

On Becoming an Exchange: Translating Michel Callon into a Political Economy of Communication

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Abstract: Financial technology and information are more than economic stimuli and commodities, and hence political economists ought to look beyond their discipline to understand the multi-faceted nature of information and technology. Using a case study of trading technologies of Nasdaq stocks prior to the dot-com boom, this paper argues that Michel Callon's writings lend insight to political economists. Three key terms of Callon (Actor-Network Theory; framing: metrology and calculation; and performative economics) are applied to analyse Nasdaq. We suggest how Callon's key terms help understand the dialectics of critical theories. However, Callon's dismissal of capitalism as a macro structure requires political economists' critical appraisal.

Keywords: Michel Callon, Political Economy of Information, Financial Information, Trading Technologies, Nasdaq.

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Despite the financial markets' ubiquitous presence in the mainstream media and their significant role in U.S. and global economies, they have long escaped scrutiny from Communication scholars. The 2008 financial crisis has finally prompted them to look at the intersection between media, culture, and the financial sectors. Five journals ran special issues on the crisis: *The International Journal of Communication* (vol. 4, 2010), *Journal of Communication Inquiry* (vol. 34, no. 4, 2010), *Journalism* (vol. 14, no. 2, 2013), *Popular Communication* (vol. 8, no. 3, 2010), and *Triple C: Communication, Capitalism and Critique* (vol. 8, no. 2, 2010).

Political economists in the Communication discipline are at the forefront in critiquing an historical materialism of the financial markets in relation to media and culture because of their interest in understanding how capital flows and how capitalism evolves. For example, in the leading essay of the *International Journal of Communication*, Chakravartty and Schiller (2010) explained the crisis with the concept "neoliberal digital capitalism", which "denotes a phase change in a 500-year history marked [...] by episodic crises. [...] The specificity of digital capitalism is generated within abiding structural trends and persistent crisis tendencies, rather than in the political economy's putative evolution out of them" (672). They further explained the crisis by an over-investment in the information and communications sectors and a liberalisation of the telecommunications industry.

In the introductory essay in *Triple C*, Fuchs et al. (2010) stated that the 2008 financial crisis signals a crisis of capitalism. In Fuchs (2011), he quoted Marcuse that crisis is a negating moment of economic structure. Critical scholars should challenge capitalism as a social order, particularly the inherent contradictions, "the antagonism between productive forces and relationships of production [that] contains and develops its negativity" (26). A dialectical approach allows for human actions to effect social changes through struggles. Therefore, political economists ought to "systematically classify actual and potential research about capitalist crises, communication, culture, and ICTs" (197) by explicating four roles that the media play in the capitalist economy: (1) the commodity form of the media, (2) the ideological form of the media, (3) media reception, and (4) alternative media. In their model, financialisation takes place when finance capital flows to the industries of media content, technology, and infrastructure, as well as those of advertising, public relations, and marketing. Investment banks

increasingly scrutinise the performance of media companies. Fuchs et al. (2010) suggested that one of the seven analytical aspects of the media economy is “the interaction of the finance economy and the media economy”. Some examples of this topic are “the role of ICTs in the globalization and acceleration of financial markets, the role of ICTs in creating new high-risk financial instrument, the role of finance capital in the media industries, or the connection of the new economy crisis 2000 and the housing and financial crisis 2008” (201).

Prior to the new economy crisis 2000 (dubbed as the dot-com boom), political economists had examined the roles that technology and information play in capitalism. They have pointed out that information and technology are commodities produced by transnational corporations to make money (examples are: Mosco and Wasko 1988; Schiller 1999, 2007). The political economic view contrasts a neo-classical view that information is generated in the markets and that technology is extraneous to them. Later, some other political economists provided an understanding of financial information by pointing out information is reflexive and constitutive (examples are: Davis 2005, 2007, 2011; Thompson 2009, 2010, 2013). Existing political economic studies have yet to offer a complete picture of the complex relationship between information, technology, and the financial markets. There remain the questions if different technologies create different properties of information, and if they constitute specific financial markets and diverse economies (Lee 2014b).

To paint a more complete picture of the relationship between information, technology, and the financial markets, there requires recognition that financial technology and information are not mere commodities, different technologies create specific properties of information, and financial information is qualitatively different from non-financial information. Political economists hence need to look beyond their field and discipline to develop a more complete understanding of financial technology and information. Here I argue that Michel Callon's writings on economies and economics offer insights for political economists because he pointed out that metrology and calculation are integral to economics (Callon 1998) and that economics—as a technology—“performs” an economy (Callon 1999). A direct engagement with economics as a technology recognises that economic activities in the financial markets are real and materially embedded. Therefore, it is not useful to dismiss finance capital as fictitious and to claim that financial activities do not contribute to the “real” economy as some political economists from the monopoly capital school do. For example, Foster and Magdoff (2009) called for a return to a production-based economy for a sustainable future because only production activities create surplus value. This view can be traced to Marx's *Capitalism* Vol. III in which finance capital was seen as a parasite of productive capital because it belongs to the sphere of the circulation of capital, it does not create surplus value. This paper disagrees that finance capital is fictitious because economic activities are technologically embedded in the circulation of capital.

To illustrate how Callon's writings may expand a political economic understanding of financial information, this paper employs a case study of trading technologies for stocks listed in Nasdaq prior to the financial market crash in April 2000.¹ It is argued that there has not been a unified financial market for trading, much less a unified economy. This implies that financial economies are hybrid and diverse, and are much more complicated to trace than existing studies on the dot-com bubble suggested. The word “translating” in the title is used in the spirit of Callon in the sense that transformations occur in the process of assemblage. Translating Callon's ideas requires questioning some political economic assumptions, such as the dialectics between agency and structure of social changes. Nevertheless, political economists also need to critically evaluate Callon's decades-long writings to understand his views on power, social relations, and capitalism.

The school of political economy of communication that is discussed here is what some call radical (Winseck 2010) or critical political economy (Fuchs et al. 2010). Some key areas interrogated by the critical school are capital, capitalism, capitalist crisis, dialectics, surplus

¹ NASDAQ is an acronym for National Association of Securities Dealers Automated Quotations, a technologically enabled communication system. After it became a stock exchange in 1990, the lower case name Nasdaq has been more commonly used. In this paper, Nasdaq is used throughout to emphasise that it is an exchange.

value, accumulation, and class (Fuchs et al. 2010). In comparison to other schools of political economy (neoclassical, Schumpeterian, and cultural industries), the critical school has so far provided the most compelling account of the relations between information, technology, and the economy because it situates the production and consumption of information and technology in the trajectory of capitalism, and it sees capitalism as historical.

The dot-com bust and Nasdaq are chosen as a case study for two reasons. First, there was a proliferation of political economic critiques of the so-called information age and the new economy in the late 1990s and the early 2000s; but few, if any, attend to stock exchanges. Not only is Nasdaq an exchange that lists high-tech companies (such as Microsoft, Cisco, Intel) and start-up firms, but Nasdaq trading technologies and indices also constituted the dot-com bust. The monopoly capital school suggests that financialisation leads to financial crisis because finance capital is only a circulation of capital. But this school has conventionally ignored how financialisation relies on a wide array of technology. The second reason why the dot-com boom was chosen is because since its inception, Nasdaq has been a computerised communication system, which matches buyers with sellers. Without a trading floor like the New York Stock Exchange, the Nasdaq trading model may materialise an economic ideal in which self-interested, anonymous individuals make rational choices based on perfect information. Yet, the dot-com boom may show that either something went very wrong with the ideal economic model or that trading technologies and the trading model did not do what they were intended to do. By choosing a financial crisis, which the digital capitalism school commonly (and conveniently) regarded as a result of bloated investment in the information and communication technologies sectors, it is hoped that this paper can offer an alternative account of how technologically-embedded financial information creates diverse financial markets.

The Nasdaq analysis may connect Callon's ideas to a critical political economy of communication by showing *what* technologies were used to resolve the inherent contradictions in finance capital. Callon does not ask *why* an event took place but *what* event and *how* it took place. The paper structure is as follows: First, gaps in current writings on financial exchanges and the dot-com bubble are discussed. Second, communication literature that applied Callon's writings is reviewed. Third, a brief history of the inception of Nasdaq in the 1970s and its transformations prior to the dot-com boom was laid out. Fourth, Callon's key terms such as a performative economics, Actor-Network Theory (ANT), framing: metrology and calculation are defined and applied to the Nasdaq case study. Fifth, the application of Callon's key terms to the dialectics of critical theories (such as macro-micro, agency-structure, materialist-symbolic) is discussed. Finally, future research directions that address the dialectics between space and time conclude the essay.

1. Gaps in Current Writings on Financial Exchanges and the Dot-com Bubble

Three bodies of literature are discussed here: first, the popular press has provided many accounts of why and how the dot-com bubble occurred, but financial exchanges are seen as neutral and autonomous platforms on which hi-tech stocks are traded. Second, studies on trading technologies tend to focus on how technologies alter trading behaviours and the financial markets, they see technologies as tools that perfect the financial markets; financial crisis is seen as a temporary phenomenon that will be resolved in a self-adjusting market. Third, a political economic critique of the information economy focuses on the financialisation of the economy, the commodification and the reflexivity of information and technology, and their relations to capital accumulation, but existing political economic literature pays little attention to stock exchanges and trading technologies.

The origin of the dot-com bubble is detailed in many journalistic accounts (examples are: Cassidy 2002; Lewis 2009; Lowenstein 2004), first-person narratives (Kuo 2001), and academic studies (Haacke 2004; Hiraoka 2005). The narrative commonly reckons that digital technology is the driving force of the dot-com frenzy. The bubble is believed to commence in 1995 with the Netscape IPO. The narrative begins with ARPANET—the earliest web communication system developed by the US Department of Defense—being released to the Na-

tional Science Foundation and renamed as NSFNET, which then became a private-sector enterprise on which Netscape—the first widely-used commercial browser—was built. Once the Internet became privatised, it was deemed an unfettered force that revolutionised commerce. In these writings, human greed and blind optimism explain the bubble: Silicon Valley enterprises made stock options a norm. Employees started to see their jobs as an investment rather than as employment. They cashed in their stocks once the companies went public, and then invested the new wealth in their own start-up companies. Wall Street bankers' insatiable appetite led them to underwrite dot-com start-ups that had yet to turn a profit. The media's reliance on overly optimistic Wall Street analysts' reports helped fuel the frenzy. Those analysts in turn became media personalities who sold their own analyses online. Day traders exploited the after-hours trading opportunities to make and break the market after the professionals retired for the day. Capitalists foolishly believed that online commerce had created a frictionless capitalism and that digital communication had eliminated the time lag in economic production. The same kind of human greed is used to explain the Tulip Mania and the South Sea Bubble occurred centuries ago. It implies human nature transcends the history of capitalism. These studies have correctly pointed out that the investment frenzy was ignited by the myth of information and communication technologies bringing unprecedented wealth in the information economy, but they have not pointed out Nasdaq is an information technology. In other words, Nasdaq made possible certain kinds of trading and speculation that a floor-based, auction system (such as the NYSE) could not. The irony is that the availability of the almost instant, objective information on Nasdaq has not prevented speculative bubbles from happening. This may mean that, contrary to neoclassical economic belief, perfect information does not lead to a perfect market.

The second body of literature consists of a handful of studies that focus on Nasdaq as an exchange and a technology. Ingebretsen (2002) is the only detailed account of Nasdaq history; Heckman (2001) and Smith et al. (1998) listed some “objective” milestones. Some academic studies (such as Hansda and Ray 2002; Sabourin and Serval 2007) looked at the effects of trading technologies on globalisation and trading systems. These studies complement the first body of literature by seeing Nasdaq as a paramount force behind stock trading and by explicating technologies alter the financial markets. However, they view financial bubbles as occurrences that will be resolved in a self-adjusting market; that market failures as self-corrective. They do not view trading technologies may constitute speculative bubbles.

The above two bodies of literature neglect the roles that the financial markets and technological invention play in capitalism. They deem both financial markets and technological invention are “natural” to capitalism. To them, the financial markets are ahistorical and technological development is inevitable. Political economic work—the third body of literature—reveals the process of capital accumulation through financialisation—as proposed by the monopoly capital school—and commodification—as proposed by the digital capitalism school.

Baran and Sweezy's thesis of monopoly capital (1966) has influenced Marxist political economists (such as Magdoff and Sweezy 1977, Foster and Magdoff 2009, McChesney, Wood, and Foster 1998, Foster and McChesney 2012) who explain the financial crises in mid-1970s, 2000 and 2008 by “stagflation” experienced in the US since the 1970s. As early as 1973, Magdoff and Sweezy (1977) suggested that inflation and stagnation are inherent in monopoly capitalism. Inflation occurs because it is a means to produce and expand surplus value. Stagnation occurs because corporations control prices and wages. The stagflation that US experienced since the 1970s resulted from prolonged periods of accumulation due to new technology as well as wars and reconstruction. To Magdoff and Sweezy, an overaccumulation of capital reflects a mature capitalism. Foster and Magdoff (2009), McChesney, Wood, and Foster (1998) largely follow this argument. They see the over-blown information economy in the late 1990s and the speculative housing market in the late 2000s masked the stagnation in US industrial production. They reasoned that while technology such as the mass production of automobiles had at times stimulated the economy for a prolonged period, new communication and information technologies failed to stimulate the economy for an extended period of time. Speculative finance was seen as an economic stimulus, which even-

tually caused the 2008 financial crisis. Drawing on Magdoff and Sweezy, Foster and Magdoff (2009) suggested that stagflation and financialisation are symbiotic, yet antagonistic. Foster and McChesney (2012) further explain that financialisation exacerbates the paradox of accumulation. At the base, there is the paradox of productive economy (i.e. the barrier to capital over-accumulation is capital over-accumulation itself!) On the top of the base, speculative financial assets contradict the productive economy. Thus they call for a return to investment in production, which is deemed essential to the “real” economy.

Disagreeing with the monopoly capital school, the Digital Capitalism school in the field of Communication highlighted the process of commodification by pointing out that information and technology are key concepts to understand contemporary capitalism, in particular the role that information plays in an increasingly privatised world (Mosco and Wasko, 1988; Schiller, 1999, 2007). Therefore, they attend to the production, distribution, and consumption of commodified information. However, they tend to lump all types of digital information together. Lee (2013) hence argues that financial information is not only a commodity, but is also spatiality and temporality because the exchange value of information depends on spatial differentiation and timely delivery. Financial information companies such as Reuters need to sell financial information to as many subscribers as possible, yet they have to maintain that the tailor-made information gives the subscribers an edge in the financial markets. (This contradiction will be revisited in Section 5 of the paper.) Therefore, they need to employ rhetoric to suggest their in-house communication technologies have annihilated both time and space. Furthermore, Hope (2006, 2009, 2010, 2011) suggested that the concepts of time and temporality can be used to critique the political economy of global capitalism, one of which is financial journalism infusing the “time world” of television by blurring the boundary between news and finance.

More recently, a few political economists draw attention to the reflexive and constitutive nature of financial information and the media (examples are: Davis 2005, 2007, 2011). Thompson (2009, 2010) maintains that economic and symbolic processes constitute each other, which result in three kinds of relationship between financial reality and financial information. First, an implicit, performative relationship of which “the concepts, theories and discourses deployed by market actors to define, calculate, and articulate financial conditions help to constitute and performatively reproduce those conditions” (Thompson 2009, 85); Second, a transactional reflexivity that “crystalises” trading actions and generates price movement; Third, a game reflexivity that involves market participants guessing what others' actions might be and responding to those anticipated actions.

Davis (2007) focuses on the economic consequence of regulated financial information internally produced and consumed in a deregulated exchange. He argues that a competitive market for financial information resulted in economic inefficiency and cost-ineffectiveness because companies that produce and disseminate the information are self-serving. A lack of objective and independent information source resulted in an over-valuation of companies, which leads to crises. He advocates that financial information be public goods because information symmetry is crucial to market efficiency. Davis believes that universal and objective financial information can potentially exist.

On the other hand, Thompson (2013) does not believe that it is possible to validate the independence of financial information because of the symbolic ontology of finance capital. He asserts that the relations between fundamentals and prices is reflexive: “as prices respond to new information in real time, the price changes register on trading screens, feeding back into investor perceptions” (3). He believes that reflexive communicative processes are related to crisis because the intersubjective codes shared by market participants tend to break down in such a time. Even though information symmetry is made possible by communication technologies, there may not be symmetry in meaning or trading response. Lastly, Lee (2014) continues an investigation of the nature of financial information by arguing that the earliest form of Nasdaq—as a communication system—standardised the over-the-counter markets by embedding economic practice in technology and by disembedding prices from social relations. At the same time, it generated a new market by creating a new time pattern in trading and by tabulating large amounts of data.

2. Applying Michel Callon to Communicatio

Although a few scholars have called for an integration of Science and Technology Studies (STS) into the studies of communication and media, little work has taken advantages of Michel Callon's writings. The handful of studies in the communication discipline that applied Callon's work focus more on science and technology than on economics and finance (two examples are Basel 2011 and Eriksson 2005).

Baldwin-Philippi (2011) and Wajcman and Jones (2012) believe that STS allow communication scholars to focus on both the form and the content of technology; to question the process of inventing a technology and creating an artefact; and to see technology not as a static object in a closed state. Couldry (2008) suggested that ANT is useful to media theories because it questions if the media are social. He disagrees that the media are the natural channels of social life and social engagement: instead they are highly specific and institutionally focused. He believes that ANT's emphasis on space fills a void in media theories because it seeks to understand the spatial dimension of power in a stretched-out network. Mosco (2009), who sees political economy as a study of power relations, states that spatialisation sheds light on "the institutional extension of corporate power in the communication industry" (158). He urged political economists to consider STS in order to advance an understanding of "the mutual constitution of knowledge and social practice" (Mosco 2009, 234); of human society; and of popular knowledge and a democracy of actors. Unfortunately, he did not give any specific research directions as to how political economists can apply STS to refine the three vantage points to the study of political economy (commodification, structuration, and spatialisation). Arsenault (2011) and Arsenault and Castells (2008) add to a political economic understanding of media industries by highlighting the power of media corporations being embedded in networks and by emphasising the processes of association. Media corporations may appear to compete with each other, but in fact they strategically collaborate with each other to achieve specific outcomes. The network dissolves once the strategies are changed.

3. Nasdaq: Technology, Exchange, and Market

To reconstruct the events and processes of Nasdaq, three types of documents were used: first, *Wall Street Journal* and *New York Times* archives from 1985 to 2001; second, Nasdaq's own publications such as newsletters and reports; third, secondary documents about the history of Nasdaq (the only two book length volumes are Heckman [2001] and Ingebretsen [2002]). While newspaper articles gave details on the *processes* of new implementations in Nasdaq, Nasdaq's publications and secondary documents gave a coherent story that explains what may have been the *cause* and *effect* of the implementations.

Information technology has been paramount to the development of Nasdaq, which began as a computerised communication system on February 4, 1971 as a result of *Report of Special Study of Securities Markets of the Securities and Exchange Commission* (SEC 1963). Prior to Nasdaq, over-the-counter (OTC) stocks were traded over the telephone between brokers, market dealers (retailers), and market makers (wholesalers). Because there was no centralised location for trading, prices quoted by market makers were deemed unfair because of a lack of transparency. Therefore, the OTC markets were viewed as chaotic and irrational, hence less prestigious than the centralised, floor-based NYSE and the then AMEX (American Stock Exchange).

Nasdaq was invented to organise the dispersed and non-transparent OTC markets by standardising quotes. At the most basic level, all participants were able to see the median bid and ask prices for the 2,500 stocks listed on Nasdaq. The prices were believed to enable stockbrokers to make the best deals by selecting from a wider range of market dealers. Nasdaq was seen to fulfil the neoclassical economic ideal of actors making rational choices based on perfect information.

As Lee (2014) argues, Nasdaq was conceived as a technology that centralises the OTC markets, but interestingly, the computer screen was seen as the site where the centralisation took place because subscribers could access the same information from the monitor. However, soon after its launch, the Nasdaq terminal—in particular the screen that displays the

quotes—was believed to have brought the market into being. The disembodied prices from individual traders made person-to-person economic activities something “outside” the markets. Person-to-person interactions still constituted the markets, but because they did not involve all subscribers; and because human interactions could not be “crystallised” and calculated into prices, they were not deemed objective information. Further, the Congress believed that an expansion of Nasdaq technology to other stock exchanges would achieve an easier surveillance, thus a more ideal financial market (Forbes 1971).

From the time when Nasdaq was launched in 1971 to the time when Netscape was listed on Nasdaq in 1995, the computerised communication system has undergone several major changes. During the same period, SEC regulations were also revised to respond to financial crises. Two changes that may relate to the dot-com bubble are: (1) the mandatory participation for market makers in the Screen-based Order Routing and Execution System (SOES) after the 1987 market crash and; (2) the competition with Electronic Communication Networks (ECNs) after the passing of SEC Order Handling Rules (OHR) in 1997. Both measures were to ensure a competitive and efficient market where non-institutional investors with limited assets could participate in the trading.

The first change that may explain the dot-com bubble is an automatic system that led to unanticipated short-selling. Prior to 1987, stockbrokers could place orders in two ways through market makers: via the telephone or, if the orders were less than 500 shares, via the SOES. SOES automatically reported and forwarded to clearing as “locked in” (Smith et al. 1998). Although SOES started in 1982, market makers were not mandated to use it. However, during the 1987 market crash, market makers refused to pick up the phone to execute sell orders from panicky brokers. Consequently, no one knew what the “true” market was because of market makers' unresponsiveness (Lohse 1997). The mandatory participation in SOES gave rise to a new group of investors known as the SOES bandits who took advantages of automatic execution by rallying the prices of certain stocks before the institutional investors placed their orders through market makers (Smith et al. 1998). The bandits' short-selling led to volatile stock trading in which five to ten million US dollars could move in minutes (Lucchetti 1999).

The second change that may explain the dot-com bubble is the rise of Electronic Communication Networks (ECNs), which also led to short-selling, this time by institutional investors. There were nine operating ECNs during the bubble. The first one, Institutional Networks Corporation (later renamed as Instinet), was launched in 1967 to directly link buyers to sellers on an anonymous and confidential basis. On the one hand, Nasdaq operates as a dealer-market, which means that market makers are the only suppliers of liquidity, and they make profits by the spread between the bidding and asking prices. Market makers used their own money to buy bulks of stocks; hence they were seen as guardians of the Nasdaq market by overseeing trading activities being “normal”. On the other hand, ECNs operate as agent networks—that is, there is no intermediary between buyers and sellers; they make profits by charging a commission fee (Sabourin and Serval 2007). Participants entered a price at which they wished to trade on an ECN and waited for offers. The absence of wholesalers like market makers means activities could be “abnormal” where extraordinarily high prices are bid and low prices are sold. Instinet became more prominent when Reuters acquired it in 1986. By acquiring Instinet after the deregulation of the London Stock Exchange, Reuters hoped to sell more information to the U.S. and to move deeper into financial services (Putka 1985). ECNs also rose to prominence when SEC ruled in 1997 that ECNs could directly compete with Nasdaq dealers. Under the OHR ruling, non-Nasdaq members could buy shares at quotes posted by Nasdaq market makers, who then had to honour the orders. Prior to OHR, market makers could ignore the orders placed by the public. Because trading on Instinet is anonymous and confidential, firms did not have to identify themselves when they engaged in short-selling. Towards the height of the dot-com bubble, twenty-seven percent of trading on Nasdaq was done on ECNs and Instinet accounted for 40% of the trading volume in Nasdaq's ten largest stocks (Ip 1999). In July 1999, Instinet wanted to become a fully-fledged exchange by expanding into brokerage service (*Wall Street Journal* 2000). The burst of the dot-com bubble however halted the plan; few investors were interested in taking yet another

dot-com company public (Edmonston 2001).

3.1. Applying Callon's Key Concepts to Nasdaq: How to Become an Exchanges

Three key ideas of Michel Callon are introduced in this section, they are (1) Actor-Network Theory (ANT); (2) a performative economics; and (3) framing: metrology and calculation. Callon's writings are informed by, and in turn inform, those of Bruno Latour, John Law, Andrew Barry, Don Slater, Yuval Millo, Fabian Muniesa, and Donald MacKenzie; therefore, the key concepts here do not come from Callon alone. In addition, his earlier writings focused more on the studies of science; therefore, his later work on economics is more prominently highlighted in what follows.

3.2. Actor-Network Theory (ANT)

In Actor-Network Theory's (ANT) view of society, "social" is not a description of a phenomenon, like economic and geographic are. ANT scholars reject the use of "social" as an adjective because this implies a social context of non-social activities, such as the socialisation of stockbrokers whose predominant identity is economic. Latour (2005) does not believe the "social" can explain the economic, the scientific, and so on. Instead the "social" needs to be explained. "Social" is the glue to connect the actors; it trails actors' associations. An actor is "whatever unit of discourse [that] is invested of a role"; "its shifting network of connections with, and different from, other entities" constitutes it (Barry and Slater 2002a, 177). Actors are not limited to human beings; indeed ANT examines the process of an assemblage of human and non-human, natural and human-made actors. To Callon and Law (1995), there is nothing special or particular about humans; they are not a different class from non-humans. Further, non-human actors are more than resources or constraints; they act on human actors and on each other as well (Callon and Law 1997). With this definition, Nasdaq is an assemblage of market participants, machines, and regulations.

With the rising popularity of various "network" theories since the 1990s, ANT is often misunderstood as a theory of a web of actors or as that of an instantaneous, unmediated access to information (Latour 1999). Applying ANT to analyse Nasdaq does not mean that Nasdaq is a mediated network that connects different actors on the cyberspace, but an examination of how diverse networks such as institution, society, and nation-state formed during the assembly.

3.2.1. How Does a Technology Become a Market?

Nasdaq was conceived as a technology, but once the over-the-counter (OTC) market participants adopted it in 1971, it not only represented, but also became the OTC markets. The markets were seen to have become an external force outside participants because the technology enabled the disembedding of social relations from prices, which became something external to the market participants when information was input into and tabulated by the machine. The Nasdaq monitor did not represent a market "out there", but acted as a projection plane, which conflates different kinds of information into layers of contexts (Knorr Cetina 2005).

3.2.1.1. The Telephone

The screen became the site where the OTC markets took place. The markets were represented on screen with a constant update of explicit, transactional information (Thompson 2009) such as the volume and the price of shares bought and sold. Non-screen-based technologies that were also essential to trading became taken for granted. They were still part of the network but were seen as outside the market. For example, brokers still called market dealers to place orders, yet the telephone and the speech act of placing an order ("I will buy...")—though constituted market activities—were deemed outside the markets because they were not screen-based technology, and hence were not devices that "make" the markets. Reflectively, Nasdaq's self-study stated that, "the growth of the Nasdaq marketplace is

largely displacing the phone as a trading tool” (Smith et al. 1998, 32).

At times of “market failure”, the telephone was seen as part of the network. The telephone as a technological device was brought into the foreground during the 1997 market crash when market makers refused to pick up the telephone. It had been assumed that the markets were at work as long as the prices of Nasdaq stocks were shown on the screen. Nevertheless, because market makers input the prices, once they abandoned the phone, market activities stopped. The prices on the screen, albeit unchanging, were no longer reflective of what the *Wall Street Journal* called the “true” market (Lohse 1997). This implies two things: first, the existence of a market relies on a range of screen-based and non-screen-based technologies, from the telephone to the computer screen; second, each technology implies a different epistemology and ontology of the market. During the 1997 market crash, both market makers and brokers had a sense of what the markets were, though these markets were not quantitatively measured, but qualitatively perceived. In other words, when technology disables transactional reflexivity (Thompson 2009) by not generating market prices, game reflexivity takes a more prominent role in participants' actions. Different types of information reflexivity perform different markets. If market makers had not known what the markets were, they would have picked up the phone.

3.2.1.2. Screen-based Order Routing and Execution System (SOES)

The SOES technology illustrates that human actors act on non-human actors and both take up network attributes. After the 1997 market crash, the automated SOES was mandated for all market makers to facilitate a continual Nasdaq market and exchange. In SOES, small orders were placed and cleared automatically through an electronic system. The rule was implemented to avoid “stalling” the markets at the time of crisis. Automated trading further disembedded economic activities from social relations because human actors were faulted for interfering with the markets. Technology, on the other hand, was seen as a facilitator of a rational market in which information is unfettered.

The mandatory participation in SOES however created another unanticipated problem for the markets, which was volatile price changes resulted from day-traders short-selling hi-tech stocks in small orders. Day-traders were blamed by market makers for disrupting the markets because their activities could not be monitored by the wholesalers. Of course what day traders—as new actors in the network—did was to simply take up the network attribute enabled by technology by trading in small orders electronically! Rather than suggesting that amateurs created chaos in the market, it is better to suggest that technology and regulations enabled human actors to perform a new kind of economic activity and to create a new reality of an economy. In other words, technologies defined channels and modalities of financial actions.

3.3. A Performative Economics

To suggest that economics is performative is to suggest that an economic discourse is not outside the economic reality that it describes. The discourse constructs reality as an object whilst acting on it at the same time (Callon 2007; see also McCloskey 1985). Nevertheless, the discursive has to be manifested through the material: the materiality of a computer screen matters to a discourse as much as a legal document.

Callon (1998) believes that economics does not explain the economy, but constitutes it. Economics consists of theories, formulae, technologies, practices, and artefacts. Because economics constitutes the economy, sociologists should spend less time on denouncing economics as ideological and on embedding the social to the economic (Barry and Slater 2002a). Applying the concept of performativity, MacKenzie (2006) argues that modern finance theories—Black-Scholes Model for options pricing in particular—affect the financial markets because the application of theories alters market processes towards a greater conformity to the theories. As a result, financial models make theories “more true”. Finance theories are incorporated into the financial markets' infrastructure technically, linguistically, and legitimately. However, if finance theories undermine the market conditions, then “reality” is conceived independently of its theoretical underpinning.

Conceiving economics as performative is emancipatory because performativity implies “a plurality of possible organisations of economic activity and several programs that can be conceived of and tested, that is, (co)performed” (Callon 2007, 350).

3.3.1. Declaring a bubble

A good example to illustrate that an economic discourse is integral to an economic reality is the declaration of financial bubbles. In the popular press, a bubble is declared when there is a quicker and higher than usual increase in an index. It is usual to find news headlines announcing the ups and downs of indices rather than the over-valuation of companies. For example, the Nasdaq Composite Index was five-times higher at the dot-com peak in March 2000 than in 1994 before the boom began. The *Wall Street Journal* used headlines such as “Nasdaq raises the bar again, to 4787.08, as techs push index toward milestone” (March 2, 2000, C1) and “Nasdaq Index touches 5000, then posts drop” (March 8, 2000, C9). Similarly, the bust was declared when the index dropped to 4,300 in April from 5,000 in March 2000. Headlines such as “Tech issues fall, as Nasdaq drops 161.40 points” (April 25, 2000, C1) confirmed the doom. The media reinforce the objectivity of indices in reflecting the economy rather than seeing indices as a discourse that constitutes an economy. Because the fundamental value of assets cannot be merely calculated from stock prices, over-valuation is only calculated after the bubble is declared. Resultantly, the index explains the over-valuation, not the other way round.

3.3.2. Diverse Markets

A centralised market is an impossible ideal because different technologies constitute different markets. In a centralised market, every participant has the same information at the same time. From the time when Nasdaq was conceived to unify the dispersed OTC markets to the time when Nasdaq became an exchange for hi-tech stocks, there was no centralised market. Diverse markets were results of different trading devices, different levels of price disclosure, and different ways to calculate prices. As Callon asserts, actors take up network attributes manifested by different technologies, tools, artefacts, formulae, and so on.

The early Nasdaq illustrates that there were two co-existing and co-dependent markets. At the beginning, there were two kinds of quotes: the median ask and sell prices of stocks for brokers and all the bid and ask prices for market dealers and market makers. Because brokers still had to place their orders through market dealers, the quotes on the screen were for reference only. Market dealers could give a less favourable price because brokers did not know the lowest and highest bids. Technology has not altered the unbalanced power relations between market makers, market dealers, and brokers. Therefore, the earliest Nasdaq did not unify the markets; it instead created two co-existing, co-dependent market realities—one belonged to the brokers, the other belonged to the dealers and makers (Lee 2014). Different levels of price disclosure were sometimes conscious decisions made by market participants, sometimes with unintentional results. In this instance, it was the participants' decisions to determine the levels of price disclosure, even though technology allowed for a full disclosure. Information asymmetry ensured a trading edge for market makers and dealers. This situation was deemed not ideal for a centralised market because of the absence of perfect information. Later in 1980, the highest and the lowest bids were disclosed to brokers.

Different levels of price disclosure also lead to unintentional results, one of which resulted from price information only reflected quotes, but not transactions in the earliest Nasdaq system. The trade volume of each stock was only tabulated at the end of the trading day. The performance of the markets was unknown until at closing after numerous actions took place in response to information about what the prices *might* be like. Real-time updates of volume trading did not become available until 1987.

Another example of diverse markets is the introduction of ECNs to trade Nasdaq stocks. To re-cap, ECNs are electronic systems that bypass intermediaries (such as market dealers and makers) so that buyers and sellers could make deals directly. Because trading through the Nasdaq system required NASD membership, the public (i.e. amateur investors) could

only trade through ECNs. As a result, Nasdaq stocks were traded in two markets: one for institutions and dealers, and the other for everyone else (Ip 1999). An unintentional thing occurred: ECNs also attracted institutional investors and Nasdaq members because they could buy and sell in large volumes anonymously. Because ECN participants were unidentified, they were said to “spoofer” the markets in a more volatile manner within a shorter period of time (Morgenson 1999b; Power and Taylor 1995). The short-sellers manipulated the market by placing a sizeable order only to withdraw minutes later to create a buying wave. It was assumed that amateur investors do not have any legitimacy to move the markets because they create chaos. Once again, actors take up the network attributes; the market is constituted by technology, not merely by the actors' intention.

Given the competition from ECNs to trade Nasdaq stocks prior to the dot-com bust, the different technologies to trade, and after-hours trading, it is no wonder why the SEC Chairman Arther Levitt called for an electronic and centralised market for stock trading in order to eliminate fragmentation in Nasdaq markets (Morgenson 1999a). The irony is that this is precisely why Nasdaq was created in the first place two decades ago. This shows that technology is not a tool that perfects the markets partly because powerful actors wanted to maintain information asymmetry for their advantages. Even when new trading technologies and platforms were introduced to bypass the control of dominant players, specific technologies performed specific markets.

3.4. Framing: Metrology and Calculation

Political economists from the monopoly capital school suggested that the information economy in the late 1990s only accounted for a small fraction of the U.S. economy (McChesney et al. 1998) whilst those from the digital capitalism school asserted that information is economically significant in a capitalist economy (Schiller 2007). Callon would respond to both schools by asking what instruments are used to measure the economy.

The role of economics is to establish framing (Slater 2011)—the process of the relevant being singled out from the irrelevant, thus allowing for calculation and co-ordination (Law 1999). Framing also separates and individualises objects into discrete transactable entities (Barry and Slater 2002a). Individualisation and singularisation in turn establish the properties of the products (Callon and Muniesa 2005). For example, in the trading of commodity futures, one unit of lean hog is (arbitrarily) set at 40,000 pounds. The frame for futures is not about the actual animals as in livestock trade, but them as an aggregate.

Economic markets rely on metrology and calculation, which do not quantify a reality, but create one (Barry and Slater 2002a). Calculation is both qualitative and quantitative, it “expose[s] the elements allowing markets to behave as calculative collective devices” (Callon and Muniesa 2005). Specifically, the financial markets, tools, equipment, metrological systems, and procedures make a financial formula or an auction system work (Callon 2007). Because all actions are calculative, economics creates calculated actors (Callon 1998). Therefore, the economic man is not a myth, he is “formative, framed and equipped with prostheses which help how in his calculations” (Callon 1998, 51). Taking into account materiality means that the markets are multi-faceted, diverse, reflexive, hybrid, and evolving (Callon et al. 2002).

3.4.1. The Nasdaq Composite Index

A financial index creates a specific market reality. The Nasdaq Composite Index was conceived as a reflection of a centralised market system that measured the performance of the OTC securities market (NASD Newsletter 1976), but it calculates a very specific economy. Although it includes all domestic and international based common type stocks listed on the Nasdaq Stock Market, it usually rose when the industrial index fell (Browning 1999b). Therefore, Nasdaq only reflects one economy, not *the* economy. It reflects an earlier assertion that there are diverse markets. In addition, during the dot-com bubble, sixty-five stocks out of 3,000 dominated the entire growth of the index; also, as long as the stocks of Microsoft, Cisco, Intel, MCI World Communication, and Sun rose, the Index would rise (Browning 1999a).

The high stock prices of these five listings moved the market in a more pronounced ways than other listings. Yet the Nasdaq Composite Index is seen as an objective measurement of the performance of hi-tech stocks, if not the economy. Because calculation is essential to the composition of a stock index, it establishes a frame to single out the relevant (such as the price of each share of stocks) from the irrelevant (such as the price of each company stock) (Browning 1999a). How the Nasdaq Composite Index is calculated hence quantify a reality in which the performance of a small number of hi-tech companies became the barometre of an economy. The hi-tech bubble depended on the performance of a handful of companies, but investors poured money into any hi-tech stock to further confirm the “realness” of the rallying market.

4. Implications of Studying Nasdaq on a Political Economy of Communication

A political economic analysis effects a dialectical critique of the finance capital. Dialectical thinking is critical to understand capitalism because it demystifies capitalism being an ahistorical and natural economic system. Dialectical thinking reveals reality is a complex *process*, which is full of contradictions and potentials for change at the same time (Fuchs 2011). Financial information in a capitalistic system illustrates this contradiction: on one hand, private firms have to attract as many subscribers to pay for the commodity (i.e. financial information) as possible. On the other hand, private firms need to ensure that not every subscriber has the same quantity and quality of information or else no one has an advantage in the markets.

Privatised information is contradictory to information being open and public. Private firms ensure that the provision of financial information adheres to a neoclassical ideal of an efficient market. In this thought, technology is neutral and autonomous and is designed to maximise market efficiency. In neoclassical economic thought, perfect information leads to a perfect market in which rational actors rely on a full disclosure of information to make decisions. Therefore, information symmetry is essential to an efficient market. In addition, information is generated in markets as price. Market information is seen as independent of the technology that generates it. In other words, information is seen to be disembedded from technology. In this view, all financial information is quantitatively and qualitatively identical.

Political economists have responded to neoclassical economists by arguing that information is a privatised commodity and that information is reflexive and constitutive of the market. Because financial information is a commodity, only those who could afford to pay for privatised information have access to timely and specialised information. This leads to an asymmetry of information. For instance Reuters highlighted that it has a private cable line that relays speedy information to subscribers. Davis (2005, 2007) has shown that financial professionals do not rely on information from the press, but on analysts' reports. Information asymmetry is vital to the trading edge of market participants. Therefore, there is a strong desire to control both the channel and the disclosure level of financial information.

Although political economists are successful at pointing out the false reality that capitalism paints, STS scholars are more successful at *tracing* the brush strokes on the painting. For example, capitalism paints a society that privileges exchange value over use value, but how exactly do capitalists accomplish it? STS scholars are not interested in *what* the painting is like (i.e. the subjects, the composition) and *what* message it tries to convey, but *what kinds of materials, technologies, and techniques* are used in the painting. Therefore in the following, five dialectics (whole-part; macro-micro; structure-agency; material-symbol; use value-exchange value) are examined based on the case study of Nasdaq. It will be shown *what materials, technologies, and techniques* create the contradictions and how resolutions are sought through a *re-assembling* of different materials, technologies, and techniques.

4.1. Whole-part

Capitalism paints itself as a system, not a process. The Nasdaq market is seen as a rule-based system, not a fluid and temporary network. The objective of Actor-Network Theory (ANT) is to open the “black box” that is constructed when a situation is stabilised, when a

mechanism is closed, and when positions are allocated (Callon 1980). A black box contains modes of thoughts, habits, forces, and objects (Callon and Latour 1981). Opening a black box therefore traces what is analysed and what is not; what is considered relevant and what is suppressed; what is intangible and taken for granted; and what is problematised and unknown (Callon 1980). Once the box is closed, interactions become stabilised and are reproduced (Law 1992). A stabilised situation becomes an entity in which the black box translates its various constituent materials (Callon and Law 1997).

To resolve the tension between a neoclassical ideal of perfect information and a market necessity of asymmetrical information, Nasdaq did not present itself as an assemblage of technology, rules, and social actors. Instead, Nasdaq presented itself as a market, a system of exchange. In other words, what participants pay for is not an access to information embedded in technological devices, but an access to a market. To re-cap, a network consists of both human and non-human agents. The earliest Nasdaq was not only a technological device that connects dispersed buyers and sellers, but it was also a specific way of how the markets could be abstracted into prices through specific calculation. Because prices were disembedded from social relations, the markets were then perceived to be an autonomous being that processes information with no human intervention. The false reality painted is that the market is a whole and is a stable, self-regulated system. Nasdaq—as visualised through a computer screen—did not represent a market “out there”, but it became a market of exchange. The Nasdaq Composite Index further reinforced the myth that the market can be quantitatively measured with little human intervention. In pre-Nasdaq days, the performance of the OTC markets could only be qualitatively known through participants' trading activities. With Nasdaq, market performance became something external to participants.

4.2. Macro-micro

Political economists' macro view of the economy has been critiqued to neglect the resistance and creativity exercised by the less powerful at the micro level. Callon does not believe there are a macro and micro levels of society, but only macro and micro actors. Power relations govern macro actors and micro actors. Macro actors are able to sit on a black box and temporarily close it better than micro actors. Macro actors are able to speak of and for “us” by translating other actors into a single will (Callon and Latour 1981). Because macro actors appear to be bigger and more complex than micro actors, they elude analysis. In a stabilised situation (i.e. when the black box is closed and sat on by the macro actor), a network appears like a single point actor (such as an institution or a nation-state) (Law 1991) and is masked by an apparent unity (Law 1992).

A market is a macro actor that sits on a temporarily closed black box. At a non-crisis time, the situation is seen to be stabilised, and there is rarely any question about what the market mechanism is. The case of Nasdaq shows that after a market crash, the black box was opened so that the contents could be reviewed. New actors such as devices and regulations were added to the black box, which was then closed until the next market crash.

4.3. Structure-agency

Giddens' concept of structuration has influenced how political economists view the dialectics between structure and agency. He asserts that human agency constitutes social structure, which in turn provides a context for individual action. Mosco (2009) believes that by situating power at the centre of a political economic analysis, social relations are revealed in the study of structuration. Fuchs (2011) believes that the dialectics between structure and agency allows for the possibility of social change through human struggles.

Because there is no macro and micro levels of society in ANT, there is no separation between agency and structure as well. Actor and network are only two sides of a coin (Callon 1998). Actors are network effects; they take up the network's attributes (Law 1999). ANT is more interested in summing up the “interactions through various kinds of devices, inscriptions, forms and formulae, into a very local, very practical, and tiny locus” (Latour 1999, 17). With this definition of “social”, society is a connecting element inside tiny conduits, not a sta-

bilised object. Because context flows through networks, agency is not separated from structure. ANT's insistence on the inseparable agency from structure may go against a common sociological view. However, as shown in the Nasdaq case study, because ANT is interested in understanding how a situation becomes stabilised, not in how capitalism is constituted by social relations, it may help to describe how the market is falsely seen as a force of freedom. Market technologies are seen as an emancipating force to level the playing field: for example, the earliest Nasdaq is said to give over-the-counter trading a unified market by providing and disseminating objective median buy and sell price; ECNs is said to give non-Nasdaq members a chance to strike gold in the dot-com market. However, technology is not seen as a tool of opportunity (or oppression) in ANT; it, along with the market participants, is part of a network that neither supports nor opposes to the market.

4.4. Materialist-symbolic

Only humans use technologies to exercise power during their physical absence. In this sense, Callon's idea of power is similar to Foucault's assertion that power is exercised through discourse and apparatus, and to fetish of which an object becomes a power. Law (1999) thinks power is not only embedded in "social" relations, but also in technical, architectural, textual, and natural relations. Therefore, power is strategised through all these relations and materials. Actors only have the power if they are elements of a network (Barry and Slater 2002a). Couldry (2008) finds ANT to be useful at making visible how institutions benefit from power asymmetries in the distribution of symbolic resources. The media are the material "obligatory passing points" and "circuits of communication" (8) through which they reach the audience. To apply Callon's ideas, market makers can assume more power in Nasdaq stock trading not only because of their possession of liquidity, but also because of their possessions of the *meanings* of instruments and passing points of liquidity.

At the time of crisis, the meanings of the instruments and passing points were questioned. For example, the telephone was taken for granted as an instrument where brokers could place bids with market dealers. However when market dealers abandoned the phone, the instrument was highlighted as the source of why the markets stalled. During the time of crisis, the black box of Nasdaq was pried open and its contents were examined. New technological devices were introduced to the black box because they enabled (or disabled) new market activities. For example, by mandating the automatic execution of small orders through the Screen-based Order Routing and Execution System, market dealers could not ignore buying and selling from brokers.

4.5. Use Value-Exchange Value

The Nasdaq analysis confirms a Marxist observation that the transformation of use value into exchange value requires a transformation from the concrete to the abstract. Abstracting the concrete requires quantification as well as "purification" where the relevant is separated from the irrelevant. In pre-Nasdaq time, over-the-counter brokers learned about stock prices through market makers. Financial information—which consists of prices as well as opinions, hearsay, and gossips—did not have an exchange value. Wholesalers made money through "spreads" by controlling information rather than selling information. Once Nasdaq standardised and tabulated price information, stock price was the only relevant information, thus it became a commodity with a standardised exchange value for all broker subscribers. Opinions, hearsay, and gossips became irrelevant information to the automatic exchange; they do not have an exchange value in the markets. This commodification process requires framing that separates and individualises objects into discrete transactable entities (Barry and Slater 2002a). The only kind of commodified financial information was one with transactional reflexivity because objective information can be tracked and calculated.

5. Concluding Remarks: Future Directions

The previous section has shown what technologies were used to solve the contradictions in

capitalism during the dot-com boom. Integrating Michel Callon into a political economy of communication however requires a critical evaluation of his work that spanned over a few decades. Power, social relations, and capitalism are three pillars in the critique of a political economy of communication. Whilst political economists may accept Callon's concepts of power and social relations as discussed above in 5.2 macro-micro and 5.3 structure-agency respectively, they may be less forgiving of his critique of capitalism. Callon dismisses the idea that there is such a thing called capitalism because macro structure does not exist (Barry and Slater 2002b). Capitalism is seen as an invention of anti-capitalism. Sociologists hence are advised to abandon their critical position, and to replace conflicts with connecting, controlling, and framing localities. To Callon, a political economic critique of capitalism is undoubtedly a fruitless pursuit because it only makes capitalism a totality. Latour (2005) is equally dismissive of the presumption of capitalism. Instead of seeing capitalism acting "sur-reptitiously" as an infrastructure, he believes that one should study places such as a trading room; trace movements that start and end in a corporate office; and examine constant circulations of documents, stories, accounts, goods, and passions. To quote from Latour (2005):

A Wall Street trading does connect to the 'whole world' through the tiny but expeditious conduits of millions of bits of information per second, which, after having been digested by traders, are flashed back to the very same place by the Reuters or Bloomberg trading screens that register all of the transactions and are then wired to the 'rest of the (connected) world' to determine someone's net worth (178).

Because Latour does not see capitalism as an infrastructure of any local actions, he would then ask where an over-investment of the hi-tech sector took place during the dot-com boom. This calls into the question of the spatiality and temporality of capital accumulation of a more localised understanding of where and how decisions are being made, as well as what technological devices are used for decision-making. To Couldry (2008), media theorists have ignored the spatial dimension of media power. To him, the media, as a complex connectivity, is not a spatial vacuum, but a specific and material organisation of space. Nonetheless, Couldry (2008) remarks that ANT places little emphasis on time. Callon's work tends to focus on case studies of a singular temporality than on historical transformations (Davis 2006). Political economists, on the contrary, are interested in the history of capitalism. Harvey (1989) argues that Marx's political economy privileges time over space: Marx was keener on the dialectics of time and value. To Harvey, financial markets were created to solve the inherent contradictions in capitalism by providing a spatiotemporal fix. In all the above theorisation, there lacks an understanding of the dialectics of the materiality of time and space, namely how the temporality of capital accumulation transforms its spatialities through technologies. Answering this question requires more evidence than the current case study of Nasdaq can provide. To this end, this essay only serves as a beginning of a potentially vivid discussion of the translation of Callon's writings into a political economy of communication, one that is long due but timely.

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