increase research and development. Market pressures on managers to maximize shareholder value and avoid risky investments in long-term product development mean that firms use capital to increase share values and outsource risky research to smaller firms (Lazonick and Tulum 2011). Second, and perhaps more interesting, is Daraprim drug case discussed by Glabau (2016, 2017). In 2015, the then CEO of Turing Pharmaceuticals, Martin Shkreli, was raked over the proverbial coals because Turing raised the cost of Daraprim 5,000% from US$13.50 to US$750 per tablet (Glabau 2016). It looked like Food and Drug Administration (FDA) regulations had given Turing a monopoly on the drug through a market exclusivity agreement given to firms that test old drugs to ensure they are compliant with current regulations. However, these regulations did not limit other firms from also making similar agreements with the FDA. Rather, it seems like Turing exploited FDA rules on market exclusivity by convincing the previous rights holder to starve the market so no other company could get hold of any Daraprim tablets to run their own tests (Olson 2015). Rather than a case of government regulation or monopoly rights gone bad, Daraprim represents an active (re)configuring of the market and technoscience in order to extract rents. Obviously, the ethical and societal implications of this example illustrate the problematic side of rentiership, but they also obscure the potential to configure markets and technoscience in ways that encourage outcomes we might want to support.

Renewable energy would be an obvious example again, in that it will require the wholesale reconfigurations of sociotechnical systems in order to replace fossil fuels (Birch and Calvert 2015; Tyfield 2017).

Conclusion

My aim in this article was to think through the implications of STS for economic rent theory—and vice versa—in light of the increasing importance of rentiership in contemporary capitalism, as evidenced by—but not limited to—things like the spread of IPRs, financing of technology start-ups, monetization of free labor, and discursive role of future expectations in financing research and development (e.g., Mirowski 2012; Beckert 2013; Birch 2017c, 2017d; Schwartz 2017). In arguing that these things are characteristics of an increasingly technoscientific capitalism, I wanted to show how STS can contribute analytically to ongoing debates about the implications of contemporary changes in capitalism for research and innovation (e.g., Tyfield 2012; Birch 2013; Tyfield et al. 2017).

The emergence of rentiership as a very pressing and very current public issue reflected in concerns about growing inequality, stagnating social mobility, intergenerational conflicts, and suchlike is being taken up as a topic in a range of disciplines (e.g., Piketty 2014; Sayer 2015; Ward and Aalbers 2016; Andreucci et al. 2017), although perhaps without the alacrity that it could be. While much of this might seem more suited to debates in these other disciplines, especially in fields like political economy, I argued that STS can contribute something important to these discussions and to the analytical and empirical work needed in order to understand the current transformation and state of capitalism.

In fact, in light of the increasing co-constitution of capitalism and technoscience reflected in recent trends, it is evident that STS is perhaps one of the (inter)disciplines best placed to contribute to this examination of rentiership in an increasingly technoscientific capitalism. This is why I asked the question: what might STS contribute to the analysis of rentiership in technoscientific capitalism? Some STS scholars have already started to do this (e.g., Fuller 2002, 2016; Cooper and Waldby 2014; Birch 2017a, 2017b, 2017e; McGoey 2017), but there is plenty of analytical and empirical room for more to enter the fray, and in several ways.

First, generally, STS scholars are well-placed to make important contributions to a renewed political economy, as a discipline and object of study. This is because technoscience increasingly defines contemporary political economy, hence why I stressed the need to examine a specifically

"technoscientific" capitalism (Sunder Rajan 2006). Everyday life is increasingly configured by the technoscience needed to produce, transport, consume, and recycle (or throw-away) products and services; for example, electronically tagged clothing and their containers, all of whose movement and distribution can be globally coordinated from almost anywhere (Busch 2011). Global political decisions are also highly consequential. For example, decisions like the 2008 changes to the Systems of National Accounts—an international statistical standard produced by the United Nations—have far-reaching implications for the management of scientific research and development (R&D). The 2008 decision reclassified R&D spending as an asset investment, rather than production expenditure, meaning that science has been transformed into the production of (largely private) assets, which entails a range of new valuation, governance, and management dynamics (Birch 2017b).

Second, and more specifically, STS has a lot to offer political economy, and other disciplines, engaging with rentiership. There is a dearth of literature looking at the specifics of rentiership; that is, the question of *how* economic rents are made and *how* value is extracted in particular cases. Most discussions of rentiership are macro-centered, including much of what I have referenced here. The methodological approach and philosophy that underpins STS—to follow the actors (and actants)—represents an important approach to take in analyzing rentiership. For example, it is possible to envision STS-informed research that follows the actors involved in creating new assets, identifying how to turn things into assets, and how then to extract rents through different modes of ownership and control. Some people are doing this sort of work already as mentioned above. Obviously, this means that STS scholars will need to develop new competencies—in finance, business governance, accounting, and so on—but this is the kind of bread and butter activity that STS scholars do anyway (e.g., in researching science and technology).

Third, and finally, STS is an analytical approach that seeks to treat its object of study symmetrically (Bloor 1976). This principle can provide an important analytical counter to the assumption that rentiership is—both analytically and normatively—problematic (e.g., a market distortion or unfair activity). While there are likely forms of rentiership that we do not want to promote or support politically (e.g., monopolies resulting from network effects—Morozov 2016), there are other forms that may enable us to assert greater control over our lives, especially as they are entangled with technoscientific developments (e.g., exploitation of personal data, automation's impact on employment, extension of surveillance).

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Notes

1. More recently, other science and technology studies (STS) scholars have posited the notion of "epistemic capitalism" (Fochler 2016; Fochler and Singl 2018).
2. A growing literature outside STS is also engaging with assets as an analytical category and object of study, including feminists (e.g., Adkins 2018), geographers (e.g., Ouma forthcoming), political economists (e.g., Ward and Swyngedouw 2018), legal theorists (e.g., Dreyfuss and Frankel 2015), political ecologists (e.g., Ducastel and Anseeuw 2017), sociologists (e.g., Boltanski and Esquerre 2016), and historians (e.g., Levy 2018).
3. In a recent article, Hodgson (2017) points out that capitalism could only really take off when land was released from limitations on its transfer and sale, so that it could be used as collateral; this contrasts with the notion that capitalism arose as the result of secure property rights. As such, it is possible that economic rents only emerge because of capitalism rather than reflecting a feudal hangover. Prior

to its use as collateral, the value of land was set by custom or whim; once it is released from customary restraints, it could be repriced to reflect the expected returns from production.

4. It is important to note that intellectual property rights (IPRs) can reflect more than one form of economic rent: first, they represent monopoly rents accrued through monopoly rights (e.g., patents, copyright) to research and its outputs (Mirowski 2011); second, they represent rent-seeking on the part of IPR creators and holders to extend or strengthen intellectual property protection by influencing policy-making (Tyfield 2008); and third, they represent a particular property system underpinning a new innovation regime (Coriat, Orsi, and Weinstein 2003). These three might necessary accompany—or coproduce—each other, as the evolution of the biotechnology industry since the 1970s largely illustrates (Slaughter and Rhoades 2004).
5. An example of monopoly rent derived from the qualities of an asset itself, which is relevant to STS, could include the particular posttreatment qualities of certain biological materials (e.g., cell lines—see Waldby and Mitchell 2006) or their specific biophysical materialities (e.g., energy content of different biofuel feedstocks—see Birch and Calvert 2015). This form of monopoly rent can be equated with the neoclassical conception of "Schumpeterian rent"; for example, the well-known management theorist David Teece (2003) conceptualizes Schumpeterian rent as a reflection of the quality or specificity of an asset rather than the degree of a firm's market monopoly or control.

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Author Biography

Kean Birch is an associate professor in the Department of Geography at York University, Canada. His latest book is *Neoliberal Bio-economies? The Co-construction of Markets and Natures* (2018, Palgrave Macmillan).