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Original Article

Science, Technology, & Human Values
1-29
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DOI: 10.1177/01622439251352167
journals.sagepub.com/home/sth

Do Artifacts Have Political Economy?

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Abstract

Harking back to Langdon Winner's now classic essay "Do artifacts have politics?," my aim in this article is to ask a very similar question—namely, do artifacts have political economy? Following Winner and with the same objective in mind, I analyze artifacts that: (1) have been designed in ways that embed particular political economies; or (2) are compatible with particular political economies. I illustrate the former using Winner's own example of Robert Moses and the design of bridges in New York City. For the latter, I illustrate a *strong* and *weak* version of the compatibility claim, with the strong version characterized by the adoption of both a particular technology and political economy while the weak version is characterized by the adaptation of the social context to a particular technology and political economy. I use the example of advertising technology ("adtech") and generative artificial intelligence respectively to illustrate these two versions. I frame this discussion within an approach I define as *constructivist political economy* sitting at the interface of science and technology studies and political economy, which can provide a useful analytical tool to analyze and address the vagaries of contemporary technoscientific capitalism.

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Keywords
constructivist political economy, assetization, Langdon Winner, Robert Moses, advertising technology, generative artificial intelligence, tech bros

Introduction

> What is happening is not just a battle for market control. A small number of tech titans are busy designing our collective future, presenting their societal vision, and specific beliefs about our humanity, as the only possible path. Hiding behind an illusion of natural market forces, they are harnessing their wealth and influence to shape not just productization and implementation of AI technology, but also the research. (Judy Estrin 2024[1])

Two important issues are worth considering at the point I am writing this. First, there is growing concern about the huge investments being made into digital and artificial intelligence infrastructures—especially cloud computing, cloud storage, and GPU chips—by multinational corporations like Alphabet, Amazon, Microsoft, and Nvidia, amongst others. In a June 2024 report by investment bank Goldman Sachs, Head of Global Equity Research Jim Covello argues that the expected USD1 trillion plus investment spend on these infrastructures in the coming years raises an important question: "What $1tn problem will AI solve?" (Sachs Goldman 2024, 10). Similar concerns emerged within the investor community with many of these multinationals experiencing significant declines in their share price during August 2024.[2] Second, the "tech" founder and investor class flexed its political muscle in the runup to and outcome of the 2024 US presidential election, including endorsing Trump for president, donating to the Trump campaign and then inauguration, and joining its administration. For example, venture capitalists Marc Andreessen and Ben Horowitz outline on their podcast the economic reasons leading them to politically support Republican contender Donald Trump; while the Democratic Party venture capitalist donor Reid Hoffman has stated that he would like Kamala Harris to fire FTC Chair Lina Khan if Kamala is elected. See https://www.youtube.com/watch?v=n_sNclEgQZQ&list=WL&index=26&t=4277s and https://www.cnbc.com/2024/07/26/two-billionaire-harris-donors-hope-she-will-fire-ftc-chair-lina-khan.html

These issues highlight an emerging sociotechnical problem: fewer and fewer people have a say in the political-economic direction of technoscientific innovation and development. Multinationals, billionaires, venture

capitalists, and wealthy "techbros" increasingly dominate decision-making about the future direction of technoscience and, by extension society, through their allocation of societal resources based upon certain political-economic logics, which directly impacts the rest of us. And this is the case even when there are clear grounds to mistrust the motivations, ideas, and very capabilities of those plutocratic social actors to allocate resources equitably and even efficiently. We are facing a future in which a "tech oligarchy," in Cohen's (2025) terms, controls both the agenda for and investment in our technological futures (also Tutton 2021), presaging a world in which a small and socially narrow group of people (mostly wealthy men) get to decide what and how to respond to collectively important issues.

The problematic sociotechnical implications of the narrowing of investment funding, logics, and decision-making are amply illustrated by the recent history of so-called "unicorns" (a private firm valued at over USD1 billion), such as the US company WeWork (Brown and Farrell 2021; Wiedeman 2020). Established in 2008, WeWork eventually filed for bankruptcy in November 2023. WeWork was a much-vaunted unicorn valued at USD47 billion at its peak, before its subsequent fall. Started by Adam Neumann and Miguel McKelvey, WeWork offered short-term coworking space for hire to anyone who needed it. Framed as a technological disruptor of the office space market, WeWork's business model entailed the leasing of office space from real estate firms over the long-term at lower prices than they would re-lease it to shorter-term occupants. Despite its unicorn status, WeWork's finances and business model unraveled quickly as they neared their proposed launch in the public capital markets in 2019.[3]

By the time it declared bankruptcy, an enormous amount of money had been invested in WeWork. WeWork's most famous investor was Masayoshi Son, founder of the Japanese investment management company SoftBank and manager of a USD100 billion Vision Fund established in 2017 (Mallaby 2022). Investing massively in WeWork, Son's plan seemed to be to drive out other startup competitors, relying upon the winner-takes-all logic that increasingly underpins the digital technology sector (Birch 2023a). In total, Reuters reported that SoftBank invested around USD16 billion into WeWork, including paying USD1.7 billion to Adam Neumann as part of a deal for him to "relinquish control."[4] There is little to show for all this wasted investment. Notably, it is important to emphasize that WeWork is not an outlier, or unusual case. Unicorns frequently fail (e.g., Theranos, FTX, Quibi) or lose considerable value (e.g., BYJU), wasting the money invested in them; in fact, the mode of valuation underpinning these highly valued private firms is premised on only a few

investments making huge returns and the rest falling by the wayside (Birch 2023b). Considerable investment, time, and effort are wasted with this prevailing innovation model.

In light of these sociotechnical impacts, it is important for science and technology studies (STSs) scholars to engage with and in political economy in order to be able to analyze and comment on the agendas for, direction of, and problems with technoscientific change at present. By political economy, I mean a focus on and examination of the allocation of societal resources, the ideas that inform that allocation, and the impacts of those ideas and allocations on societies. Contemporary capitalism, for example, is increasingly characterized by the entanglement of technoscience and financial logics, to an extent that some STS scholars use the term technoscientific capitalism (Birch and Muniesa 2020; Sunder Rajan 2006). Public, political, and policy perceptions and understandings of contemporary technoscientific capitalism often fall into the trap of either technological determinism—assuming that economic success depends upon technological usefulness—or political-economic determinism—assuming that technological diffusion depends upon naturalized market success. STS has the analytical tools necessary to avoid these pitfalls and contribute to the still very necessary critique of capitalism; to do so, though, requires a refinement and honing of our analytical tools in order to tread the fine line between both forms of determinism.

My aim in this article is to present one suggestion for how to undertake this continuing critique of capitalism. To do this, I hark back to Winner's (1980) now classic paper, "Do artifacts have politics?" I focus on a very similar question in this article, namely, do artifacts have political economy?

Winner's original contribution was to examine the politics inherent within things, without resorting to simplistic technological determinism (see MacKenzie and Wajcman 1999; Selinger and Durant 2022). He outlined two cases to illustrate his argument: first, artifacts can be designed in ways that advantage some and disadvantage others; and second, artifacts can be "compatible with … particular kinds of political relationships" (Winner 1980, 123). In asking my own question, I outline exemplary cases of where artifacts: (1) have been designed in ways that embed particular political economies; or (2) are compatible with particular political economies. I illustrate the former using Winner's own famous case study; that is, Robert Moses and his bridges in New York City in the early-to-mid twentieth century. In turning to the latter, I seek to illustrate, like Winner, a *strong* and *weak* version of this claim by outlining artifacts that have an inherent political economy (strong version) and artifacts that are compatible with a particular political economy (weak version). I use the example of

online advertising technology (adtech) and generative artificial intelligence respectively to illustrate these two versions, where one reflects the extension and expansion of technologies whose only purpose is to generate data assets (adtech) and the other reflects technologies increasingly reliant upon the concentration of capital in cloud computing infrastructures (generative AI). I frame this discussion within what I call *constructivist political economy*, an analytical approach sitting at the interface between science and technology studies (STS) and critical political economy. Constructivist political economy provides a set of analytical tools needed for STS scholars (and others) to understand and address the problems and vagaries of contemporary technoscientific capitalism.

Constructivist Political Economy

Political economy entails a concern with the allocation of societal resources, the ideas and epistemologies that inform and justify that allocation, and the impacts and implications of both the allocation and the legitimating ideas on our societies. Today, there are quite a range of political economy approaches and perspectives, variously characterized by their analytical focus on geopolitics, national comparisons, feminism, race, and so on. From whichever starting point, political economy is concerned with systems of political and economic organization and coordination that underlie the allocation of societal resources (e.g., public and private funding of science and innovation), representing quite different epistemic legitimations; for example, Elder-Vass (2022) outlines the difference between marginalist notions of value (i.e., utility preferences in supply and demand markers) that underlie contemporary economics and contrasts this with Marxist notions of value which are defined by labor power. Each perspective frames individual and collective decision-making in quite different ways.

Over the last few years, a form of *constructivist* political economy has been emerging at the interface of STS and political economy (see Birch 2013; MacKenzie 2021; Söderberg 2017; Tyfield et al. 2017). It melds quite different theoretical premises, assumptions, and approaches to get at the uniqueness of contemporary technoscientific capitalism: on the one side sits STS with its emphasis on the sociopolitical specificity, contingency, and multiplicity of scientific and technological developments, relations, and materialities; while on the other side sits political economy with its emphasis on the logics of capital accumulation like profit maximization, market competition, and labor exploitation. Inflected by STS sensibilities, a key concern for this constructivist political economy is understanding the relation

between the politics, economics, and production of knowledge, both as an object of study (e.g., science) and as a reflexive concern with the consequences of the social scientific investigation itself (e.g., internal STS debates).

As Tyfield et al. (2017) note, it is possible to identify distinct political economies in the intellectual foundations of early STS-related thinkers like J.D. Bernal and Michael Polanyi, whose theoretical frameworks are clearly shaped by Marxist and Austrian conceptions of political economy respectively. Early STS scholars engaged with a range of issues at the interface of Marxist political economy and technoscience, including the labor process (Levidow and Young 1981), Marxism and technology (MacKenzie 1984), biotechnology (Yoxen 1984), and manufacturing technologies (Noble 1977). Other significant STS contributions to this engagement came from feminists like Wajcman (1991) and Haraway (1991) who analyzed how gender relations have shaped technological change and the materialities of technoscience. Many of these STS scholars were involved in activist movements, publishing radical critiques of science and technology, campaigning on scientific or technological issues, or advocating for public interest science rather than private or military technologies. However, according to Moore (2021), North American STS shifted away from political economy in the 1980s as the strong program, actor-network theory, and laboratory studies rose to intellectual prominence within STS, leading to a growing focus on scientific and technological controversies and their governance (also Mirowski 2011). Similar trends could be seen in other intellectual centers of STS at the time.

STS interest in political economy did not disappear. Instead, there was shift in focus onto how the allocation of public and private funding configures the organization of science, technology, and innovation (Fuller 2002; Sismondo 2004). In the 1990s, it is possible to identify the growing influence of Max Weber on North American sociology presaging this organizational turn in STS and reflecting a side-lining of the earlier influence of Marx. Perhaps best exemplified by the work on "academic capitalism," this shift is evident in Hackett's (1990) argument about the "changing organizational cultures" in science away from public-interest to profit-oriented research. Similar arguments are present in Powell (1990) and collaborators (Powell, Koput, and Smith-Doerr 1996) work on innovation in science sectors (e.g., biotechnology), where they were concerned with the generativity of the interorganizational "nexus" between universities and private enterprises. Centering on understanding the organizational changes happening inside universities and public research general, this STS research agenda

focused on analyzing how commercial logics transformed the public interest mandates of universities and academic research (Slaughter and Rhoades 2004). These concerns are reflected in later work on the new political sociology of science, which is often centered on organizational analyses and a critique of capitalist inequalities (Frickel and Moore 2006).

At the end of the 1990s there was a significant resurgence of interest in political economy within STS, largely started by the work of Callon (1998, 2021; Çalışkan and Callon 2009) and others on the performativity of economics. This literature flipped the analytical lens on its head by deploying STS approaches to study political economy, examining political-economic practices, knowledges, etc., at the microscale. In focusing on the construction of markets, scholars like Callon (2021) sought to understand how markets and market interactions are constituted by and through an assemblage of technoeconomic devices, instruments, practices, and knowledge claims. Others contributed to this intellectual program, especially through a focus on the sociomaterial configuration of finance and financial markets, leading to the establishment of new STS subfields such as social studies of finance (e.g., Beunza and Stark 2004; Callon and Muniesa 2005; Knorr Cetina and Preda 2001; MacKenzie 2001, 2008). The core contribution of this literature is the argument that economic ideas and theories performatively bring an "economy" into being that reflects the claims of these economic theories (i.e., practices shaped by knowledges).

The resurgence of STS interest in political economy was also evident in a growing literature analyzing the implications of the commercialization of science and technology on the forms, practices, and organization of knowledge production, primarily through the study of the macroeconomic relations, structures, and processes of a specifically technoscientific "capitalism." Mirowski (2011) represents a key intellectual stimulus to this research agenda. In his work, he outlined three "regimes" of (US-based) science since the start of the twentieth century: pre-Second World War regime characterized by industrial funding of science; post-Second World War regime characterized by government funding, especially from the military; and a post-1980s regime characterized by neoliberalism and market-focused funding (see also Lave, Mirowski, and Randalls 2010). Each scientific regime entails a particular form of knowledge production (e.g., private commercialization) configured by historically specific capitalist logics, forms, and practices (e.g., neoliberalism) (Mirowski 2011). As subsequent work by others in this intellectual vein highlights (e.g., Tyfield 2012; Tyfield et al. 2017), the changing political economy of research and innovation shapes knowledge as intellectual property, thereby undermining

both the (economistic) notion of science as a public good and public (or open) science itself (Mirowski 2018), while configuring innovation as a legitimating trope for the reproduction of prevailing inequities (Benjamin 2019) or continuing pursuit of capitalist economic growth (Irani 2023).

A constructivist political economy emerges from the fertile ground of concepts, theories, and/or analytical approaches concerned with the vernacular and everyday practices and practicalities of *doing* political economy while being *within* political economy. This can be seen in the growing interest in processes like valuation and assetization, where there is a concern with a dual process of how social actors understand the political-economic object of interest (e.g., value, assets) *and* how that political-economic object came about precisely through its framing as an object of and for governance. Within valuation studies, for example, scholars analyze how value is constituted by an array of technoeconomic subjectivities, relations, materials, and materialities (e.g., Asdal and Huse 2023; Doganova 2018; Muniesa 2014; Muniesa et al. 2017). Similarly, within the literature on assetization (e.g., Birch 2017; Birch & Muniesa 2020), scholars are trying to understand the particularities of the transformation of things into assets and the societal implications of governing them as assets. Both literatures are interested in the interactions between the "how" of political economy, like the creation of new intellectual property rights and technologies (e.g., digital rights management), and the broader political-economic imperatives, like changing macroeconomic rules and structures (e.g., investment law), which constitute new technoeconomic forms, formations, and effects (Dobeson, Brill, and Veit Braun 2025). As Birch (2024) highlights, these forms entail new ways of governing and organizing society, as well as technoscience; for example, Falkenberg and Fochler (2024) argue that "asset thinking" changes what academic researchers do and why, especially when it comes to understandings of epistemic value.

My argument is that these different intellectual strands in STS can be brought together to outline a specifically *constructivist* political-economic approach. On the one hand, the more microscale focus of performativity has opened up conceptual analysis of the technoeconomic knowledges, practices, and relations that constitute and legitimate specific revenue, income, and capital streams (e.g., profit, rent). On the other hand, the more macroscale approach underpinning the interest in changing political economies of research and innovation provides the conceptual room to analyze who is making the technoeconomic decisions and how this configures the allocation of societal resources. Bringing these together means focusing analytically and empirically on both the object of study (e.g.,

economy) *and* the fields (e.g., economics) and social actors (e.g., economists) constituting it. Furthermore, it means unpacking how political economies—of whatever sort—are configured by epistemic and normative knowledge claims that social actors produce reflexively in order to deliberately shape the interacting economy and technoscientific paradigm.

Consequently, a constructivist political economy is not only applicable in an analysis of the technoeconomic relations, practices, and organizing of technoscientific *capitalism*, it is also relevant for understanding the constitutive role of diverse technoeconomic knowledges, practices, etc., of alternative political economies. Hence, a constructivist political economy cuts both ways. We can see an example of this in Medina's (2011) research on attempts by Salvador Allende's government to technologically organize Chile's economy to cement a socialist economy; and also in Parthasarathy's (2022) work on inclusive innovation as an alternative approach in international development. On the other hand, Glabau's (2022) work on food allergy advocacy recounts the longstanding role of health advocates and activists in shaping the design of technologies, but by drawing on Black feminist thought she shows how food allergy science and industry can end up supporting prevailing gender, racial, and class hierarchies in the United States; similarly Phan (2019) argues that problematic gendered and racialized relations are reproduced in the design of digital assistants like Amazon Echo.

This ongoing intellectual debate about how STS can and does contribute to political economy is important for understanding and critiquing the dynamics of a contemporary technoscientific capitalism dominated by a tech elite/oligarchy (Cohen 2025). We need to find ways to integrate STS perspectives on sociotechnical contingency with the assumptions in political economy about what drives economic activities, organization, and practices today—namely capitalism. In thinking through the future of capitalism, a constructivist political economy lens can help to keep both systematic processes and structures *and* contingent knowledges and practices within our analytical purview—all with the hope that we can affect some form of positive social and technoscientific change. Critically, it is vital to think in terms of "technoeconomic" relations, devices, organizations, claims, etc., to understand how technoscientific capitalism is configured in ways that constitute capitalist technoscience. To do this, though, requires, like Winner, an intellectual engagement with the relations between technoscience and political economy that neither falls back on forms of technological determinism nor forms of political-economic determinism. By political-economic determinism, I mean the assumption that political economy follows its own internal and naturalistic logic as opposed to being comprised

of a messy, overlapping, and evolving configuration. To illustrate these analytical points, I return to the question Langdon Winner raised nearly 40 years ago, with a twist.

Do Artifacts Have Political Economy?

So, do artifacts have political economy? By artifacts, I mean technologies, machines, objects, infrastructures, nonhuman actants, and other materialities—or, more simply, the *things* that we, as humans, surround ourselves with. In his original framing of his similar question, Winner (1980) was concerned with identifying the politics inherent to things. Contra technological determinism, Winner's (1980, 123) politics of artifacts claim is a more specific argument that material things matter politically and "can contain political properties." He outlines two ways that this is the case.

First, things can be designed or arranged in particular ways that benefit some and disadvantage others—a common complaint in debates about the social, racial, and gender biases and prejudices built into recent digital and algorithmic technologies (e.g., Benjamin 2019; Eubanks 2017; Phan 2019). Winner illustrated the politics of design with the now-classic example of the low overpasses on Long Island, United States, built by Robert Moses, the "master planner" of New York for much of the twentieth century. Drawing on the massive biography of Moses written by Caro (1975), Winner (1980, 123) highlights that the reason for the design of the low overpasses was "Moses's social-class bias and racial prejudice"; the bridges were designed and built deliberately to be too low for busses to pass under them, thereby limiting access to the beaches on Long Island for those who could not afford to drive a car. Winner (1980, 125) argued that the overpasses on Long Island illustrate how a politics of bias and prejudice is built into an artifact, which "precede the *use* of the things in question." The story of Moses's bridges has morphed over time in STS into a tale of Winner's bridges, told to new students and used to frame debates about the partiality of technology and science (Joerges 1999).[5] Second, Winner (1980, 123) emphasized that certain things are "compatible with, particular kinds of political relationships"; he further differentiated between "strong" and "weak" versions of this claim, noting the strong relationship between authoritarian control afforded by factories, and the weak relationship between forms of energy and forms of politics; for example, nuclear energy is compatible with centralized, hierarchical politics necessary to secure uranium supplies, while renewable energy is compatible with a more decentralized and democratic politics.

In the rest of this section, I use Winner's arguments as a starting point to illustrate how artifacts also have a political economy. First, some technologies have a particular political economy designed into them, which I illustrate by analyzing Robert Moses's other bridges, the ones that funded the rest of his grand ideas. Second, some technologies are compatible with a particular political economy: to illustrate the *strong* version I discuss advertising technology (adtech); and to illustrate the *weak* version I discuss the recent emergence of generative AI technologies.

Robert Moses's Other Bridges

There is another aspect to the story of Robert Moses's bridges that Winner does not delve into, but which provides just as interesting a case for asking, do artifacts have political economy? Here, it is possible to examine Moses's *other* bridges, especially New York's Triborough Bridge, which opened in 1936 and whose existence helps to explain Moses's long-term dominance and control over New York infrastructure planning and development. Moses's other bridges are a good illustration of how artifacts can also have a political economy designed into them.

The Triborough Bridge itself—now known as the Robert F. Kennedy Bridge—connects Manhattan, Queens, and the Bronx in New York City. It actually consists of three main bridges that span the Harlem River via Randalls Island, as well as the road network on the island itself. It was originally financed by the Triborough Bridge Authority (TBA), established in 1933 by the State of New York specifically to finance and run the Triborough Bridge until it paid off its financing costs. The legislation for the Authority was crafted by Moses and he served as its chair. As Caro (1975) points out, as an independent agency the TBA sat outside of government control, whether municipal, state, or federal government. As part of its mandate, the TBA was allowed to "issue its own bonds secured by toll revenues" (Caro 1975, 356), representing a very specific form of public financing akin to contemporary public–private partnerships.

> Since they finance their projects through the sale of revenue bonds to private investors, they therefore build these projects without using any public funds. Projects built by authorities, he [Moses] said, cost the taxpayers nothing. (Caro 1975, 31)

Like all such "authorities" in the United States, the TBA was created with one purpose—to build a bridge—and could not undertake other activities,

at least initially. To generate revenues, it could charge a toll, and Moses controlled the revenues from these tolls (Flint 2009).

> Originally, [Moses] had conceived of his authorities in the traditional mold: the legislation he had drafted establishing the Triborough, Henry Hudson and Marine Parkway bodies, for example, had explicitly authorized each to construct only a single, specific project and to issue bonds only for that project; the bonds were to be paid off as soon as possible, and not only was a time limit (forty years) set on their expiration but that time limit also limited the authority's life—as soon as its bonds were paid off, it was to go out of existence and turn over its bridge to the city government. (Caro 1975, 636)

The TBA had an expected 40-year lifespan, which was meant to enable the toll revenues to pay back the bonds. After which it was meant to revert politically to government control and become toll-free. Much of the success of the TBA, then, rested on the toll revenues it could generate. And the political economy of the bridge was designed and built into its material form:

> The plans called for a two-deck, sixteen-lane affair. Such a bridge would have a capacity of approximately 16,000,000 vehicles per year, but traffic studies Moses had commissioned had convinced him that it would be forty years before that capacity would be needed. (Moses was, in fact, worried about attracting even the 7,500,000 vehicles per year required to meet amortization and interest payments on the Authority bonds purchased by the PWA [Public Works Administration]; he was convinced that only a network of excellent approach roads that would make the trip via Triborough clearly superior to the old, toll-free, routes would persuade that number of drivers to pay twenty-five cents per trip). (Caro 1975, 399)

The physical landscape (e.g., roads) had to be designed to ensure the financial calculations and future revenues underpinning the bridge's construction and operations were met. Moses reinforced this political economy in his arguments over the need to build a series of approach roads to ensure that enough drivers would use the bridge.

> He [Moses] told him [Harold L. Ickes, from the Public Works Administration] that without such roads the number of motorists who would use the new bridge would be too small to enable the Authority to meet the payments on the bonds the PWA had purchased—an argument that weighed heavily with the thrifty Ickes. (Caro 1975, 401)

According to Moses, the monetary revenues needed by the TBA depended upon the material design and restructuring of the road infrastructure to ensure that more drivers would be directed toward the bridge, thereby ensuring suitably high toll revenues. What is most significant here is that Moses worked out that he could capitalize these revenues (see Birch and Muniesa 2020; Muniesa et al. 2017), thereby enabling him to further extend his political control over planning and development in New York City. To do so, he had to turn the bridge into an *asset*.

> Madigan and others close to Robert Moses saw his supple mind coiling around the possibilities. The actuality of the money, he began to realize, was not its most significant aspect. Its potential was what mattered. The total annual income of his authorities was, by 1938, $4,500,000. This amount was not insignificant to him; it was as large as his total annual Park Department budget. But it was not as significant as $81,000,000. And $81,000,000 was the amount of forty-year, 4 percent, revenue bonds that could be floated—"capitalized" was the word in the bankers' vocabulary that Moses was learning—with an income of $4,500,000. If he was able to keep the authorities' revenues and use them to float bonds, he would be able to float $81,000,000, or $35,000,000 more than the total $46,000,000 in bonds that the three New York City bridge authorities currently had outstanding. He would have $81,000,000 to use to create dreams and power. (Caro 1975, 637)

If he could capitalize toll revenues, Moses could keep building new infrastructure and turn that new infrastructure into yet more assets by capitalizing their revenues. For me, this is a good example of assetization (Birch 2017; Birch and Muniesa 2020), in which something (a bridge) is turned into a political-economic object through its construction as an object of investment and an investable object; that is, as something than can be controlled by an entity to which future revenues or asset accrue (Birch 2017). To turn the Triborough Bridge into an asset, Moses had to change the Act that created it, which he did.

> The existence of the Triborough Authority "shall continue only until all its bonds have been paid in full," the act said. But, because of Moses' amendments, the Authority no longer had to pay its bonds in full. Every time it had enough money to pay them in full, it could instead use the money to issue new bonds in their place. The amendments meant that unless it wanted to, the Authority wouldn't ever have to turn its bridges over to the city. It might, if it so desired, be able to keep the bridges—and stay in existence—as long as the city stayed in existence. (Caro 1975, 645)

From this explanation, it appears that Moses continually started new projects by extending the capitalization of infrastructure, creating a series of material assets that provided a stream of future revenues to finance his plans, thereby entrenching his political power. Managing these revenues was not a simple task, since such revenues were not necessarily a steady income stream but could be quite "lumpy" (Leyshon and Thrift 2007). Consequently, financiers played an important role in this process, helping Moses reconceptualize the bridges as revenue streams while creating the financial instruments needed to smooth out the revenue flows. As Caro (1975, 657) notes:

> The change reflected the importance Moses had come to place on bankers' values —a bridge could be built slightly more cheaply than a tunnel, would cost slightly less to operate and could, per dollar spent, carry slightly more traffic.

In this way, we can see how artifacts have a political economy designed into them. Moses designed the Triborough and other bridges as assets by shaping the urban landscape in certain ways, and capitalizing the future revenues from bridge tolls by selling bonds to finance further construction (Birch and Muniesa 2020). And he did so on the basis of ideas derived from financial understandings of the world. He thereby leveraged finance in the political pursuit of a particular sociomaterial transformation designed around privileging private automobiles in urban planning.[6] Financial logics, in turn, came to configure this transformation through the shaping of this sociomaterial landscape to save costs, but primarily to generate traffic which he understood as future revenues that could reinforce his political power. An important point to emphasize, and perhaps something that differentiates my argument from Winner's, is that this political-economic design of artifacts was not static, happening at one point in time. Moses temporally managed the technoeconomic function of the bridges as assets (Birch 2017), reflecting his (changing) objectives and concerns within the wider political-economic context in which he operated.

Compatibility with Political Economy: Advertising Technology and Artificial Intelligence

Strong Compatibility: Advertising Technology

In turning to the compatibility between political economy and artifacts, I start with online advertising technology ("adtech"). Increasingly, digital

technologies are being blamed for a range of social and political ills, from the rise of misinformation and its impacts on elections to the embedding of social biases and prejudices in algorithmic systems (Benjamin 2019; Eubanks 2017). In particular, Zuboff's 2019 book *The Age of Surveillance Capitalism* hit a public and political nerve, becoming an international bestseller as a result. She focused especially on how companies like Google and Facebook collect and exploit our personal data through online advertising, which, she argues, was at least partially catalyzed by the rise of a neoliberal regime in the United States. The regulatory gap this political regime engendered provided the space for increasingly promiscuous and prolific personal and user data collection by a range of emerging digital tech firms (especially Facebook and Google).

Adtech is an outgrowth of earlier online advertising, which began in the mid-1990s when advertisers started putting static banner ads on websites (McGuigan 2023). Adtech represents the intermediaries that sit between advertisers and the publishers who are trying to sell their online ad space, called "ad inventory." Adtech has got increasingly complex over time and now includes a series of entities who sit between advertisers and publishers. Probably the most important shift in adtech came with the expansion of programmatic advertising from the late 2000s, following and enabled by the expansion of personal and user data collection. The rise of programmatic advertising entailed a transformation in how online advertising functioned, as adtech companies sought to target ads to specific individuals on the basis of those individuals' preferences and behaviors, where information about individual preferences and behaviors was derived from the analysis of personal and user data collected about them (Birch 2023b; MacKenzie, Çalışkan, and Rommerskirchen 2023).

Programmatic advertising is now underpinned by real-time bidding (RTB), in which advertisers bid for each individual impression in automated auctions. Below is a simplified illustration of how the auction process operates, with each distinct adtech entity bolded:

- Someone visits a **website**.
- Before the website loads, the visit triggers the website's **ad server (publisher)** to identify the person (using **data management platforms** that contract with **data brokers** and others) and send this information to one or more **ad exchanges** via "**supply-side" platforms**.
- **Ad exchanges** request bids from "**demand-side" platforms** working for **advertisers** looking for people to advertise to.

- **Demand-side platforms** submit bids to this auction on behalf of **ad servers (advertiser)**.
- **Ad exchanges** then pick the winners and return bids to the **ad server (publisher)** to pick.
- The website finishes loading and shows the ad from the **advertiser**. (Gerardin and Katsifis 2019, 2020)

As this simplified example illustrates, the adtech sector comprises an array of entities that all need user data to participate in RTB, both resulting from and leading to a huge growth in the collection of personal and user data from the mid-2010s onward (Birch 2023b; MacKenzie, Çalışkan, and Rommerskirchen 2023). The systemic effects of this huge increase in data collection and its sharing across the adtech sector are myriad, but have specifically included the undermining of privacy and data protection rights (Zuboff 2019).[7]

Adtech is a good example of the strong compatibility between a particular technology and particular political economy; adtech is characterized by a "rentiership" logic in which both business models and technologies aim to generate and monetize personal and user data. Over time, the adtech sector has developed and rolled out technologies to generate personal and user data as its dependence on that data has increased with individual targeting. On the one hand, these data-producing technologies include cookies, application programming interfaces, software development kits, and other digital tools that enable various other companies to connect into the adtech ecosystem (Birch and Bronson 2022); and, on the other hand, they include technologies that encourage user engagement with platforms, ecosystems, and networks, leading to the installation and extension of technologies designed to encourage the use of websites, applications, software, and other digital technologies (Birch, Troy, and Callum 2021; Wu, Taneja, and Webster 2021).

Here, adtech is strongly compatible with a rentiership logic and practices (Birch 2020; Sadowski 2020). By this, I mean that when we adopt adtech, we are also adopting a particular political economy alongside the technology. This is evident on two fronts.

First, over time research on user behaviors and psychologies has been deployed in adtech in a reflexive strategy to understand and enroll an increasing number of users. Certain data came to be seen as valuable, leading adtech and digital tech firms to standardize their metrics as a way to justify an advertising business model. For example, digital tech firms create technologies not only to keep people online but also to keep them using digital products, and thereby generate the valuable user data that adtech needs to support their

advertising business model. Eyal's 2014 book *Hooked* is a guide for businesses on how to configure their websites or applications or services to generate valuable user data by encouraging user engagement. Eyal mentions sociotechnical developments like auto-scrolling, variable rewards, endowed progress effects, social affirmation, and gamification as ways to keep users engaged and generating data. To an extent, it does not even matter whether the user data they collect is even accurate, since *any* "user engagement" metrics can end up reinforcing the adtech system; these metrics represent "attention assets" that underpin the value of the ad inventory which adtech sell and take their cut from (Hwang 2020).

Second, adtech has become increasingly concentrated over time, with Google and Facebook representing 60 percent of market share of global digital advertising (Birch 2023b). This is not accidental, nor the result of internal technological or political-economic efficiency. Rather, companies like Google are constantly and deliberately developing and deploying new technologies to undermine their competitors and increase their market dominance (MacKenzie, Çalışkan, and Rommerskirchen 2023), as well as lobbying governments to protect their market position (Foroohar 2019). Because they are dependent upon advertising for the vast majority of their revenues, Google (circa 80 percent from advertising revenues) and Facebook (circa 97 percent from advertising revenues) install technologies in their adtech ecosystems to attract advertisers to their ecosystems (Birch 2023b). For example, Google introduced technologies, such as "dynamic allocation" in 2009 and "enhanced dynamic allocation" in 2014, which enable advertisers to use real-time performance data in automated auctions but only if those advertisers use Google's adtech platforms. Google also constructed real-time auctions in such a way as to limit advertisers' and publishers' access to data about those auctions, so that those advertisers and publishers had both to trust Google was running them fairly—which is alleged to not have been the case—and to depend upon Google for data analytics about the success of their campaigns or value of their ad inventory (Birch 2023b). These evolving technologies reflect a strong compatibility with rentiership logics in which the business model and strategy is to control both economically and politically the access that other firms have to the key resources underpinning the digital economy (i.e., personal and user data).

Weak Compatibility: Generative Artificial Intelligence

The furor surrounding the firing (and then rehiring) of Sam Altman as CEO of OpenAI by its Board of Directors in November 2023 provides a useful

insight into the political economy of AI, and, for my purposes here, offers an entry point into examining the "weak" version of compatibility between technoscience and political economy. AI technologies are proliferating rapidly according to many commentators, with news stories daily outlining the wonders we are about to experience, or the threats—everyday or existential—we are about to face. As a result, AI has become the focus of considerable financial investment and policymaking around the world; many countries or jurisdictions are discussing or developing new AI regulations.[8] For example, the European Union claims to be leading the way with the world's "first" comprehensive AI law, representing part of a broader suite of digital strategies and policies.[9]

AI is increasingly associated with generative technologies based on neural networks, covering image generation and large language models like OpenAI's DALL-E and ChatGPT. Why are we seeing these generative AI technologies emerge now? This question highlights a fundamental issue of what societal and political conditions lead to the expansion and spread of generative AI technologies. From the perspective of STS thinkers (e.g., Bender et al. 2021; Collins 2018; Whittaker 2021), this is a normal question, but for many people it might seem rather odd. I assume that a majority of publics and policymakers think that generative AI technologies are spreading today because of their (internal) technical benefits and commercial viability. This is evident in the policy framing of generative AI as the fount of productivity growth by the World Economic Forum and Tony Blair Institute for Global Change.[10] Here, generative AI technologies are specifically framed by their political economy, which policymakers, politicians, and publics are expected to adapt to if they want to "change the course of human progress."

From the "weak" position, the answer to the question of why generative AI technologies *now* is that they are compatible with the specific political-economic consequence of Big Tech's market dominance and power (see Birch 2023b; Birch and Troy 2022; Open Markets Institute 2023; Vipra and West 2023).[11] Current generative AI technologies such as large language models (LLMs) are constituted by what Collins (2018) calls "brute strength" computing power; specifically, machine learning depends upon the massive processing of information in order to train models. As Bender et al. (2021) put it, LLMs can be characterized as "stochastic parrots," whose outputs reflect a probabilistic calculation of past trends in the training datasets. These aspects of LLMs can be seen as a function of Big Tech's market dominance, including the supply of semiconductors (e.g., GPUs by Nvidia) and control over key training datasets (Open Markets Institute 2023).

Aside from the now well-documented biases and prejudices this can embed in these technologies (Bender et al. 2021; Drage and Frabetti 2024), this means that generative AI is necessarily reliant upon significant computing capacity and is constitutive of highly generic output. And both these reflect a weak compatibility with a political economy increasingly constituted by market concentration and monopoly. Collins (2018), Whittaker (2021), Open Market Institute (2023), Vipra and West (2023), and others have highlighted the dependence of generative AI technological development on computing capacity, most of which is now controlled by Big Tech and other large multinationals: such dependence is evident in the OpenAI saga in which Sam Altman's reinstatement as CEO can be seen as a consequence of Microsoft's influence on OpenAI, which is dependent upon Microsoft's investment constituted by access to Azure's compute credits. Market concentration and power is also reflected in the accelerating influence of business on AI research and innovation more generally (Ahmed, Wahed, and Thompson 2023). I characterize generative AI as "weak" compatibility because of the economic and political push behind adapting ourselves to generative AI (Widder and Hicks 2024), which distinguishes itself from the strong compatibility; that is, weak compatibility necessitates the adaptation of the sociotechnical context to align artifact and political economy.

Conclusion

So, do artifacts have political economy? My answer is: yes, they do. Starting with Moses's *other* bridges—namely the Triborough Bridge in New York City—I have sought to illustrate exactly how things have political economy to them. Moses's other bridges were designed in a way to ensure that they could be turned into financial assets that underpinned the expansion of his municipal empire; political economy was inserted into an artifact. I also distinguished between strong and weak versions of the political economy of artifacts, focusing specifically on advertising technology (adtech) and generative artificial intelligence: strong compatibility is based on adopting both technology and political economy together, while weak compatibility is based on adapting the social context to a technology and political economy.

The Triborough Bridge represents the design of techno-economic relations into an artifact. The bridge became both a financial and material object, constituting its transformation into a financial asset by Robert Moses, to provide him with the economic and political power to substantially expand and cement his building plans in New York City during his

four-decade career as a (nonelected) public official. Car drivers were reimagined as income generators; bridges as revenue streams; and the bonds underpinning the bridges as capitalizable financial claims. The bridge, in turn, was materially designed to generate greater traffic than a tunnel or public transit, especially when the surrounding landscapes were redesigned to push drivers onto the bridge. At the time, bridges were distinct, easily differentiated artifacts that could be managed through a bond-issuing political authority like the TBA. Converting them into financial assets locked-in infrastructure development in New York City to a particular transit regime privileging automobiles and sidelining other options (e.g., public transit). Without Moses's other bridges, he would not have had such an impact on urban development in the United States.

In turning to strong and weak versions of compatibility between technoscience and political economy, I first sought to illustrate how one set of technologies (adtech) correspond to a particular political-economic logic, namely rentiership (Birch 2020). Strong compatibility entails adopting both the technology and political economy. Adtech has evolved in ways that mean online advertising is now defined by the collection and exploitation of personal and user data, entailing the installation of digital technologies that stimulate user engagement precisely to monetize this engagement through advertising: there is no other reason for these technologies. We can see this on a daily basis with, for example, clickbait websites designed purely to attract viewers in order to sell that engagement to advertisers. Second, I sought to illustrate how another set of technologies—in this case generative artificial intelligence—and their political economy is defined by a political and economic push to adapt the social context to the demands of the sector.

In considering whether artifacts have political economy, I have drawn on a constructivist political economy comprising insights in STS and political economy as an example of the analytical tools we can deploy to critique contemporary technoscientific capitalism. This intellectual project of constructivist political economy can help us to understand the reflexive and performative nature of technopolitical economy as both a set of social practices (e.g., the economy) and knowledge claims about those practices (e.g., economics), which is much needed in light of several critical issues facing us today and in the near future, from the need to address climate change through rising economic inequality to crises in healthcare provision.

First, a constructivist political economy can help analyze the implications of reflexive performativity endemic in contemporary capitalism. Reflexivity is evident in STS studies of the promises, expectations, and so on that social actors deploy to enroll support for their projects (Birch 2023b; Brown and

Michael 2003). We need to extend this work, however. Social actors are not "economy dopes"—to reappropriate Harold Garfinkel's terminology—reflecting a deficit model of social actors needing to learn how the economy works from experts with defined expertise (i.e., economists). Rather, we have to examine how social actors reflexively perform the economy but by going beyond Callon's (1998) original formulation. Building on Callon, we now need to appreciate that social actors themselves know they are performing the economy and know what they are doing when they seek to change economic ideas (e.g., capitalization, see Caro 1975) and the impacts these ideas have on the economy; they seek, in common parlance, to game the economy.

Second, it could help reverse the almost absolute and certainly abject surrender of politicians and policymakers to an imagined—and damaging—notion of "the economy" often evident in regulatory capture (Davis and Abraham 2013). Here, I think a contradiction emerges with the first issue above, in that there are "mythical" economic entities (e.g., the market) that exert enormous influence over social action, especially the pursuit of collective action. Governments continue to play a key role in technoscientific development, but in ways that abandon its political agenda and direction to private industry and, thereby, leave publics with limited influence over the direction of research and innovation agendas and their outcomes. STS can provide tools to rethink the legitimating narratives and ideas underpinning research and innovation, emphasizing a broader array of societal objectives than the monetary or economic rationales that dominate today (e.g., the idea that universities are primarily job training institutions).

Third, a constructivist political economy can help examine the development and deployment of science and technology undertaken within commercially oriented organizations. Although STS scholars argue about the respective role of the private and public sectors in science and innovation policy (e.g., Mirowski 2011; Shapin 2008), it is evident that contemporary technoscientific capitalism is defined by the dominance of private industry in driving technoscientific developments. There are many examples of this: one is the role and importance of ghost management practices in pharmaceutical developments (Sismondo 2018); and another is the "parasitic" nature of digital technologies, such as adtech, developed for no other purpose than to generate revenues by undermining competitors or competition, whether or not they generate social benefits (Birch 2023b). This raises a methodological issue for STS scholars because we face higher barriers to studying private science than public science, yet we need to turn more of our attention to the research and innovation going on in private industry.

Finally, and following on from the last point, it can help dismantle the ascendance of money as the primary (if not sole) arbiter of technoscientific quality and legitimacy. We might return to Lyotard (1984) here, since he defined sociotechnical systems as self-reinforcing in nature, meaning that systemic success ends up resting upon which systems have the most money to reinforce their knowledge claims. Most pertinent today would be the privileged position of certain social actors—especially "tech" CEOs and billionaires—who are lauded as the fount of *collective* technoscientific wisdom and insight, representing important drivers of societal transformation purely on the basis of their financial power—which is used to legitimate their insights (Cohen 2025). Our collective capacity to decide our technoscientific futures is eroded as these wealthy individuals are put on pedestals as technoscientific geniuses to which we should bow. At present, the structure and practices of venture capital investment is centered on generating enormous returns from a handful of (monopolistic) investments rather than supporting an ecosystem of small, competing startups (Birch 2023a). We need to work toward politically undermining an innovation system in which a particular mode of venture capital valuation is privileged—a system premised on creating enormous wealth for a few individuals, rather than spreading out these rewards for innovation more equitably.

Currently, we are facing a future determined by a handful of super-wealthy individuals who have not only lost touch with the everyday struggles of most people around the world, but who can by dint of their economic and political power impose their own visions on our societies. Moreover, they can avoid the consequences of their own power, visions, and hubris by playing political arbitrage, moving to different countries as they lose favor; or economic arbitrage, moving their financial largesse to new areas of research and development as they see fit. This is a deeply problematic political economy that we, as STS scholars, desperately need to engage with *and* change if we want to avoid the continuing fallout from the abject failure of these techno-elites to solve our collective problems. Doing so requires us to be engaged in the minutiae and boring work of not only researching but also contributing to the development of political-economic standards, rules, regulations, and other knowledge claims/practices implicated in the operations of the economy. The increasingly reflexive understanding of and appreciation by political-economic actors—that is, the awareness that economies are performatively constituted—means that our economies are being gamed and are going to be increasingly gamed by those with the resources to do so. A constructivist political economy provides us with some important tools necessary to challenges these actions.

Declaration of Conflicting Interests

The author declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the Social Sciences and Humanities Research Council of Canada (Grant No. 435-2018-1136) and also in part by the Connected Minds Program, supported by Canada First Research Excellence Fund (Grant No. CFREF-2022-00010).

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Notes

1. https://time.com/6302761/ai-risks-autonomy/
2. https://www.youtube.com/watch?v=9DANrNUHzSM&list=WL&index=28
3. WeWork tried to justify its future profitability—having not made a profit up to that point—on the basis of something they called "community-adjusted EBITDA" in its financial reporting (Brown and Farrell 2021). EBITDA stands for "earnings before interest, taxes, depreciation, and amortization" and is a widely used metric by investors to capture earnings before companies have to make a range of accounting adjustments (e.g., depreciation). As a business organization, WeWork sought to redefine accounting practices and knowledge claims with their community-adjusted EBITDA to make themselves look better financially; it was premised on the idea that the costs of their growth model (especially marketing) were temporary, so should not factor into profitability calculations (Wiedeman 2020). In the end, they did not succeed in convincing others of their knowledge claims and their 2019 IPO attempt came apart at the seams.
4. https://finance.yahoo.com/news/timeline-softbanks-bets-wework-totaled-194817277.html
5. I was in New York in April 2024, and being an STS scholar thought it an interesting exercise to visit Jones Beach, the focus of Winner's argument. I tried using Google Maps to work out how to get there via public transit, but Google Maps indicated it was not possible.
6. For discussion of this privileging of particular automobilities, see Brown et al. 2009. See Tyfield (2014) for a discussion of China.

7. https://www.forbes.com/sites/hessiejones/2021/10/18/real-time-bidding-the-ad-industry-has-crossed-a-very-dangerous-line/
8. https://www2.deloitte.com/us/en/insights/industry/public-sector/ai-regulations-around-the-world.html?id=us:2sm:3li:4diUS176826:5awa:6di:MMDDYY:author&pkid=1011893
9. https://www.europarl.europa.eu/news/en/headlines/society/20230601STO93804/eu-ai-act-first-regulation-on-artificial-intelligence
10. https://www.weforum.org/stories/2024/01/ai-productivity-knowledge/ and https://institute.global/insights/politics-and-governance/governing-in-the-age-of-ai-a-new-model-to-transform-the-state
11. I am going to leave aside discussion of the impacts and implications of automation and AI on work and employment as another example of the compatibility of AI with capitalism (Delfanti and Frey 2021).

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