Calming Speculative Traffic: Towards and infrastructural theory of financial markets

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Abstract

This paper argues that the concept of infrastructure offers geographers a useful framework to understand the resilient influence of financial markets on the socio-economy. An infrastructural perspective reframes the politics of financial markets by considering them as vital systems that are deeply integrated with the "real economy". This helps explain the success the financial sector has in reframing regulatory debates away from discussions of action that might shrink financial markets, and instead toward incremental change and technical fixes that end up supporting the growth of the system. The infrastructural perspective also allows us to consider financial markets as technical systems that are inherently limited in their capacity to process financial transactions, which in turn helps explain their tendency to fail. Comparing the flow of speculative trades through financial markets to the flow of traffic through congested roads, the paper employs a case study of the 1987 U.S. stock market crash and its regulatory aftermath. It suggests that in the wake of the 1987 crash, which was caused by an inability to process trades fast enough, U.S. regulators found it politically impossible to impose any significant limits on speculative trading. Wary of market congestion contributing to another financial "accident", they instead expanded the speculative capacity of the markets. But just as expanded road systems attract more autos and produce an array of externalities, enhanced market capacity only attracts more speculation and related externalities, not least a deepening of speculative financialization.

Key Words: Infrastructure, finance, financial markets, financial regulation, derivatives, traffic calming, speculation, liquidity

1. Introduction: Speed Kills

In July of 2011 the city of Los Angeles, California braced for an immanent "Carmageddon". County transportation officials were planning to close the I-405 expressway for repairs during a weekend in mid-July. The 405 is a major thoroughfare, and one of the busiest roads in Los Angeles, one of the most congested cities in the US (Schrank, et al. 2015). However, despite predictions of chaos, publicity related to the closure convinced many to avoid their cars altogether, and in the end

there was less congestion than the previous normal weekend. More people used commuter rail than during any other weekend in the system's 19 year history (Metrolink 2011), and local air pollution was lower than usual (Weiss et al. 2011). The Carmageddon weekend—far from a disaster—confirmed a paradox of urban traffic engineering known as "induced demand" (Goodwin 1996). That is, increasing the automobile capacity of congested roads encourages more drivers to use them, quickly leading to further congestion, and usually attempts to "engineer" traffic through technical systems. Conversely, congestion has a way of regulating itself, mainly by discouraging more drivers from using the road.

The closure of the 405 without serious incident fuelled the long term transition in L.A. road governance from one focused on increasing the capacity of the city's road system, towards one of reducing capacity and moving towards multi-use "complete streets" (see City of Los Angeles 2015). While not all Angelenos agree, there is increasing consensus that the city can no longer afford the dangers, costs, and trade-offs of reproducing automobile infrastructure at the levels it has for the past 50 years, let alone expand it. Breaking the assumption that more and wider roads are the solution, or simply that traffic congestion is not necessarily a bad thing, is contentious because it demands consideration of the total costs of automobiles and roads to society. As the authors of L.A.'s "Mobility Plan 2035" repeatedly note, changing the emphasis of the city's road infrastructure will also change day to day life in the city, meaning that in this context residents, planners, and politicians must reconsider not just transport and mobility, but things like public health, zoning and neighbourhood development strategies.

This story may seem like an odd way to begin a paper on finance. But in fact there are many parallels between traffic systems and financial markets. On the simplest level, both are vital to the reproduction of the economy and heavily regulated by the state. Moreover, both transportation and finance are crucial to the production of value, but considered by many to be non-productive economic sectors. And finally, like transportation systems, financial markets are increasingly interconnected and technologically sophisticated, serving almost everyone in society, and necessary for the movement of commodities and capital—if not people—through space. This paper argues that we could learn much from thinking about the system of financial intermediation in the economy as a transportation system, or more generally as a system of *economic infrastructure*.

As economies across the globe have become more dependent on financial firms, markets, and regulators, ever more social, political and economic capital is sunk into the financial system's reproduction. This development translates into influence over larger and more complicated

geographies, what many broadly refer to as financialization. Yet, despite repeated financial crises—or "crashes"—over the last generation, society has failed in almost all efforts to reduce the system's capacity and influence. On the contrary, the incremental reform of the system has tended to result in increasing its capacity and its technocratic regulation. When it comes to trading volumes, there is a widespread assumption not only that more is better, but *more is safer*. As a result market trading volumes have exploded (Wojcik 2011) and financial development or financial "deepening" has intensified across the globe (see IMF 2015). At the same time global financial regulatory structures have grown in size and complexity and become increasingly dependent upon sophisticated and costly technological systems that serve as the backbone of both financial market trading systems, and the public and private risk management systems that surveil them (Barth, et al. 2012, Bamberger 2010). While it has received some attention (cf. Engelen, et al. 2011), the technocratic management of this complex system deserves more attention from geographers not least because it continues to compress economic time-space at shocking, if not completely incomprehensible speeds through processes like high frequency trading (see Grindsted 2016, Zook and Grote 2016).

Imagining finance, and particularly financial markets, as economic infrastructure makes at least three contributions to existing debates in economic geography and proximate disciplines. First, it reframes the politics of financial markets by imagining them as a "vital system" that demands special protection by the state (Collier and Lakoff 2014). This contributes to existing work demonstrating how finance is deeply integrated with the "real economy" (Coe, et al. 2014, Hall 2012, Dixon 2014, Sokol 2013, Pike and Pollard 2010, Ouma 2016), but it also helps explain how finance is depoliticized (DeGoede 2005) because of it is assumed to serve the public or national interest. Second, it situates financial markets as mundane and technical systems, which explains their inherently limited capacity to process financial transactions. This explains their tendency to fail when their capacity is overstretched, but also why regulatory action that might shrink financial markets is redirected toward incremental change and technical fixes that result in the growth of the system. Third, it provides a framework for analysing how financial markets, not unlike roads, produce economic interdependencies across space. Through all three of these, the relatively simple aim of the paper is to situate financial markets within a dilemma that is familiar within the study of infrastructure. That is to understand finance as a system whose reproduction earns *political support* not because it has some *intrinsic virtue,* but rather because it is indispensable to reproduction of the contemporary space economy.

The paper proceeds as follows. In sections 2 and 3, it interrogates the concept of infrastructure, both as a general concept as well as one that could be applied to the operations and politics of financial systems. Second, in sections 4 and 5 it analyses the theory of "induced demand", or the notion that efficient systems, whether for automobile traffic or stock trading, inherently attract increasing volumes that lead to congestion, breakdown and crisis. Third, in a brief case study in Section 6, the paper examines the events following the 1987 stock market crash in the U.S., where the capacity of the stock market trading systems were overwhelmed causing an almost complete, albeit short-term, shutdown of the entire financial system. It focuses mainly on the politics of regulation and market reform following the crash and attempts to explain how the markets were rebuilt to handle more, instead of less speculation mainly by widening the financial "roads" between the New York and Chicago financial markets.

2: Infrastructural Inversion

Infrastructure is a relatively new concept, conventionally defined as those things that are necessary or "prerequisite" for an economy to develop and function (Rankin 2009). Originally conceived as "social overhead capital", infrastructure usually refers to those objects and systems that provide broad socio-economic benefits across a range of institutions, sectors, or geographic scales (Rankin 2009), as opposed to serving narrow or specific interests. Being fundamentally relational, infrastructure is often defined as physical or material objects that assist the connection or circulation of bodies and commodities, the most obvious examples being roads, bridges, sewers, harbours, and airports. Larkin argues that infrastructures are systems of matter that "enable the movement of other matter" (2013: 329).

While roads, water pipes and other things that constitute interconnection are usually considered infrastructure, automobiles, water, and other objects that move through them are usually considered resources or commodities. As such infrastructural systems typically only become an object of inquiry when they break down and sever the connections they normally facilitate (Star and Ruhleder 1996). Similarly, infrastructure is often imagined as apolitical—the result of expert or technical practices belonging to the mundane realm of engineering and scientific calculation. As Timothy Mitchell says, "The promise of infrastructure is to provide a service that works continuously in the background, supplying a durable and uninterrupted flow of essential services and amenities. Political agency forms to cope with its interruption, unavailability, or breakdown" (2014: 438-9).

Reacting to this operational invisibility, Bowker (1994) has argued for an "infrastructural inversion", or a shift in analytical emphasis turning infrastructural "substrate into substance" (Star and Rhuleder 1996: 113). Put differently, to invert an infrastructure is to study the politics or economics *of the opacity and technicity of infrastructure*. Geographers, particularly those interested in urban structures and lives (Graham and Marvin 2001), have been at the forefront of this shifting perspective, questioning its purported technicity, and arguing that infrastructure is a "complex social and technological *process* that enables—or disables—particular kinds of action in the city" (Graham and McFarlane, 2015: 1). Showing that urban infrastructures are "social in every respect" (Amin 2014: 138), geographers have demonstrated how infrastructures contribute directly to the reproduction of unevenness in socio-economic space.

The relationality of infrastructure also constitutes a unique relationship with territory. The constitutive objects and systems of infrastructure usually facilitate movement across space, or produce connectivity between various commodities, technologies, actors and institutions. Roads and other "rights of way" are good examples of infrastructure's relationship with not just physical, but political-economic geography as they require unique property relations and laws, and as such a unique relationship to the state. Mann (1984) argued that modern bureaucratic states such as the U.S. reproduced much of their autonomy and legitimacy through the construction and enactment of "infrastructural power", or the complex systems of state sponsored socio-economic provision across a territorialized civil society. In this vein, O'Neill (2013: 452) argues that infrastructure constitutes a unique category, that is "neither, by nature, a public or a private good."

This holds even in the face of the widespread trends toward privatization and financialization of infrastructure. The auctioning off of both existing state owned assets as well as private contracts for the construction of new infrastructure is widespread. However, arguing that this is a wholesale transformation from public to private goods misses a key point. That is since early capitalism, and particularly since World War II, infrastructure has been crucial to economic development strategies, particularly around the construction of supply chains and the division of labour, or simply put around the construction of a market economy (O'Neill 2013, Buhr 2009, Rankin 2009). So while much infrastructure may have been publically funded, the aim was not only social or public benefit, but also the private accumulation of capital. More recently, as explicit infrastructure privatization schemes have become popular, the local state—far from exiting the scene—has taken on new roles to ensure the future production of financial value from formally public assets (Weber 2010, Ashton, et al. 2014).

The growth of the internet and the accompanying emergence of a vast economy of digital technologies further necessitates an infrastructural inversion by blurring the line between the techno-material and the socio-political. Take the infrastructure of the "smart city" for instance. It is constituted by roads networks and electricity grids, but also the interconnected systems of data collection, digital sensors, benchmarks, and dashboards that measure and visualize traffic and electricity use, and thus enable real-time infrastructural governance (see Kitchin, et al. 2015). Systems of data collection, manipulation, and information management add another layer of complexity to the urban form, which at the same time produces technocratic opacity as well as exposing the otherwise invisible plumbing of the city to public scrutiny and even resistance (Easterling 2014). The important point is that contemporary infrastructure is constituted by the hybridized context of physical objects, technological systems, digital flows and the relations between them.

Furthermore, in the highly technical economic geographies of the 21st Century, logistical management has taken on new importance (Cowen 2014) and as such the role of the state and the nature of governance has changed. First, there is a shift toward the management of the *circulation* of capital, commodities and bodies (Cowen 2014, Langley 2014). Second, in the emphasis of governance on circulation through and across space, the state increasingly must protect the complex and interconnected "vital systems" that facilitate this movement against sabotage or breakdown (Collier and Lakoff 2015). The "security" surrounding logistical infrastructure has taken on a new technical character and importance, and as a result the state security apparatuses are distributed through the globalized and technical (re)organization of transport, labour, trade, and markets (Cowen 2014).

3: Trafficking in Finance

While geographers have not explicitly analysed finance as a transport system or more generally as economic infrastructure, many have made related arguments about the fundamental entanglement of finance with "the rest" of the economy. I will not provide a systematic review of the geographic literature on finance, but I am building on a subset of that work beginning with the "integrationist" assumption (Pike and Pollard 2010) that the financial sector and financial markets are inseparable components of contemporary capitalist economies. By this I mean that finance is constitutive of non-financial production (see Coe et al. 2014, Hall 2012, Sokol 2013, Dixon 2014), and without it, what we imagine to be the global economy would not exist. This is hardly a provocative argument. In a capitalist economy banks are essential for the management of the money form, the conversion of savings into investment, and the (re)circulation of surplus value. Banks have arguably been vital infrastructure for

these processes since the beginning of capitalism, and supported as such by the state. As Martin (1999: 6) has suggested, the financial system is the "wiring" or "circuitry" of the socio-economy. In the last 40 years, however, financial intermediation including banking has become increasingly marketized, diversified and fragmented (Engelen et al. 2011), but also inseparable from all sorts of previously non-financial processes.

While this inseparability is often framed as "financialization", I will mostly avoid that concept for some of the reasons recently outlined by Christophers (2015). In relation to recent work in economic geography however, the infrastructural perspective may actually offer a corrective for some of the "limits" that Christophers identifies. Part of the problem of the concept of financialization is that it too often assumes there is distinct thing called the "financial sector", and that this thing is increasingly influential over the rest of, or the "real" economy (Pike and Pollard 2010). An infrastructural perspective begs the question whether these "financialized" things or processes continue to be distinctly "financial" (if they ever were), or alternatively whether they are just the mundane substrate of "ordinary" (Lee 2006) economic life.

To clarify, the starting assumption here is that the economy *is* deeply "financialized", but not just by the Financial Sector. Rather, most economic processes are now dependent on processes that resemble what the financial sector does, but over which that sector long ago lost its monopoly—if it ever had one. An infrastructural perspective, not unlike the "operations of capital" approach (Ouma 2016, Mezzadra and Neilson 2015), argues that the socio-spatial organization of the contemporary economy would not exist in its present form without socio-technical systems that facilitate increasingly ordinary processes like real-time payment, micro-lending and borrowing, or the incessant pricing—or indexing—of just about everything by capital, debt, and derivative markets. Consequently Christophers (2015) makes a valid point—that financialization is conceptually limited—but these limits are exactly the sorts of things that numerous "financial geographers" have recently been working to overcome in their exploration of "new" economic geographies (i.e. Sokol 2013, Dixon 2014, see also Ouma 2016, Hall 2012).

Leyshon and Thrift (2007: 98) for instance, describe the relatively mundane process of securitization, or financialization as a process of exploiting the "bread and butter of income flows from real assets". One of their key examples is the securitization of infrastructural systems—or at least the income flows from them—like roads, water, and telecommunications. This "financialization" of infrastructural systems has received significant attention elsewhere (cf. O'Neill 2009, O'Neill 2013).

However, while scholars have asked how infrastructural systems are being exploited for financial profit, no one has considered how the financial system itself has become a "vital system" (Collier and Lakoff 2014) necessary for the reproduction of the economy, at least not in the terms of infrastructure.

Possibly the closest geographers have come is in the recent discussion of the "integrated global economic system encompassing both financial and production networks" (Coe et al. 2014: 766). An infrastructural perspective on finance builds on this work by arguing that financial markets have become the closest thing possible to a *sin qua non* for a globally interconnected capitalist economy (Sassen 2006). This is not to suggest that financial infrastructure flattens global space—far from it. As Dixon says in reference to the global "mosaic" of variegated economic regions, "finance is the grout that fills the crevices between the pieces of the mosaic, bringing them closer together" (2014: 37).

At the micro-level Callon and Muniesa (2005) point out the importance of markets as "calculative collective devices" where the complicated social problem of agreeing on the characteristics, and eventually the fair price of potential commodities is worked out. The contribution of this work, often grouped under the heading of the Social Studies of Finance, is the importance of non-human actants to the experimental process of social calculation. Often technical objects like spreadsheets, computer screens, and even prices themselves become crucial material indexes or "prosthetics" of market exchange that depending on their nature, circulate at various scales (Caliskan 2010), but also become relatively fixed in space producing "micro-structures" (Knorr Cetina and Brugger 2002) of what appear as a placeless "global" markets.

The challenge from Star and Rhuleder's (1996) perspective is to "invert" these micro infrastructural technologies and processes. That is to appreciate how they cohere to form a stable and mundane financial order, but as such an order that society grows to depend upon so that it becomes increasingly difficult to dislodge even in the face of breakdown or crisis. Put differently, the challenge is to understand how, as Engelen, et al. (2011, esp. 1-32) explain the reaction to the 2008 crisis, an "elite political debacle" is instead framed as a "socio-technical accident", which then contributes to the "subordination of political calculation to financial power" (228).

Here the infrastructural perspective demonstrates how finance has become embedded in a politics of operational efficiency, or biopolitical "security" (Langley 2014). Namely, the reason it is difficult to limit financial markets because they are deeply entangled in most parts of socio-economic life. Like the provision of clean water, it is relatively easy to frame the financial infrastructure as a pre-requisite for economic prosperity. In this regard my infrastructural argument builds on Langley's recent

work that analyses financial crisis governance not as an attempt to ameliorate the excesses of the financial system, or to quash excessive speculation in financial markets, but instead as the practice of securing a financialized future. Drawing on Foucault, Langley argues that crisis governance is constituted by the discursive construction and management of a set of "provisionally figured and relatively discrete problems" (2014: 6). These "problems" are constructed through a politics of neoliberal consensus where the volatile tendencies and speculative nature of finance and financial markets are prefigured as manageable risks internal to the operation of the financial system, rather than first order threats to socio-economic equality and justice. The methods by which financial markets will be repaired after a crash may be debated, but much like the repair of bridges or electricity lines after a storm, the necessity of repairing them *to begin with* is beyond debate. Instead financial crisis management has become a technocratic practice designed to secure a financialized future by employing ever-more financial logics and apparatuses.

Consider how finance has become entangled with anticipatory planning and risk management apparatuses concerned with things like natural catastrophe and cyberterrorism. The U.S. Department of Homeland Security considers the financial services sector a "critical infrastructure sector" and refers to the interconnected financial system "the backbone of the Nation's economy and a vital component of the global economy" (Homeland Security 2010: i). Likewise, the UK's Centre for the Protection of National Infrastructure includes financial services as part of "those facilities, systems, sites and networks necessary for the functioning of the country and the delivery of essential services upon which daily life in the UK depends" (UK CPNI 2015). Much of the focus of these agencies and risk management apparatuses they support are concerned with external threats to the financial system, but regardless of the cause, market failure has similar results. As the 2008 financial meltdown demonstrated, whatever the cause, when financial markets are suddenly unable to consistently price money and other financial instruments, macro-economic chaos quickly ensues, and states and regulators will typically do everything in their power to get them working again.

Financial systems have been vulnerable to various sorts of breakdown (e.g. human panic, technical failure) as long as they have existed, but it is only in recent history that digital technology has come to play a central role in their day to day operation. Wires, codes, screens, and digital algorithms—what we might call digital infrastructure—are now crucial to financial calculation and trading (cf. Knorr Cetina and Brugger 2002, Sassen 2006, Pasquale 2015). As a result, over the last 30 years, and particularly since the 2008 collapse, financial regulation has increasingly taken on the character of a

series of complex "technical fixes" (Engelen, et al. 2011, Morgan 2012, see also Bamberger 2010) that above all else seek to ensure that financial markets do not suddenly lose their capacity to translate the complex interconnections of the global economy into relatively simple financial prices.

Before moving on, I want to be clear that analyzing finance as an infrastructural system has limits, especially if it is done in isolation from other frameworks. First, privileging the technical aspects of financial systems risks slipping into technological determinism, which risks ignoring longer term trends of capitalist development, class politics, and the contradictions inherent to the production and circulation of surplus value (Harvey 1982). Second, similar to the "social studies of finance", which tends to privilege non-human actors and employ concepts such as performativity and assemblage, the pathway to a political-economic critique of finance is possible, but not obvious (see Christophers 2014). These limits should be taken seriously, but they do not preclude the value of the analytical approach that I have outlined in this section. On the contrary, turning the economic infrastructural "substrate into substance" as Star and Rhuleder (1996) suggest ought to provide researchers with an additional pathway to grapple with some of the more opaque, but nevertheless consequential aspects of geographic political economies. Possibly the most obvious route to overcoming these challenges is to engage with the peculiar politics of the regulation of "vital systems".

4: Traffic Calming

While I propose the framing of finance as economic infrastructure, in the case study below I suggest that the specific relationship between stock markets and stock futures markets can be better understood as a road system. As mentioned at the outset, over the last generation there has been a shift in the practice of traffic engineering, particularly in large U.S. cities. The shift can be summarized as an abandonment of the notion that roads should be designed primarily to move the largest number of combustion powered vehicles from one point to another as quickly as possible (Schwartz 2015). Instead, many city and town roads are now designed to limit automobile capacity and slow autos down, what is sometimes called "traffic calming".

Traffic regulation takes innumerable forms, and I will only scratch the surface. The most common are explicit measures like lower speed limits, more stop sings and speed humps, or the use of computer models to regulate access to expressways depending on traffic flows. Traffic calming, longer a trend in Europe than the U.S., is more implicit where road spaces are physically redesigned to nudge human behaviour towards safer and slower driving—or even to disincentivize driving all together. The most common approach is to narrow or remove lanes. An extreme approach, something promoted by

the Dutch traffic architect Hans Monderman, is to completely de-regulate the road by removing almost all street signs and markings. The goal in this case is to restructure the city street into a more ambiguous space for biking, pedestrians, or even play (Vanderbilt 2008, 2009).

The logic behind traffic calming is somewhat counterintuitive. The argument is that roads become safer when motorists are encouraged to experience them as fundamentally dangerous. This is accomplished in large part by obliging drivers to see the road as a shared space that requires slower speeds, and encouraging all road users to pay more attention to their surroundings. Monderman wants to eliminate the overly technical attempts to manage the road, and instead turn a "traffic world into a social world" (Vanderbilt 2008). For many, efforts like this are not only attempts to make roads safer, but to appreciate that reducing the number of cars also reduces the externalities caused by automobiles. From the immense costs of building and maintaining road infrastructure to public health issues related to a lack of exercise to carbon emissions to the dysfunctional geopolitics of sourcing petroleum, many people believe that automobiles should no longer be a social affordance.

Furthermore, there is a realization that congestion in many densely populated places cannot actually be solved (Goodwin 1996). Drawing on the concept of "induced demand", engineers have begun to appreciate that the less congested a road is, the more drivers it attracts (Vanderbilt 2009). Congested roads accomplish the opposite by encouraging people to use alternative transportation methods, or simply choose to live and work in different places[1]. Not unlike "Jevons Paradox", in more complex systems (see below) these concepts beg the question of whether increasing capacity makes a system more resilient, or simply prone to breakdown at a larger scale.

As a definitive example of infrastructure, city roads have this exact problem. That is, urban transportation systems designed around smaller capacity, multi-use streets or public transportation should be more resilient in the face of traffic accidents or repair closures than urban systems designed around high capacity, automobile focused expressways. But this is not just because less people will be driving cars. It both reflects and requires broader changes in the socio-economic geography of cities and suburbs (see Graham and Marvin 2001, esp. 117-121), meaning that over time the spatial structure of the city will necessarily adjust to different patterns of daily life. The key point is that choices about the capacity of street and expressway infrastructure cannot be disentangled from larger questions of the politics of urban policy and planning, urban political economy, and day to day city life.

[1] These "incentives" have uneven social impacts, particularly for those who have fewer choices about where to live and work.

5. Liquidating market capacity

The notion of induced demand in the study of traffic congestion is more than just a metaphor to understand financial markets. While Keynes (1936) did not use the term, he was interested in the same problem. His basic argument was that any regular flow of market prices, or one that people could reasonably expect to continue in the future, would attract those with little interest in the underlying commodities, but rather a desire to trade in search of quick profits. In other words, liquid markets attract short-term speculators. In this situation, however, the market can quickly become an institutional—or we might say infrastructural—necessity for the economy. Keynes described it this way:

> Thus investment becomes reasonably "safe" for the individual investor over short periods, and hence over a succession of short periods however many, if he can fairly rely on there being no breakdown in the convention [the market] and on his therefore having an opportunity to revise his judgment and change his investment, before there has been time for much to happen. Investments that are "fixed" for the community are thus made "liquid" for the individual (1964: 153).

The fixed investment for the "community" is the liquid market itself, meaning that collectively the community of investors needs to take steps to safeguard that liquidity. The problem is that financial markets have a tendency, particularly strong over the last 30 years, to become entangled in just about every aspect of socio-economic life. As such the "community" includes not just financial speculators, but just about everyone with a stake in the capitalist economy. This helps explain why the capitalist state has little choice but to rescue financial markets when they fail.

Keynes furthermore argued that liquid markets were especially subject to "waves of optimistic and pessimistic sentiment" (1964: 154). This sentiment would tend to move market prices violently, and/or create price bubbles large enough that when they pop could break the "convention" itself. Minsky (1986) elaborated this in his "financial instability hypothesis" arguing that credit-fueled financial markets are particularly subject to bubbles and crashes.

Drawing on Minsky and various strands of systems theory, Mirowski (2010) has argued that this tendency for financial markets to rupture is more technical and systematic than the problem of speculative caprice. Mirowski argues that the emergence of financial derivatives in particular has facilitated the construction of an interconnected system of market "computation". Offering a corrective to neo-classical economic theory of market liquidity, he focuses on the ways an interconnected system of financial markets reduces the complexities and "risks" of the capitalist economy into legibly priced and easily tradable securities and derivatives contracts. The problem for Mirowski is that these markets are "dissipative" systems (Dragos and Wilkins 2014), meaning that they

enhance entropy, or simply put—create irreversible complexity. This is not a problem as long as the markets consistently function as price mechanisms. However, if the heightened complexity of the market system overwhelms the computational capacity of any particular market mechanism and that market suddenly loses its capacity to produce prices, the entire market system loses its capacity to translate—or compute—the messy complexities of its financialized subjects into prices. In other words, the highly complex system of contemporary financial markets are subject to what Mirowski calls "inherent vice", or the inherent tendency to fail and leave economic worlds more risky and complicated than they were before they became dependent on financial market systems.

6.1: Failing forward through 1987

> "The crash of October 1987 is a case in point: the world's first seemingly traumatic financial event without obvious economic causes or consequences….The crash of 1987 marks the beginning of the age of Financial Unreason, when panic became just another, quotidian aspect of financial life. At the time, to a lot of people, it felt like the end of something. In retrospect, it appears to be more of a beginning" (Lewis 2009: 13).

Lewis marks 1987 as the beginning of the current age of financial panic. What he does not explain is that the mid-1980s also marked an important period in the growth and maturation of speculative financial markets, not only as politically legitimate institutions, but also as highly influential processes in the globalizing economy (Sassen 2006). Stock markets volumes had not yet exploded the way they would in the 1990s (see Wojcik 2011), but the stage was being set for this growth. During the mid-1980s there was titanic growth in institutional investors and portfolio managers responsible for managing pension and mutual funds (Clark 2000). Along with this came an appetite for devices to manage the risks of portfolio investment (MacKenzie 2006). The 1980s were also when the notion of enhancing "shareholder value" emerged as a guiding principal of corporate governance (Froud, et al. 2000). The key point is that the 1987 crash was not just a sign of a financial sector mysteriously losing its rational bearings. Rather it was the result of the accelerating integration of financial markets, financial speculation, and financial risk management into the day to day functioning of the U.S., if not the global economy.

This brief case study examines the reaction to the 1987 stock market crash that was centered on the New York Stock Exchange and the Chicago Mercantile Exchange. The main argument is that the wrong lessons were learned in the aftermath of the crash, and as such the emergent political consensus "failed forward" (Peck 2010: 6) by encouraging instead of limiting financial market integration. First, rather than realizing that the stock market had become *too liquid*, and as such too influenced by

speculative trading, many concluded that the market was *not liquid enough*. In other words, although hotly debated at the outset, consensus emerged that the technical capacity of the market needed to expand even faster. Second, rather than realizing that the dependency of the U.S. and global economy on the continuous functioning of the integrated stock and futures markets was a dangerous but reversible trend, the regulatory debates after the crash resulted in the normalization of this dependence. At a time when an infrastructural inversion was desperately needed, the crash instead turned this dependence into a mundane fact of economic life—a sign that politically the financial markets were taking on the character of infrastructure. The analysis of the crash is based on thirty in depth interviews with traders, exchange executives, and government regulators, as well as a textual analysis of government and private sector reports, newspapers and trade magazines.

6.2: Historical context

Beginning with the 1934 Securities Exchange Act and as a direct result of the 1929 crash, speculation was curtailed in U.S. stock markets. The main device used to keep speculation under control were significant restrictions on the amount of credit that could be used to buy securities. At the time, Congress considered a complete ban on credit, but decided against it (Federal Reserve 1984). They mandated that the Federal Reserve Bank set credit or "margin" limits and that the newly established Securities and Exchange Commission (SEC) enforce those rules. These margin levels have fluctuated since 1934, but since 1974, buyers have been required to front at least 50% of the purchase price of securities.

The history of the development of futures or "derivatives" contracts on stocks has been covered elsewhere (cf. MacKenzie 2006) as has the history and geography of the regulation of these markets (Millo 2007), but a quick introduction is necessary. Originally designed as an aggregate measurement of the prices of a basket of stocks, indexes gained popularity in the late 1970s as the basis for "unmanaged" mutual funds, or vehicles to invest in large groups of stocks without incurring the costs of trading each stock individually. In 1982 the Chicago Mercantile Exchange (CME) created new derivatives contracts to hedge and speculate on changes in the value of New York based stock market indexes, in this case the Standard and Poor's 500.

Because the new contracts were considered "futures" and not securities, the Federal Reserve and SEC had no jurisdiction to set margin limits for the new futures contracts. Instead the Commodity Futures Trading Commission (CFTC), which had a long history of deferring to the Chicago futures

exchanges, had exclusive jurisdiction over these new contracts (see Millo 2007, Muellerleile 2015). As a result the margin requirements on stock index futures purchases were 10% or less, as opposed to 50% for the underlying stocks. The discrepancy was not lost on the SEC, who were concerned about inviting a new speculative vehicle into the realm of stock markets. They battled the CFTC for control over index futures, but they lost (see Millo 2007).

The invention of stock index futures had an almost immediate impact on the underlying stock markets. Since the 1950s, economists had been working on ways to predict and improve the returns on portfolios of stock investments (MacKenzie 2006). A new invented a new risk management product called "portfolio insurance" was invented in the late 1970s whereby customers could use Chicago index futures to hedge their New York stock investments (MacKenzie 2006, Bookstaber 2007). The "insurance" quickly became popular with institutional investors who received a daily report advising them how to adjust the proportion of stocks versus futures held in their portfolios. With daily or "dynamic" adjustments, hypothetically the managers could maximize gains and minimize losses, or simply maintain a consistent return on their portfolio regardless how the stock market moved. At a macro level, this insurance system incentivized stock market investing for those who may have otherwise avoided it because there appeared to be less risk of loss if the market began to drop precipitously. Consequently, stock index futures not only produced more business for the Chicago exchanges, but they also funnelled more capital into the underlying stock exchanges in New York, putting upward pressure on prices and contributing to the bull market of 1982-1987 (Brady Report 1988). Furthermore, by the mid-1980s many stock brokerage firms had developed "program trading" to automatically trigger buys and sells based on price movements.

While speculation had always been an aspect of stock market investing, this was the beginning of the institutionalized and automated entanglement of the inherently speculative Chicago futures markets with the New York capital markets. In a sense the Chicagoans built a speculative expressway between the two markets where barely a walking path previously existed. They constructed an economic right of way, but with little concern over how it might change the economic "neighbourhoods" that it would inevitably transform.

6.2 Black Monday

Over the first eight months of 1987, the Dow Jones Industrial Average (DJIA) would rise more than 40%, but in September the market began to waver. During the week of October 12, the market became volatile, generally in a downward direction. On Friday of that week, the market dropped more

than 100 points, the largest daily point drop ever. It was an apprehensive weekend for Wall Street. On Monday morning the index futures in Chicago immediately opened down intensifying the selling pressure in New York. Many of the New York Stock Exchange (NYSE) stock traders, or "specialists" had so many sell orders that they could not establish an orderly flow of trades, and instead just stopped taking orders. This turned into a downward spiral of panic back and forth between New York and Chicago.

By the end of the day the DJIA had fallen 508 points, about 22.5%, which was larger than any day in 1929. The S&P 500 futures index at the CME was down 29%. The bursting bubble spread around the world with similar drops in London, Tokyo, and Hong Kong (see Brady Report 1988 for an overview of the events). The following day, Tuesday, October 20, was another wild day, with dramatic drops in the morning and a partial recovery in the afternoon after the U.S. Federal Reserve, with its new chairman Alan Greenspan, assured banks that it would inject money into the system in the case of a deepening crisis.

While the extent is debated, it is widely agreed that selling related to portfolio insurance played an important role in the crash both through automatic and human induced selling (see Brady Report, Bookstaber 2007, MacKenzie 2006). When stocks began to fall precipitously, the prescribed dynamic hedging strategy was to sell a larger portion of stocks in New York and increase the hedge in Chicago by selling futures. When the market began to fall, automated or "program" kicked in and sent even more sell orders to the floors of the exchanges. Normally this would drive prices down until they reached the point when buyers would step in and restore some sort of "equilibrium". But on this day there were so few buyers that the markets in many stocks, particularly those managed by "specialists" at the New York Stock Exchange, stopped functioning[2]. A number of my interviewees described the situation as total chaos, what later became known as the "market break". The chairman of the SEC at the time said in a personal interview, "part of the problem was that there had not been any communication between the two markets. Nobody at the NYSE knew to call Merc [the Chicago Mercantile Exchange], nobody at Merc knew to call the NYSE or NASDAQ." To return to the

[2] In Chicago the exchanges were until quite recently, run as open outcry auction markets, where no one is compelled to buy or sell at any time. Any member is allowed to trade with any other member as long as the trades happen within the confines of the trading "pit" during trading hours. From the beginning of its history until very recently the New York Stock Exchange was very different. On the NYSE, "specialists" are responsible for small groups of stocks at their "post". They become either the buyer or seller of every trade, and it is their responsibility to maintain an orderly market, meaning that they must buy and sell out of their own inventory of stocks when there are not enough outside orders on one side of the market.

comparison with roads, the new expressway had quickly attracted more traffic than it could hold, and it turned into complete and almost irreversible gridlock.

October 19th, what became known as "Black Monday", wiped out $1 trillion in virtual wealth in one day (Brady Report 1988). Despite fear of a broad economic collapse, there was little medium or long-term macro-economic trauma as a result of the crash. Nevertheless, it is difficult to exaggerate the short-term uproar the crash caused in the press, the public, political and academic circles, and in the financial industry itself[3]. President Reagan quickly announced the appointment of a task force headed by former Wall Street banker and U.S. Senator, Nicholas Brady, to study and quickly report on the crash. The CME, whose index futures were initially blamed by many in New York for the crash, appointed a "blue ribbon" commission of prominent economists to study and issue a report. Among others, the U.S. Congress, NYSE, SEC, and CFTC also commissioned studies.

Most of the exchanges, regulatory agencies, as well as Congress commissioned studies of the crash, but the Brady Report carried the most weight, and was seemingly the least biased, at least with regard to discrimination between the securities industry and futures industry. Echoing the Federal Reserve's work four years earlier (Federal Reserve 1984), the report came to one overriding conclusion: there was no longer any operational separation between the stock markets and the futures markets. In other words, it was no longer plausible that these markets functioned independently or that the Chicago futures markets were merely a derivative of the truly consequential capital markets in New York. Rather, in Callon and Muniesa's (2005) language they had become a single "calculative collective device", or in Mirowski's (2010) terminology they were a single computational mechanism, and in their breakdown had created a level of irreversible financial complexity not experienced since 1929.

There were extended debates and arguments, some lasting years, over the causes of the market crash. More importantly, in virtually all of the reform efforts, there was intense and often explicitly political manoeuvring to establish the particular problems or problematics that would become the objects of action (see Langley 2014). The most contentious of these were over the possibility of imposing higher margin limits on index futures contracts to bring them in line with the limits of stock purchases. The SEC realized that the emergence of the Chicago futures markets not only added an additional speculative element to the financial system, but that the futures—what would soon become known as derivatives—were making the entire system more interdependent and complex.

[3] For a newspaper article length retrospective, one week after the event, covering what happened, initial reactions, and the initial reforms being considered, see Rustin, R. and Ricks, T. "Never Again? Stocks' Plunge Bring Calls for Overhaul of Financial Markets", *Wall Street Journal*, Oct. 26, 1987, pg. 1

The Chicago exchanges were much more dependent on speculative trading for survival than the New York exchanges. Furthermore, because the Chicago markets were "derivative" of the New York markets, their growth was largely dependent upon increasing volumes in New York. But at the same time, as the futures or derivatives markets grew as an alternative outlet for speculative trading, growth in the New York capital markets was increasingly dependent upon the availability of the hedging or insurance qualities of the Chicago instruments.

Given the realization that together the stock and futures markets together constituted more of a "vital system" than ever before, the Brady Commission recommended that one governmental agency be made responsible for "coordinating the few, but critical, regulatory issues which have an impact across the related market segment and throughout the financial system". The most important of these issues were making margins "consistent across marketplaces", "unifying" clearing systems, and implementing "circuit breakers" to halt computerized trading if and when the next crash happened (Brady Report 1988: 59). The commission authors argued that failure to coordinate these through one single regulator would "impose pervasive, unavoidable, and possibly destabilizing influences" on the markets (ibid).

The increased margins that the SEC proposed would have significantly limited the amount of *speculative capital* that could flow through New York's, but more importantly Chicago's markets. The SEC's proposed remedy to the crash was basically to "calm" the entire market system by making it more difficult to participate. I will skip many of the details, but the Chicagoans had no interest in slowing the markets down. They fought hard against this potentiality, especially by lobbying in Washington D.C. to retain the CFTC's exclusive jurisdiction over all futures instruments. The Chicagoans demanded an absolute separation from the SEC and their more sceptical attitude toward speculation. They were ultimately successful, and no meaningful changes to margin limits were implemented[4]. Increasing margin was, however, very likely the only reform with any real possibility of slowing the markets down[5].

[4] The jurisdictional battles and legislative reform efforts continued into the early 1990s. In 1992 Congress did transfer authority for margins on stock index futures to the Federal Reserve, but shortly thereafter the Fed. delegated this responsibility to the CFTC, and the CFTC delegated it to the futures exchanges (Seligman 2003). Shortly after the crash, the CME raised margins on speculative index futures to 15%, and 10% for hedging, but to the SEC's chagrin, lowered the hedging margins back to 3% within a year of the '87 crash (Ruder 1988).

[5] This explains why, going back at least 100 years, and right through my interviews with numerous Chicago exchange officials between 2010 and 2012, maintaining self-regulation of margins was a life and death issue for their markets (see Muellerleile 2015).

6.3 Wasting a Good Crisis

With no progress on calming the markets, but still a desire to avoid another market break, attention quickly turned to expanding their capacity. The SEC, NYSE, CFTC, and CME disagreed about many things, but one thing they co-operated on was improvement of coordination and communication between the markets. Most everyone agreed that the futures exchanges were more technologically advanced and more liquid, so most attention was focused on updating the NYSE's "market mechanisms" as the Brady Report called them. A Congressional staff member who was closely involved in the regulatory negotiations said this in a personal interview in 2012:

> …the problems that came up in 1987 were more that the market expanded so quickly, both for stocks and for stock index futures, that the data systems, the electronic systems at the exchanges both in New York and Chicago just became obsolete before their time. So that you had a rush of trading and the trading systems didn't have the capacity to handle them.

In particular, the crash had put intense pressure on the NYSE to reform its specialist-based trading system. There was less patience for human intermediaries in the market system, especially humans that might decide that the market ought to slow down or even halt trading during a crisis. David Ruder, the SEC Chairman at the time, was initially one of the strongest proponents of increasing margin limits. But he also seemed resigned to the fact that futures markets would only become more entangled in the stock markets, so it seemed reasonable to prepare the stock markets for increased volume and volatility. A year after the crash, he commended the stock exchanges for increasing their trading system capacities to be able to handle 600 million shares a day (Ruder 1988) up from roughly 250 million in 1987. The NYSE's short-term goal was to increase that capacity to one billion shares a day in large part to ensure that their connections to the speculative futures markets would never again be threatened.

Between 1987 and 1992, the stock and futures exchanges set up formal lines of communication—many of them automated—agreeing to share information on large trades and settlement positions, and to coordinate computerized "shock absorbers" or "circuit breakers" to create automatic short term trading halts in the case of the threat of another crisis (Ruder 1988, Seligman 2003). These automated stop signs and contingent speed limits seemed like very reasonable solutions given that the problem had successfully been framed as one of a lack of connectedness between the markets, not one of too much connectedness. With the possibility of discouraging speculation out of the way, no one was troubled that the capacity to handle more trade volume would "induce" more speculative trading, or that adding lanes to the expressway between Chicago and New York would encourage the development of more speculative financial "vehicles". Largely lost, however, was any

discussion of the further institutionalization of speculative trading, or what effects the expansion of stock markets and the related financial sector might have on the broader socio-economy.

This finally brings me back to the larger point that Keynes realized in the 1930s. That is, the absolute number of trades in a market does not matter. Rather, any market that is liquid enough to attract speculators will be subject to "waves of optimistic and pessimistic sentiment" (Keynes 1964: 154). For Keynes the goal was stability—or what we might call economic calm. It was to seek a balance between the benefits of a liquid market for investors with the risks of increasing market capacity to a level where speculators can move in and out of the market without transaction costs. If Mirowski is correct that the computational capacities of today's highly derivative and speculative markets are subject to inherent vice—and events like the 2010 "Flash Crash" seem to suggest they are—they will eventually lead to breakdown and chaos, and no level of high tech surveillance by regulators will prevent this from happening. Richard Ketchum, the director of the SEC's division of Market Regulation in 1987, reflected on the crash and explained market liquidity this way in a 2008 interview:

> You're also seeing it because—just as each time you get something that provides greater liquidity, people tend to overdo it. And futures and options offered two things to people that they had not had before: the ability to buy and sell a lot of stock equivalents very quickly, at relatively low cost; and the ability to have higher leverage because margins on the futures side were designed very differently than margins on the stock side—still dealing with Depression concerns and the like. And so the leverage was much greater. All that might be good; might be bad. But what it does do is, in that type of environment, suddenly price movements that would occur in a long time period now started to be condensed into a much shorter time period. And the other thing is, until people developed controls, this increase in leverage and increase in speed started to create what was referred to—if you look at the Brady Report and the Market Regulation Report on the crash—as illusions of liquidity. […] This is part of program trading. You would do it through programs. Now there was only one problem with that theory, an error that we've done again and again—we, the financial industry—for twenty years. That's all nice until the market suddenly becomes volatile and people get scared. But a basic rule of markets is that when liquidity disappears, it disappears completely (Ketchum 2008: 15-16).

Ketchum keys in on the most important lesson of 1987, one that is frighteningly pertinent to something like the algorithm driven Flash Crash, and the on-going risks of high frequency trading. But this is a lesson that has been learned by almost no one on Wall Street, including government regulators. That is quite simply that it is not possible to eliminate the negative effects of speculation by building more market capacity because the liquidity itself encourages more speculation which will at some point crash the market. This is the inherent vice of Mirowski's (2010) theory of a market system, and it is eerily similar to the theory of induced demand in traffic engineering. Unfortunately in 1987 and since, this contradiction has been buried under a regulatory discourse that treats financial markets as a vital

system too crucial to limit in any meaningful way. Instead the problem has become one of building technical systems of risk management to anticipate and cope with the effects of speculation.

7. Conclusion: Calming Finance

Through the case study of a financial crash and the political reaction to it, I have argued that framing financial markets as economic infrastructure, and particularly as a system of transportation infrastructure, can help economic geographers accomplish three things. First, it demonstrates how the regulatory politics of what are considered to be "vital" economic systems resist attempts to shrink those systems even in the face of system failure. As financial markets become increasingly vital to the reproduction of economic geographies at almost every scale imaginable, among other things we ought to consider their on-going crises as infrastructural breakdown. This means that without sustained critical engagement their breakdown will likely result in even more robust reconstitution. Second, borrowing the concept of "induced demand" from traffic engineering, and comparing it to Keynes's warnings about the dangers of overly liquid markets, it helps explain why speculative financial markets are always in danger of collapse. And third, it shows how privately constructed and owned, but publically regulated financial markets continue to build rights of way that draw increasingly more aspects of the socio-economy into their relational economies. This infrastructural perspective is not a substitute for interrogations of the long term tendencies of financialized capitalism, but it is a necessary complement to those approaches.

Since 1987, in the US in particular, financial regulators want their cake and to eat it too. They want innovative, fast, and efficient capital markets with low transactions costs, and crucially they want those markets to retain those qualities in the face of potential breakdown. At the same time, they want the markets to be stable, fair and transparent for all investors. Put another way, the state wants to ensure the ongoing prosperity of the speculative financial sector, but the state also wants to ensure that the mundane system of financial economic infrastructure continues to support the basic operation of the economy. The problem is that creating a balance between these is difficult, if not impossible. It has resulted in an unwillingness to limit the capacity, or even slow the acceleration in growth of financial markets, but at the same time it has fuelled an explosion of technical, technological, and technocratic apparatuses to manage the instability of financial markets. Consequently, financial markets continue to grow, and continue to attract speculative trading—most of which is now computerized and automatic.

While it may be idealistic to ask financial regulators to rethink financial market systems in light of the urban trend towards traffic calming, this should not stop critical social scientists from opening up a debate on this front. Urban residents, planners, and politicians are increasingly approaching streets from a holistic or "complete" perspective, including the appreciation of the futility of attempts to reduce congestion and the externalities of an over-reliance on cars. Put differently, the right to *live in* a city of streets is possibly becoming more important than the right to *move through* a city at speed on those same streets. A similar argument ought to be made about the right to sustainably live in an economy that is not regularly overwhelmed by the speculative imperative to circulate money and capital through that same economy.

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