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Theorizing the Bioeconomy: Biovalue, Biocapital, Bioeconomics or . . . What?

Kean Birch[1] and David Tyfield[2]

Abstract

In the policy discourses of the Organization for Economic Cooperation and Development (OECD) and European Commission (EC), modern biotechnology and the life sciences are represented as an emerging "bioeconomy" in which the latent value underpinning biological materials and products offers the opportunity for sustainable economic growth. This articulation of modern biotechnology and economic development is an emerging scholarly field producing numerous "bio-concepts." Over the last decade or so, there have been a number of attempts to theorize this relationship between biotechnologies and their capitalization. This article highlights some of the underlying ambiguities in these conceptualizations, especially in the fetishization of everything "bio." We offer an alternative view of the bioeconomy by rethinking the theoretical importance of several key economic and financial processes.

[1] Department of Social Science, York University, Toronto, Ontario, Canada
[2] Department of Sociology, Lancaster University, Lancaster, Lancashire UK

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

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Introduction

Ever since the origins of modern biotechnological knowledge in the 1970s with research on recombinant DNA and monoclonal antibodies, there has been a growing interest in (and expectations for) the development of a "biotechnology" industry. Numerous attempts to measure the biotechnology industry have been undertaken, while similar energy has been poured into promoting policy initiatives that seek to capitalize on new biotechnological knowledges (see Birch 2007a). Almost from the outset, then, biotechnology has been characterized as a new industrial sector that will transform our societies and economies.

The most recent evidence of this massaged exuberance are the policies pursued by the Organization for Economic Cooperation and Development (OECD) and European Commission (EC). For example, the OECD (2006, 1) has a produced a "policy agenda" pushing biotechnology as a new "bioeconomy," or " . . . the aggregate set of economic operations in a society that use the latent value incumbent in biological products and processes to capture new growth and welfare benefits for citizens and nations." The EC similarly stresses the value inherent in the bioeconomy, although with a much less clear definition: "The bio-economy is one of the oldest economic sectors known to humanity, and the life sciences and biotechnology are transforming it into one of the newest" (EC 2005, 2). The vagueness of these formulations has not stopped technoscientific and political–economic investment in the idea of the bioeconomy; in fact, as some argue (e.g., Hilgartner 2007), the very concept of the bioeconomy is not simply a way to anticipate or conceptualize future socioeconomic developments, it is also an attempt to shape these developments, drive them forward, and embed them in wider institutions (see also Birch, Levidow, and Papaioannou 2010).

In this article, our aim is not to attempt another definition of the anticipated or promised transformative restructuring represented by the so-called bioeconomy. It is instead to look at how science and technology studies (STS) scholars have gone about theorizing the bioeconomy and to critique some of the "bio-concepts" that they have come up with. We are interested in how they have gone about thinking/rethinking the relationship between

the life sciences and their capitalization. We are seeking to do this in order to critique certain theories that posit the emergence of new *sociotechnoeconomic* processes and relations characterized variously as "biocapital" (Rajan 2006), "biovalue" (Waldby 2000), "bioeconomics" (Rose 2001), or similar (Cooper 2008). In short, we argue that because of their particular technoscientific focus, these STS theorists have posited a transformation of modern capitalism without due attention to *the transformation of economic and financial processes in modern capitalism*.

Our first aim is to problematize the fetishization of all things "bio" evident in these theoretical discussions and to consider the relationship between political economy and biotechnology anew. In the first part of the article, we highlight the problematic adoption of Marxist language in these bio-concepts without the necessary adoption of Marx's theoretical formulation of the labor theory of value (LTV) underpinning key terms like value, capital, and surplus value. In adopting Marxian concepts, the fetishization of the "bio" has meant that—to different degrees—STS scholars like Waldby, Rose, Rajan, and Cooper have missed an important opportunity to update the understanding of the bioeconomy in light of the financial and economic restructuring of the economy. This is because these STS theorists have either not incorporated more recent political–economic analyzes or, if they have, then they have failed to adequately address their implications. In particular, we want to highlight the need to consider the importance of asset-based economic processes (e.g., property, rent, etc.) in any understanding of the bioeconomy. These *asset*-based processes contrast markedly with *commodity*-based processes (e.g., production, labor, etc.) that characterize the Marxist language and concepts on which STS theorists draw.

Our second aim is to critique the various bio-concepts (e.g., biovalue, biocapital, etc.) in light of the transformation of economic processes that necessarily alter our understanding of the political economy of the life sciences. This involves highlighting three key processes: first, a shift in value creation from productive to immaterial labor; second, the emergence of a financialized-rentier regime of accumulation; and third, the shift from commodity-based to an asset-based market exchange. In illustrating the first transformation, we draw on the work of *autonomist* Marxists who have done much to reformulate notions of biopower in Marxian terms (e.g., Lazzarrato 1997, 2004; Hardt and Negri 2000; Holloway 2002; Vann 2004). Of particular note is the theory of biocapitalism (see Morini and Fumagalli 2010; Marazzi 2011), which stands out because of the "bio" terminology while actually contrasting with the

STS fetishized emphasis on all things biological that we criticize in this article. We then draw on the work of Zeller (2008) to illustrate the second transformation and Aspers (2007, 2009) to illustrate the third transformation. These two latter transformations involve the emergence of an asset-based economy—in contrast to the commodity-based economy underpinning Marxist thought. In simple terms, the key difference between an *asset* and a *commodity* is that the former is a tangible or intangible resource that can be used to produce value and, at the same time, has value as property. In contrast, a commodity is an object produced for exchange. More importantly, a key difference is that as an asset's value increases so does demand for it, whereas the opposite relation obtains for commodities (as in classic supply–demand curves; G. Cooper 2008, 8). This distinction has implications for how we understand the realization of value through capitalist market exchange. In this article, then, we explicitly address the implications this distinction has for the bioeconomy including the emergence of new forms of intangible or immaterial labor; the dominance of a *rentier* regime; and the distinctiveness of market exchange in asset-based industries like the life sciences. Evidently, many of the knowledge and material resources developed and employed in the life sciences are ambiguous in that they embody characteristics of a commodity and an asset at the same time. Thus we are not arguing that the bioeconomy is only characterized by one form (e.g., asset) or the other, but rather we want to explore and outline the importance of the "asset-like" qualities of biotechnological knowledge and resources which is currently unexplored and unacknowledged in existing STS theories.

In this article, we start by outlining the deployment, by STS scholars, of concepts drawn from political–economic approaches, especially Marxist ones, such as "capital," "value," and "surplus value" (Conceptualizing the Bioeconomy section). We want to highlight the contradictions, ambiguities, and assumptions underlying the deployment of these concepts in these STS theories (Assumptions, Ambiguities, and Other Issues section). We do this to make the new claim that we need to understand the implications of new and different political–economic processes when considering the bioeconomy, rather than deploying political–economic concepts as an undertheorized add-on to other forms of social theorizing. We finish by offering another way to conceive of the relationship between biotechnology and political economy by looking at the transformation of financial and economic processes (Reconceptualizing the Bioeconomy section).

Conceptualizing the Bioeconomy: Biovalue, Biocapital, Bioeconomics . . .

Several STS scholars in the past decade or so have theorized the articulation of capitalism and biotechnology. Out of this meeting have come a number of theories positing particular political–economic relationships including *biovalue* (Waldby 2000), *bioeconomics* (Rose 2001), *biocapital* (Rajan 2006), and *life as surplus* (Cooper 2008). There are a number of other accounts of this articulation worthy of a full review in their own right (e.g., "genetic capital," "organic capitalism," "biowealth," etc.); something that is beyond the scope of this article. However, Stefan Helmreich (2008) has written an enlightening review of the evolution of these various concepts, which does much of the work for us. He identifies two particular clusters of theories or "species of biocapital": first, a Marxist-feminist cluster concerned with production and reproduction; and second, a Weberian-Marxist cluster concerned with how "relations of production are described alongside accountings of ethical subjectivity" (Helmreich 2008, 471). This latter cluster is also heavily influenced by the Foucauldian concept of biopolitics. In this article, we focus on this latter, largely Foucauldian perspective. It is clear that scholars from both "species" are engaged in a serious attempt to rework Marxist categories, which we do not want to denigrate. However, we would suggest that some of these reworkings are less productive than others, especially in their adoption of political–economic categories and terminology. This is particularly clear once we take seriously the foundation of a Marxian political economy, namely the LTV (or value theory of labor *per* Elson 1979).

Before looking at the more Foucauldian approaches, we want to start with Catherine Waldby (2000, 2002) since her concept of biovalue is an early and influential conceptualization of a link between capitalism and the life sciences. She argues that new biological technologies and materials such as genetic tests, stem cells, and so on, "involve a reorganization of the boundaries and elements of the human body" (2002, 308) creating new identities, socialities, and subjectivities. Deeply implicated in the "biotechnical trajectory" engendered by these new technologies and materials is the production of biovalue, which Waldby has defined as:

> . . . a surplus value of vitality and instrumental knowledge which can be placed at the disposal of the human subject. The surplus value is produced through setting up certain kinds of hierarchies in which the marginal forms of vitality—the foetal, cadaverous and extracted tissue, as well as bodies and

> body parts of the *socially* marginal—are transformed into technologies to aid the intensification of vitality for other living beings. (2000, 19)
>
> . . . the yield produced by the biotechnical reformulation of living processes. Biotechnology tries to gain traction in living processes, to induce them to increase or change their productivity. (2002, 310)

The concept of biovalue is here underpinned by a "logic of vitality," in which "biotechnology produces a margin of biovalue" from human well-being represented by a "surplus of fragmentary vitality" (ibid.); that is, "left-over" (presumably "healthy") biological material. The incentive behind the pursuit of biovalue is twofold: first, there is the use value of new technologies in the production of health and well-being; and second, there is the exchange value of new biological commodities produced for market exchange. Here we note some ambiguity in Waldby's argument, specifically with reference to the relationship between these two rather different (and Marxian) notions of value. On one hand, biovalue is "translated" into health (2002, 317); on the other hand, and slightly contradictory, biovalue is the "yield" of vitality or health (ibid., 310). Thus it would seem that there is nothing valuable about biological "fragments" (e.g., tissue) per se; it is rather the vitality or health they provide that is valuable, contradicting the need to conceptualize a new, specifically "bio-" value relationship.

Following Waldby—in time and drawing on her theoretical insight—other STS scholars have used the "bio-" prefix to conceptualize the political economy of the life sciences. As mentioned, there are a number of such analyses, but we wish to focus more explicitly on the Foucauldian perspectives in this article. Now it is perhaps pertinent, considering the importance of vitality in Waldby's work, to turn to the work of Nikolas Rose (2001, 2007a, 2007b, 2008) and his discussion of the "politics of life itself" or "vital politics." In making his argument, Rose has turned the concept biopolitics onto the molecular, interrogating changing subjectivities in light of new "bio"-technologies. He argues that "Biopolitics becomes bioeconomics, driven by the search for what Catherine Waldby has termed 'biovalue': the production of a surplus out of vitality itself" (2001, 15).

Like Waldby, Rose specifically links together two different meanings of the term value. The first is a political–economic, and Marxist, use of the term *value* to refer to economic or market practices (e.g., profit and shareholder value), while the other is a more ethical framing of the term value, which could perhaps (like Waldby above) more distinctively be termed *values* (e.g., ethics, meanings). This is most explicit when he argues that

bioethics, for example, has become "part of the machinery for governing the bioeconomy" since it facilitates "the circuits of biological material required for the generation of biocapital" (Rose 2008, 47). As such, Rose (2007a, 2007b, 2008) several times links what he calls a "somatic ethics" with the "spirit of biocapital" in his work, arguing that the "re-shaping of human beings is thus occurring within a new political economy of life in which, in part at least, biopolitics has become bioeconomics" (2007a, 17). Thus Rose not only draws on Waldby's concept of biovalue in his work, he also directly refers to "a new form of capital—biocapital" (2007b, 6)—largely inspired by the work of Sarah Franklin and Margaret Lock (2003)—which is used to characterize the "capitalization of life itself." Again, there are some ambiguities in these arguments, notably a certain lack of detail and a reliance on underspecified concepts, as discussed below. Moreover, like Waldby and perhaps as a consequence of drawing upon her concept, there are further ambiguities evident when Rose (2007a, 17-18) posits a "latent value" that can be "captured from vitality," where the former appears to represent values (e.g., human desires and aspirations) that are embodied in biological material and bodies in order to "extract a surplus—be it food, health or capital."

Although Rose quite clearly uses the concept of biocapital in his work, he does not really refer to the work of Kaushik Sunder Rajan (2006), who we want to consider next. Although he did not necessarily coin the term biocapital, Rajan's book *Biocapital* has done much to popularize the concept and is worth considering as an important extension in the conceptualization of the relationship between capitalism and the life sciences. In identifying the distinctiveness of Rajan's contribution, Stefan Helmreich (2009, 127) argues that whereas Franklin and Lock's use of biocapital refers to "reproductive technologies generative of surplus value," Rajan extends this analysis by conceptualizing the "market *potential* of bioproducts" [our emphasis]. In this, Rajan identifies speculative value as another constitutive element of biocapital. According to Rajan (2006, 3), both productive/reproductive and speculative capital are entwined in this "new face, and a new phase, of capitalism" in that "biotechnology is a form of enterprise inextricable from contemporary capitalism." This does not make biocapital a "radical rupture" in capitalism, but rather an "evolution" of capitalism (ibid., 10). In his analysis, Rajan (2006, 18) draws on Foucault—and the work of Nikolas Rose—in order to examine the future orientation and speculative evaluations inherent in biocapital; that is, the speculative value of visions, hype, and promises. From this starting point, Rajan is able to

make the argument that the "circulation of capital is intimately tied to questions of value," especially "moral value" (ibid., 41, 56). He thereby identifies the "discursive act" inherent in future visions and promises as crucial moment in the circulation of (speculative) biocapital. Again there are ambiguities in this analysis, discussed below. In part this is a consequence of Rajan treating the relationship between capital and biotechnology as universal, uncomplicated, and entwined. What is missing is the specificity of biocapital, the particularities of certain times and places.

The emphasis on speculative capital (and value/values) in Rajan's book is reiterated in the work of the final scholar we want to consider here, Melinda Cooper. In her book *Life as Surplus*, Cooper (2008, 10) argues that "neoliberalism installs speculation at the very core of production." Although her focus on financialization (i.e., the economic and political dominance of the financial sector) is a welcome contribution to theorizing the bioeconomy, Cooper's overall thesis is somewhat hard to pin down (Tyfield 2009). She claims that the life sciences are employed in the creation of surplus value, which, in turn, shapes their development; something that, in itself, is true of all capitalist enterprise. However, she highlights a singular novelty in the life sciences regarding a fusion between the perceived self-regenerative nature of biological processes and their autopoietic capacity to transcend the ecological "limits to growth" with the capacity of financial capital to transgress limits to economic growth through the dynamic of speculative promise; a claim that the recent and ongoing financial crisis has spectacularly disproved. Nevertheless, for Cooper it is the self-generative/self-regenerative possibilities of the life sciences subjected to the logic of financialization that promises surplus value from life itself. As she argues:

> . . . what is at stake and what is new in the contemporary biosciences is not so much the commodification of biological life—this is a foregone conclusion—but rather its transmutation into speculative surplus value. (2008, 148)

Furthermore, Cooper argues that this self-regenerative capacity of both life and finance leads to a neoliberalized political economy. For the (seemingly) *self*-regenerative and self-regulating capacity of living and economic processes of valorization appears to legitimate the perspective that "such systems evolve most productively when they are free from external regulation" (ibid., 44); that is, in "free market" conditions or in "nature." We now critique these arguments in more detail.

Assumptions, Ambiguities, and Other Issues

Having outlined some of the existing theoretical discussions of the relationship between capitalism and modern bioscience, we now want to provide a more in-depth critique of these conceptualizations. In particular, we identify a number of key ambiguities across the works we discussed above. First, there is an issue with how these concepts—particularly those marshaled by Waldby and Rose—link "vitality" and value. Second, there is an issue with how they conceptualize value as a dual concept comprising (broadly speaking) ethical and economic value. Third, there is an issue with the theorizing of financial speculation, especially in relation to the production of surplus value from biological resources. Finally, there is a general issue with the appropriation of Marxist terminology (e.g., surplus, capital, value, etc.) in that these concepts are selectively adopted without adequately addressing their original formulations in the LTV. We argue that this adoption of Marxist terminology, separated from the LTV, renders these STS theories of the bioeconomy opaque.

The key point to emphasize is that all these existing conceptualizations—to a greater (e.g., Waldby) or lesser (e.g., Cooper) extent—are engaged in an entirely different intellectual pursuit to that of Marx and the critique of political economy. That is, the strength of these sociological and anthropological studies of science and technology is in the development of thick description and the associated playing with conceptual vocabulary in a bid to create a new terminology that is appropriate to a similarly new social reality. However, the questions that remain are: (1) is the reality described so new and different that existing theories are in fact incapable of similar insights? and (2) why the coy use of Marx, which actually opens up this work to the criticism that they confuse more than they illuminate? We will outline an alternative deployment of Marxist ideas in a more satisfying way in the next section when we refer to the work of *autonomist* Marxists.

To start, Waldby's (2000, 2002) conceptualization of biovalue as a 'surplus of vitality' implies several problematic assumptions, which are further evident in Rose's arguments. First, there is an assumption that vitality—that is, health and well-being—is already present and even abundant (Waldby 2002, 311); that is, a *surplus* of vitality. This assumption contradicts the notion that vitality is open to exploitation through the production of commodities, because the surplus implies that vitality is already available, meaning that there is little reason to produce or pay for it. Marxist political economy raises this very question of how scarcity is *constructed* so that there is reason to pay for commodities. For example, the production of

(valuable) commodities depends on such scarcity because value, in its economic or exchange sense, is derived from the exclusion of people from access to resources (biological or otherwise); a scarcity which ultimately depends on socioeconomic institutions such as property rights (Birch 2007a) and not upon the characteristics of the biological material. Second, representing biovalue as a surplus of vitality—while being both abundant and scarce at the same time—is also problematic. In Waldby's conceptualization, we have to accept that health and well-being (i.e., vitality) are attributable to the biophysical characteristics of vital fragments (e.g., tissue, drugs, etc.), contradicting the sociological perspective that health and illness are socially constituted (Cunningham-Burley and Boulton 2000). A final issue is that vital fragments cannot, therefore, be the source of value in themselves because what is valuable is vitality, not some unmodified biological matter. What this would imply is that it is the knowledge and knowledge labor required to transform these fragments into commodities that are valuable, implying that the prefix "bio-" is rather irrelevant in this case. We may as well term it "knowledge-"value instead since it is knowledge (or, more accurately, knowledge *labor*) which creates value and not the latent qualities of the biological material itself.

Unfortunately, these problematic assumptions are necessary to the concept of biovalue because otherwise there is little conceptual difference between biovalue and value. The reason for this is that there is nothing intrinsically "bio-" about the value relationship itself, as described in this conceptualization, since it cannot relate to the specific biological resources but rather reflects the knowledge needed to develop those resources as socially constituted vitality. It would presumably be more apt then to refer to (socially constituted) health value. Waldby (2002) herself points out that health is "owed" to others and it is therefore relational rather than an immanent characteristic of either biotechnology or the capital relations surrounding it (i.e., we can think of it as a process rather than state). As such, vitality comes across as a preference (or social value) of individual citizen consumers rather than a new value (or capital) relation. Consequently, "bio-values" and not "biovalue" seems a better concept; that is, the social or ethical values that make biotechnology a profitable venture.

Once this step has been made, however, the concept of "bio-values" can also be easily incorporated within a Marxist political economy perspective, such as cultural political economy (CPE; Jessop and Sum 2006), insofar as such social values about life, health, and so on, condition what is and is not a profitable line of business, as regards issues of (coproduced) social acceptance (or not) of, and hence market demand for, particular biotechnological

innovations and their production processes. This means that while the fetishization of the "bio-" is problematic in our view—in that there is no "biovalue" in a political–economic sense—theorists like Waldby, Rose, and so on, still contribute to our understanding of "imaginaries" that pattern political–economic processes. From this perspective, the values, debates, and quandaries about what is deemed technologically "possible," culturally demanded or rejected, speculatively hyped, and so on, can be seen as crucial elements of the regularization of capital accumulation. The problem that then arises, however, is whether bio-values are so important that an entirely new prefix, signifying some momentous change, is merited. Given the relative *failure* of most biotech to date (see Nightingale and Martin 2004), at best the answer is likely to be "possibly, but only just beginning" or even "not yet."

This brings us to the second issue. It is necessary, it seems, to collapse the distinction between ethical and economic value in order to theorize a specifically "bio-" sense of value or capital; such conflation effectively dispenses with exchange value and leaves ethical value as paramount. This would seem to happen because the latter more evidently falls within the remit of STS research, whereas political–economic processes tend not to. However, in valorizing ethical values, especially in terms of health, there is a shift toward reifying the speculative expectations of future usefulness (e.g., benefits of new therapeutic treatments) and fetishizing biological matter (e.g., the "bio-") as the source of value, rather than any labor or economic process. This conflation is most evident with Rose but is also evident in Rajan and Cooper. It raises the question of whether this conflation of ethical and economic value can be done without completely destroying the meaning of the latter economic sense of value and without assuming the latent potential of all things "bio-."

Moreover, Rose's argument that the biosciences have led to a "molecularization" or "geneticization" of society, politics, and economics is premised on the idea that ethics and values inform economic practices. In itself, this is not a problematic idea and indeed resonates with recent developments toward a Marxian cultural political economy (e.g., Jessop 2005), which emphasizes the cultural conditioning of capital accumulation (as above). However, CPE does not thereby repudiate analysis of the intrinsic logic and contradictions of capital as a real abstraction, built upon analysis of the construction of (exchange) value. Conversely, Rose's focus on the novel construction of economic practice does take a definitive step away from any such analysis of exchange value, and the essential continuity it posits in all capitalist economic growth. For Rose the conceptualization

of the bioeconomy is premised on the wholesale reorientation of society (especially social values) and not on changes in political economy; a move that is also common to the other work we are considering here. It is therefore not clear why these scholars adopt Marxist terminology in order to make their claims. Nor is it clear why it is necessary to argue—or what it actually means, since so little space is devoted to explaining it—that there has been this wholesale shift from "biopolitics to bioeconomics," as Rose (2001, 2007a, 2007b) theorizes. This is especially pertinent since Foucault (1998, 141) himself explicitly argued that:

> . . . bio-power was without question an indispensible element in the development of capitalism; the latter would not have been possible without the controlled insertion of bodies into the machinery of production and the adjustment of the phenomena of population to economic processes.

Here it is perhaps the "bio-" prefix that creates the ambiguity. It might therefore be more pertinent to return to Rose's earlier work (e.g., Rose 2001) on the "politics of life itself" where the "bio" is less obvious (although still present). However, in turning to this earlier work it is evident that "vitality" is not actually the underlying logic of the bioeconomy; in fact, the underlying logic could be very different.[1] For example, it would seem more relevant, as Birch (2007b) argues, to theorize a "logic of morbidity" in which ill-health enables the biosciences to yield economic value. This is because there is no real point to bioscience research that does not identify illnesses or health "problems" since these morbidities constitute both ethical (e.g., rationales, motivations) and economic (e.g., products) value in the bioeconomy. There is no surplus health or vitality in this sense; there are only a "surplus" of new and existing conditions and symptoms that can be variously identified as social and health problems (e.g., obesity, diabetes, etc.), research goals (e.g., obesity genes), and economic opportunities (e.g., obesity pill).

The third set of issues relates closely to the second when considering the importance that speculation has in the biosciences. As others have argued (see Borup et al. 2006), expectations are constitutive of technoscience although it is not possible *ex ante* to say in what way expectations *will* constitute technoscience. In discussions of the bioeconomy, speculation is variously deployed in concepts like Carlos Novas' (2006) "political economy of hope" and, more relevant here, Rajan and Cooper's discussion of speculative capital and financialization, respectively. However, in both these latter cases, it is crucial to avoid the assumption made by these

authors that speculation and speculative capital necessarily exhausts the constitution of the bioeconomy.

Speculative capital, to which both Rajan and Cooper refer, is represented as a promissory value of new biotechnologies because it enables life science firms to raise the investment capital necessary to develop new products and, as a result, "realize value" (Rajan 2006, 129). Part of this process is the construction of consumers for these new products, hence the need to develop new diagnostic tools to create, in Rajan's words, "patients-in-waiting" (ibid., 175). In Cooper's (2008) argument, the promise of "life as surplus" results from the fusion of the self-regenerative nature of biological life and finance capital, which enables the production of surplus value. As Tyfield (2009) suggests, however, this argument problematically fuses issues of self-regenerative nature (or self-valorization in the case of capital) with questions of *surplus*, despite the lack of a necessary conceptual link between these terms. Cooper's identification of surplus with the notion of potential is unrelated to the standard use of the former term (i.e., as a surfeit), which is also its connotation in Marx as regards production of *more* value than is consumed in the purchase of the means of production, including labor power. Hence the appropriation of the Marxist concept of surplus in Cooper's argument does not reflect the position of surplus in Marx's LTV, illustrating the selective application of Marxist ideas in these theories of the bioeconomy.

More critically, the core ambiguity behind both these treatments of speculative capital (or surplus value) is the idea that financialization or speculation can rest on almost nothing or on an *entirely* promissory or self-regenerative capacity. Despite Rajan's argument, speculative value and financial investment cannot be based on the latent value of a biological resource or promised commodity. Rather these have to be derived from the value of the firm itself (e.g., shares) as evaluated and assessed by investors. As Leyshon and Thrift (2007) have argued in their article on the "capitalization of almost everything," financialization depends on revenue streams from an asset class. Hence speculative capital or surplus value cannot occur without revenue streams, which are needed to fund the high and regular returns demanded by such investors. In the case of the life sciences, most firms' speculative value is derived from the trading of shares or investments in the firm (i.e., financial assets) or intellectual property (e.g., knowledge assets) and not from trading a material commodity produced by that firm. This is because most life science firms up to now have simply not produced any "commodity" for sale (Nightingale and Martin 2004; Lazonick and Tulum 2009).

Although a firm's share value may be based on the (cultural) representation of its technoscientific capabilities, biological material and future commodity production, speculative value still has to reflect the here-and-now asset value of the firm (to investors) and not *just* the future promissory value of any revenue from biological commodities that a firm *may* (but is unlikely to) produce. This is particularly marked in the case of biotech firms: most *public* biotech firms (c. 80 percent) have no products on the market or any positive revenue stream, while private firms are almost wholly without income (Pisano 2006; Lazonick and Tulum 2009), which means that they have no revenue stream to be capitalized. The implications of this have been amply demonstrated by the impact of the financial crisis on the British biotech sector:

> More than a third—29 companies—of the listed [UK] biotech sector have gone bust since 2008 and 10 are on the brink, according to work by Paul Cuddon at analysts Peel Hunt. Another 38 are "fine" and six were bought by other companies. (The Guardian 2011)

These bankruptcies reflect the impact of the ongoing financial crisis rather than a sudden crisis of confidence in the supposedly promissory or speculative value of biological R&D or biotechnology products (i.e., commodity production). The latent value of biological resources and promised biotechnology products cannot simply disappear leading to these bankruptcies; instead, it would seem reasonable to assume that the value of these companies did not rest in anything we could characterize as "bio" in the first place. Instead, we would argue, life science firms are asset-based enterprises rather than commodity-based ones, in that their value is derived from trade in intellectual property and financial investments, not from the production of biological commodities or materials.

This brings us to the final issue we want to highlight in this section—the misappropriation or selective adoption of terms from Marxism and critical political economy (e.g., value, capital, surplus, etc.). The STS conceptualizations of the bioeconomy we highlight above adopt these specific political–economic terms without adequately addressing the original formulation of these concepts—namely the basis of value in labor (power). Commodities, be they "bio-commodities" (i.e., fragments of vitality) or normal commodities, are products of a labor process. Value is *realized* through market exchange, but it is constituted by production (or reproduction in other conceptualizations of biocapital, e.g., Franklin and Lock 2003) and it is the (exploitable) capacities and capabilities of workers (as

embodied labor power) that construct value rather than any latent characteristic of a biological product, commodity, or resource.

The metaphorical conflation of organisms with workers is problematic in this sense. As Stefan Helmreich (2007, 293) argues, many "biotech boosters" assume that biotechnology commodities are "latent" in biological materials, thereby leading to the assumption "*that biological process itself* already *constitutes a form of surplus value production*" (original emphasis). In Marxist LTV, there would be no value in a biological fragment without the effortful and waged application of knowledge and work to make that fragment into a commodity of some sort. Even though we think that this appropriation of political–economic and Marxist concepts is problematic, we do not want to argue that labor is necessarily the only issue of interest to our discussion of the bioeconomy. Indeed, what the STS perspectives we have criticized here miss is the fact that (biological) nature is an important asset, even if it is not a source of latent value from commodity production. But, in order for nature to be an asset, it needs to be turned into property. We argue in the next section that the current conceptualizations of the bioeconomy have actually missed a major element in capital accumulation in relation to the biosciences; primarily, they have failed to theorize asset-based economic processes and the realization of asset value through market exchange. We think that a discussion of these issues will therefore provide a novel and theoretically rigorous contribution to these debates by highlighting the distinctive relationship between the biosciences and capitalism; something which affixing "bio-" to concepts like value and capital does not actually do. It is this reconceptualization of the bioeconomy that we turn to next.

Reconceptualizing the Bioeconomy

Political Economy of Knowledge Labor

Our starting point is that there is nothing intrinsically valuable or capitalist about natural or biological materials without a number of supporting economic and extra-economic processes and institutions. In using terms such as value, capital, surplus, and so on, current STS conceptualizations of the bioeconomy not only misappropriate such concepts in their discussion of capitalist relations but also misrepresent modern bioscience and biotechnology.

First, such theorizing ignores the foundational understanding of (economic) value in Marxist political economy as based on the LTV. In its early

deployment by Adam Smith, value was conceived as the amount of labor necessary to produce a commodity, leading to the view that labor productivity is the foundation on which economies are based (Foley 2006). Consequently, labor productivity is the key measure of wealth in capitalist societies. On one hand, this implies that the exhaustion of natural and, we can add, biological materials is unimportant since value can be created so long as labor productivity increases even as natural and biological materials are depleted (Moore 2009). On the other hand, *autonomist* Marxists have raised the interesting point that labor and hence value can no longer be limited to such a focus on material production, but must incorporate a range of cognitive, informatic, and affective activities (e.g., Vann 2004; Morini and Fumagalli 2010; Marazzi 2011)—or "immaterial labor" (Lazzarrato, 1997, 2004).

These *autonomist* thinkers provide a useful contribution to discussions of the LTV because in their arguments they work through the relevance of Marxist ideas in modern political–economic contexts. In particular, Morini and Fumagalli (2010) argue that we are now witnessing a transition from Fordism to *biocapitalism*, which entails a whole series of new socioeconomic relationships involving the embodiment of intellectual, relational, and emotional resources and capacities. Hence, they argue that value "lies in the intellectual and relational resources of subjects, and in their ability to activate social links that can be translated into exchange value" (Morini and Fumagalli 2010, 236). The most obvious example of what they mean is something like Facebook where there is no value without the social relationships and intellectual engagement of the site's users. In this sense, as Marazzi (2011, 500) puts it, "the individual is the coproducer of what he [*sic*] consumes." The consumer or user becomes an unwaged laborer. The key point to take from this is that the STS scholars we discuss above have derived their concepts (e.g., value, capital, surplus, etc.) from the LTV without systematically working through the complexity of modern capitalism, as illustrated by the *autonomist* Marxists. It is no longer simply the production of commodities that creates value; the consumption of goods and services, along with the social and intellectual relationships this entails, also becomes an asset for companies.

Second, and in contrast to what Helmreich (2007) argues about the metaphorical treatment of biomaterials (see above), it is possible to argue that nature is also an asset rather than a commodity, especially the biological resources that can be intensified. Boyd, Prudham, and Schurman (2001) highlight a distinction between the "formal" and the "real" subsumption of nature, reflecting Marx's discussion of the formal and real subsumption

of labor. The former involves an absolute extension of control over natural resources through proprietary regimes (e.g., land enclosures, mining rights, etc.), making the appropriation of value dependent upon "strategic rent seeking." The latter, however, "refers to systematic increases in or intensification of biological productivity (i.e. yield, turnover time, metabolism, photosynthetic efficiency)" (Boyd, Prudham, and Schurman 2001, 18). This means that biological resources can be "made to act as actual forces of production" (ibid., 19) through continual modification to increase the relative surplus value in the associated production processes that has historically been the motor behind the spectacular increases of productivity characteristic of capitalism.

In their analysis, Boyd, Prudham, and Schurman (2001) specifically reference biotechnology and the possibilities it offers for the real subsumption of nature, implying that we could theorize some form of biological, rather than labor, productivity. However, despite the intensification of the productivity of biological resources, it is notable that the biological resources themselves are not necessarily turned into commodities and value is actually derived from the knowledge labor protected by laws that create and enforce intellectual property rights (see Birch, Levidow, and Papaioannou 2010). Thus the idea of biological or natural productivity is problematic since value results from the application of knowledge to nature, and the subjection of that knowledge to intellectual property rights, and not from nature itself or from particular biological material. Hence it makes no sense to add the "bio" prefix to value, capital, or any other concept associated with the LTV. Moreover, there is little evidence of successful efforts at such real subsumption to date.

So what does this all mean for understanding the bioeconomy? In current conceptualizations, there is a strong emphasis on Marxist political–economic terms such as value, capital, and surplus, framed within a sociological or anthropological approach that conflates social *values* with economic value. Although this is an interesting theoretical move, it is not adequate for our understanding. In discussing these political–economic concepts here, we have shown how value, capital, and surplus value are constituted by some form of *labor*—whether this is knowledge, immaterial, cognitive, or what-have-you labor—and not to some characteristic latent within biological matter.

Political Economy of Rentier Regimes

In light of the preceding discussion, we argue that it is important not to focus only on value, capital, or surplus as key concepts, since STS scholars

have failed to adequately adopt the Marxist LTV or systematically work through a rereading of Marxist ideas in light of new economic processes, especially those associated with the expansion of asset-based economies. This latter point is crucial, in that our emphasis on the importance of assets in understanding the bioeconomy means that the concept of "rent" offers a more promising gateway to approach these issues.

It is helpful here to draw on the work of Christian Zeller (2008) and his thorough and extensive analysis of the emergent *rentier* regime in the global bioeconomy. He highlights the need to understand several processes: first, the growing dominance of a financialized accumulation regime; second, the importance of accumulation by dispossession; and third, the extraction of rents from monopolized (because dispossessed) knowledge. We would stress that these monopoly rents exemplified by intellectual property rights (IPRs) involve a variety of different actors from life science firms through pharmaceutical multinationals to universities. All these actors pursue finance-dominated strategies to extract rent from their (and others') assets, imposing a financial logic on the production of value and its realization through market exchange, and thereby problematizing the familiar but misleading distinction of "real" versus "financial" economy. Zeller argues that the global bioeconomy is currently underpinned by this growth in rent yields; consequently, the bioeconomy cannot be seen as primarily dependent upon new sources of surplus value (or profits) derived from either labor productivity or the intensification of biological resources (see above). Instead, the bioeconomy, as it currently exists, is centered on the changing patterns of *appropriation* of value constructed *elsewhere* in the economy (e.g., Chinese factories). This process is asset-based and not commodity-based, involving the twin and interrelated redrawing of intellectual property regimes on a global scale (Orsi and Coriat 2006) and the capacity of finance, especially under conditions of financialization, to redirect flows of value to favored financial investments and assets, of which proprietary biotechnology knowledge and firms have been key examples.

The yield from rents is dependent upon knowledge monopolies created by new IPRs that have to be instituted by national and global state-led strategic action such as the Trade Related Aspects of Intellectual Property Rights (TRIPS) agreement at the World Trade Organization (WTO; see Tyfield 2008). Knowledge could therefore be characterized as yet another *fictitious commodity* to stand alongside land, labor, and money (Polanyi [1944] 2001). However, it is important to consider the financialization of the global economy here as well. These knowledge monopolies do not represent commodities in a political economic sense (i.e., objects produced for

sale), but rather financial assets or asset classes; a *fictitious asset*, if you like. The distinction between commodities and assets is thus crucial here: demand for the latter going *up* as price rises, hence affording the potential for (speculative) bubbles. Regarding patents then, while licenses to the patent enable access to knowledge as a commodity, *the patents themselves are primarily assets*; they are not strictly produced for exchange (i.e., they are fictitious) *and* they are not necessarily exchanged at all (as commodities must be), though they have the potential to be. What they do come to represent is the underlying and intangible value of a firm on which financial investments can be, and are, made (see Pagano and Rossi 2009). As such we can see connections to Rajan and Cooper's discussions of speculative capital, although we would argue that "rent" (revenue yielded from an asset that underlies its present valuation) rather than "capital" or "surplus value" is a better concept to theorize the actually existing bioeconomy because knowledge, on which the bioeconomy is largely based, is made into an asset as opposed to a commodity.

Evidently, the extraction of rent during the accumulation process is dependent upon surplus value (hence profit) from increasing labor productivity. Thus rent-seeking strategies have only assumed predominance because financialization has led to a wholesale transformation of political–economic priorities away from productive capital (i.e., commodity production) toward finance capital (i.e., asset ownership). As such, financialization is deeply implicated in the expansion of the bioeconomy, as Rajan, Cooper, and others rightly point out. However, what this has meant is the opening up or colonizing by capital of the social spaces of knowledge production and, thence, natural or biological productivity, rather than the creation of value *in* speculative and promissory visions. This colonization includes the enactment of a global IPR regime (Orsi and Coriat 2006; Sell 2003); the growing commercialization of academia (Slaughter and Rhoades 2007; Mirowski and Sent 2008); the appropriation of indigenous knowledges (Oldham 2007 ; Shiva 1998); and other things beside. Growing financialization has been led by a search for rentier opportunities, which has engendered the emergence of "specific institutional conditions, namely, property rights" (Zeller 2008, 95). With a new intellectual property (IP) regime, there is no necessary erosion of nature as a source of wealth, unlike with the extraction of surplus value from labor productivity (Moore 2009), since property rights provide the incentive to continue, in the long term, the appropriation of knowledge (e.g., patents), nature (e.g., biomass), and biological matter (e.g., vital fragments). However, knowledge, specifically, has to be made a scarce asset (i.e., a monopoly) in order to capture value (May and Sell 2006), which means that IPRs are central to the extraction of rent

from diverse forms of knowledge labor. Rent is then extracted from knowledge assets created through such labor and profits are maintained through the protection of monopoly conditions created by property rights (Zeller 2008).

Political Economy of Asset-Based Markets

What the above implies is that the realization of value from IPRs (i.e., knowledge assets) through market exchange is really the key issue in the actually existing bioeconomy; it is not value, capital, or surplus value that marks the major transformation in capital relations. It is only through the circulation of capital that rent can be extracted; it is only through the extraction of (potential) rent that scarce (and fictitious) assets produce value; and it is only through the creation of legal or technological monopolies that such assets can be created. At this juncture, we could posit a distinct *bio*-exchange moment in modern capitalism, if we so chose, to contrast with concepts like biovalue, biocapital, or life as surplus. We do not, however, want to make this suggestion since it does nothing to distinguish the bioeconomy from any other form of economic activity (e.g., why not also identify *info*-exchange for the information and communication technology (ICT) revolution?). Instead, we want to focus on "the market" as a particular economic institution in order to consider what might be distinctive about the bioeconomy.

The reason that "the market" is a particularly useful institution to consider is twofold. First, value is only realized through market exchange so there would be no value, surplus value, or capital accumulation without it; this makes markets central for understanding the bioeconomy. Second, the circulation of capital through market exchange enables the extraction of profits and rent from surplus value. The latter point is what motivates our discussion here; it is notable that the extraction of rent is dependent upon the manufacture of scarcity, especially through the replacement of "subsistence" with "choice" as Karl Polanyi (1957) put it. This is evident in IPRs that enclose (bioscientific) knowledge, creating a monopoly and, therefore, scarcity which did not exist beforehand (Birch 2007a). However, the very idea of market exchange needs unpacking because market exchange is not always the same and tends to refer to commodity markets, rather than markets for assets. In this sense, there is a need for greater specificity when we talk about "the market." We would therefore stress the need to understand the diversity in *markets* as a prerequisite for understanding the bioeconomy; for example, differences in social coordination, differences in geographies, and so on (see Birch, forthcoming).

In order to illustrate the specificity of markets, it is useful to draw on the recent work of Patrick Aspers (2007, 2009). He identifies differences in the "social order" and "social structure" of markets, which leads him to outline four different types of commodity market. By social order, Aspers refers to the difference between different commodities. On one hand, the quality (or value) of a commodity might not be separable from the status of the producer or seller; for example, a scientist may be the only person with the necessary knowledge to understand and operate a particular technology platform. On the other hand, a commodity might be standardized (i.e., fungible) so that the status of the producer or seller is no longer relevant; for example, a number of companies may produce and sell the same biogeneric drug.[2] Alongside the social order of markets, we also have to consider the social structure, or the role of market actors. Some actors can have a switch role, in that they act as buyer and seller as the same time; for example, small biotech firms acquire biological material from other small firms and also sell biological material to large pharmaceutical firms. Other actors have a fixed role in that they are either a buyer or a seller, but not both; for example, high street retailers (and consumers) purchase a product from a pharmaceutical manufacturer but do not sell anything back to the manufacturer.

While all such markets can exist in the bioeconomy, it is important to note that Aspers' work refers more specifically to commodity markets as opposed to asset markets. Although an asset can be traded as a commodity with the right financial instrumentalization (e.g., securities), assets also have some distinctive characteristics. For a start, David Harvey (2010) argues that the underlying contradiction of contemporary capitalism under conditions of overaccumulation—namely the need to solve the surplus capital problem (i.e., absorb surplus capital in new investments)—leads to excess liquidity that is then invested in assets (especially property) because assets delay the need to realize value for several years. However, such asset markets have a "Ponzi-like character" according to Harvey (2010, 21), in that the purchase of assets drives up their value leading to further investment creating an asset bubble that eventually bursts, as evident in the recent and ongoing financial crisis. This means that markets for assets such as IPRs are different in kind and form from those for commodities. For example, alongside Aspers's (2007) distinction of social order and social structure, it would also be useful to consider "social expectations" as a particular feature of asset markets, in that the current price is highly sensitive to these expectations of future return on the assets. We can break this down further by distinguishing between *short-term* and *long-term* expectations,

both of which concern expectations of profit (Foley 2006, 192-98). The former reflects more simplistic expectations about supply and demand, whereas the latter is more interesting.

With a longer time-horizon, investment risk motivates demands for greater security through the alleviation of uncertainty; there is also greater scope for self-fulfilling expectations to produce asset bubbles. Security is achieved through property rights, enabling market actors to extract rent from their assets. However, such security is achieved at a significant social cost because it not only entails the enclosure, dispossession, and monopoly of social practices and relations (e.g., knowledge production), but it can also entail self-fulfilling and self-reinforcing inflation of asset values. More specifically for our argument, this longer time-scale necessitates the construction of particular kinds of asset markets in the bioeconomy to enable the extraction of rent from newly enclosed assets (e.g., IPRs) in order to encourage investment and the circulation of capital.[3] However, there is nothing particularly "bio" to these asset markets; rather, it is the institutional conditions of IPR regimes that favor rent-based revenues and monopolistic practices as in the global concentration of the pharmaceutical sector. In this way, the bioeconomy to date is really about looking for and opening up asset markets to facilitate finance-dominated strategies; that is, the attempted construction of new opportunities to appropriate above average rates of profit through rent-seeking contrasting with commodity production and productive capital as captured in STS concepts that focus exclusively on value, capital, and surplus value. It follows that scholars like Rajan and Cooper have, to a significant extent, overlooked precisely what *is* important about the connection between the actually existing bioeconomy and financialization, while scholars like Waldby and Rose have missed this connection altogether. It is, therefore, perhaps more apt to conceptualize the bioeconomy in terms of *bio*-markets rather than as biovalue, biocapital, bioeconomics, or similar. However, considering our critique of the fetishization of such "bio" terminology, we do not want to suggest another "bio-concept" to go with the others.

In this final section, we are not arguing that labor, production, and (surplus) value are irrelevant for our understanding of the life sciences; evidently they are crucial. We maintain that value is produced solely by (knowledge) labor, though the value appropriated in the life sciences may not be produced in that sector of the economy at all. Rather than the major transformation in capital relations that STS scholars conceptualize, however, we argue that the distinctiveness of the bioeconomy lies primarily in market exchange and the realization of value through such exchange; not

in political–economic processes of value, capital, or surplus value. There is an especially unique dependence of the life sciences sector as a whole on financialized knowledge (and other intangible) assets (i.e., IPRs) for viable business models, as the recent collapse of the British life sciences demonstrates (The Guardian 2011).

From this starting point then, we argue that rather than focusing on concepts derived from Marxist theories of commodity production—and inconsistently reworking them to reveal novelty in the "bio"-economy and a transformation in capital accumulation per se—it is important to analyze finance-dominated strategies of commodity and asset production and value realization that we highlight above. Furthermore, the exact form that these finance-dominated strategies take—whether these strategies are "prosumerist" as *autonomist* Marxists might suggest with their breaking down of the distinction between production and consumption (Morini and Fumagalli 2010); economic imaginaries as the CPE agenda would posit (Jessop 2005); and/or "lateral" as the recent work of Birgitte Gorm Hansen (2011) would imply—is an open question necessitating further empirical research. Such work militates against grand theoretical claims about the "bio-" nature of capital accumulation. Finally, we are left with the key empirical question of exploring what sociotechnical and political–economic reconfiguration of the life sciences is needed to *make* it productive of surplus value from commodity production, rather than rent extraction from asset monopolies.

Conclusion

In this article we have, on one hand, provided a critique of existing theories, or bio-concepts, of the bioeconomy and, on the other hand, we have presented a new direction for thinking about the political economy of the life sciences. We started out with the aim of looking at existing conceptualizations of the bioeconomy, especially those that analyze the bioeconomy in political–economic terms. These accounts included concepts such as biovalue (Waldby 2000), bioeconomics (Rose 2001), biocapital (Rajan 2006), and "life as surplus" (Cooper 2008). We highlighted several ambiguities, problematic assumptions, and contradictions in these theoretical discussions of the bioeconomy including the linking of vitality with value; the dual conceptualization of value in ethical and economic terms; the treatment of speculation and surplus value; and, more generally, the appropriation/misappropriation of Marxist and political–economic terminology. In particular, we argued that the last of these (i.e., the adoption of Marxist

terms) actually obscures the arguments these scholars put forward, rather than providing an adequate explanation of the supposed transformative effects of the *sociotechnoeconomic* restructuring represented by the emerging bioeconomy.

Even if we ultimately reject these theories and conceptions of the bioeconomy, we still wanted to engage sympathetically and constructively with them. In order to present our reasons for rejecting these bio-concepts, we outlined three aspects of the political economy of the life sciences that need greater emphasis in future research. First, labor is still central to any political–economic analysis as the work of the *autonomist* Marxists illustrates; labor may now refer to new forms of labor (e.g., immaterial, informatics, relational, etc.) and new labor processes (e.g., in use, in consumption, etc.), but it is still the root of value in political–economic analyses. This is especially so in terms of the knowledge labor that is both turned into an asset through IPRs and is necessary to turn biological matter into commercial and profitable products. Second, the bioeconomy is underpinned by a rentier regime in which financial asset values are more important than revenues from the sale of biotechnological commodities. In this sense, speculation does not relate to biological promises but to more mundane political–economic ones (e.g., rising value of shares), although these two are not entirely separable. Finally, the "actually existing" bioeconomy is not a set of social relations based on production (e.g., value, capital) or speculation (e.g., surplus) in life science–related industries, but is embedded in particular market relations and institutions of asset value realization. That is, the political economy of the life sciences depends on the realization of value from financial and knowledge assets through exchange on markets that are not only characterized by social order and social structures, as Aspers (2007, 2009) argues, but also by *social expectations*.

Although these expectations are performative, self-fulfilling, and self-reinforcing—as with other assets (e.g., housing)—they do not necessarily lead to homogenous or convergent political economies. Rather, markets have particular geographies that help illustrate and explain the particularities and specificities of the bioeconomy and militate against universal theories or concepts (Birch, forthcoming). One example of these geographies is the way that asset values are often aggregated when traded, drawing together a range of assets as securities (Leyshon and Thrift 2007); yet the value of these aggregated assets is realized (i.e., exchanged) in specific places, such as London, New York, and so on. What this means is beyond the scope of this article, but would suggest that thinking about the bioeconomy in this way helps to avoid making general theoretical claims that have

limited empirical or analytical support. Furthermore, and crucially for our claims here, it also enables a rethink of the transformation of modern capitalism by analyzing the transformation of economic processes and not just technoscientific ones.

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Notes

1. One example of a different logic is Maria Fannin's (2010) work on the "hoarding" economy; in her discussion of stem cell science Fannin introduces the Marxist figure of the "miser"—to contrast with the capitalist—as a key conceptual angle on the bioeconomy. The miser "hoards" capital, rather than letting it circulate, just as consumers are being encouraged to "hoard" biological material (e.g., placenta) in cell banks.
2. This distinction could also be compared with that drawn by Callon (2002) for an economics of science between "emergent" and "consolidated" regimes of knowledge production respectively; see Tyfield (2011).
3. The recent work in STS on the performativity of markets (e.g., Callon 1998; MacKenzie, Muniesa, and Siu 2007) may be of assistance in researching these processes of market construction. However, similar problems regarding the neglect in this literature of issues of political economy would need to be tackled (e.g., Tyfield 2011; Jessop 2005).

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Bios

Kean Birch is an Assistant Professor in the Department of Social Science (Business and Society Program) at York University, Toronto. He is also a faculty member of the Graduate Program in Science and Technology Studies at York University. His current research interests range from the emerging bioeconomy to varieties of neoliberal restructuring. He recently co-edited *The Rise and Fall of Neoliberalism* (Zed, 2010) with Vlad Mykhnenko.

David Tyfield is a Lecturer at the Centre for Mobilities Research (CeMoRe), Sociology Department, Lancaster University. His research focuses on the interaction of cultural political economy and developments in science, technology and innovation, with particular interest in low-carbon innovation in China.