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The Infrastructures of Finance:
The London Stock Exchange and the Politics of Market Structure in Modern Britain, 1801-1914

By

John Handel

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Philosophy

in

History

in the

Graduate Division

of the

University of California, Berkeley

Committee in Charge:

Professor Thomas Laqueur, Chair
Professor James Vernon
Professor Caitlin Rosenthal
Professor Ian Duncan

Summer 2021

The Infrastructures of Finance:
The London Stock Exchange and the Politics of Market Structure in Modern Britain, 1801-1914

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John M. Handel

Abstract

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Doctor of Philosophy in History

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Professor Thomas Laqueur, Chair

Between 1801, when the London Stock Exchange was re-constituted as new, formal entity, and 1914, when WWI brought the first age of globalization to a close, financial capitalism expanded dramatically. At the beginning of the century there were only 6 formal stock exchanges in the world. By the end of it, there were almost 90. Financial markets were linked together by global telecommunications networks that allowed capital to travel at faster speeds over greater distances. Finance assumed the commanding heights not just of the economy, but also of imperial policy, as states aggressively looked to expand their informal empires through the power of the financial sector. But rather than focusing on the subjects that typically populate the financial histories of this era—the great banking families of Baring and Rothschild who floated sovereign loans and bailed out troubled states, the stockbrokers who jostled for space and profits on trading floors throughout the world, or the ebbs and flows of capital and asset prices—this dissertation tells the story of the men, women, and things who made the actions of financiers possible. Whether it was the human infrastructures of the waiters, porters, and telegraph boys who facilitated the communications between financiers, the clerks, journalists, and statisticians who provided the information and data financiers needed to make investment decisions, or the material infrastructures of telegraphs, ticker tapes, telephones, electrical circuits, batteries, and cables through which those communications and data travelled, the act of exchange was always at the mercy of the infrastructures that underpinned it. Telling a financial history that focuses on infrastructures rather than the act of exchange, changes our understanding of financial power in two ways. First, this dissertation shows how certain, powerful institutions and firms, like the London Stock Exchange, gradually began to exercise infrastructural power over states and societies by co-opting the underlying infrastructures upon which financial exchange depended. The rise of financial capitalism depended not on a lifting out or abstraction of previously personal and traditional modes of exchange but was far more about the ways finance seized hold of mundane infrastructures—like the ostensibly public infrastructure of the telegraph—and co-opted them towards financialized logics. Second, an infrastructural history of finance also restores agency to our understanding of financial history, that all too often relies on myths of the power of great men or of efficient markets. Instead, this dissertation shows how even the smallest and seemingly least powerful actors could have outsized effects on the financial system through their control over the mechanics and operations of the infrastructures of finance.

For Isabelle and Wilson

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Acknowledgements

It feels cliché to open a dissertation by citing Walter Benjamin. But after the last few years, perhaps I can be forgiven. 5 years ago, after the election of Donald Trump, I read Benjamin's "Theses on the Philosophy of History" with the students in my History 5 section. It indeed felt as if the state of emergency within which we lived had turned from the exception into the rule. Little has happened since to change that feeling. Rather than sequentially recount, like beads on a rosary, the crises that have occurred in the meantime, I will suffice to say that this dissertation, and my entire training as a historian, has been shaped by this sense of crisis. But more importantly, I have been shaped by the people who helped me survive these times of crisis, from the students in that discussion section, to my friends, colleagues, teachers, and family. The acknowledgments of this dissertation are a small down-payment on the enormous debt I owe them all.

I will start with my teachers. This dissertation was born in two seminars with Cathryn Carson. Her seminar on the history of quantification remains my platonic ideal of what a graduate seminar should be. It was bracing, interdisciplinary, philosophical, empirical, and collaborative. This dissertation is a small effort at beginning to answer the questions that were first raised in that classroom. A second research seminar she taught gave me the opportunity to try and write financial history for the first time. I failed. But by giving me the space to fail, I started asking better questions and finding better answers. The results of those failures are now Chapter 2. Thinking alongside Cathryn was truly one of the great joys of my time at Berkeley. If the project began by thinking with Cathryn, it ended by thinking with Caitlin Rosenthal. She came to this dissertation in its critical final year and I am eternally glad that she did. I cannot thank her enough for her unwavering support, her critical insights, and her persistent help. She is a model of how to combine scholarly rigor with generosity, one that I am still trying to live up to.

James Vernon was the first person to believe in this project. For that alone my debt to him is legion. There is not enough space in this entire dissertation to describe all that he has done. In addition to reading countless drafts, writing countless letters, and answering countless panicked emails, I think the biggest gift James has given me was to shake me out of my individualistic perfectionism. I learned from James that writing history is collaborative; a constant and unending dialogue, and that no one can or should do it alone. I am so deeply grateful that we learned and wrote history together. I can't imagine a better partner.

My first week at Berkeley featured a conference with all the current and former students of Tom Laqueur. It was intimidating to say the least. I remember being told that studying with Tom was like becoming family. I didn't really believe it at the time, but I was quickly proven wrong. He gave me a place to live when I needed one and helped me break into it after I'd locked myself out. There were the dinners and walks and coffees and drinks which turned into phone calls during the pandemic. But most importantly Tom became my historian's conscience. He is the voice I hear in my head when starting a new project ("what is the historical *fragestellung* you're trying to ask?"), when I'm reading sources ("how does this help show causation and change over time?") and when I'm writing ("am I actually saying what I mean or just black boxing my thinking with meaningless words?"). And, of course, I am always thinking of how to connect the particular to the cosmic. Tom is truly a master craftsman of history and to study with him has been the honor of a lifetime.

I was lucky to learn from many others while I was at Berkeley. Janaki Bakhle taught me how to read complicated texts and write about them clearly. Abhishek Kaicker taught me the

importance (and difficulty) of historical synthesis. Ian Duncan taught me how to read novels with care. Kerwin Klein taught me Hegel. In addition to the intellectual support I received, the financial and administrative support from the history department was the crucial infrastructure that supports intellectual life. I'd especially like to thank Mabel Lee, Erin Lee Inama, and Ken Mahru for their ability to combine administrative efficiency with friendliness.

My formation as a historian began well before I ever arrived at Berkeley. Jeanne Weiner, David Diehl, and Matt Meyer were the best teachers I could have asked for in middle school and high school. I was also incredibly lucky that the priest who baptized me, Fr. Michael Tan Creti, also happened to be a brilliant scholar in his own right. His encouragement to read philosophy and history from a young age has stuck with me. I only survived my time at Florida State University thanks to Chuck Upchurch and Paul Fyfe. The time they took with me made all the difference and I am glad to still have them as friends and mentors. At Cornell I could not have had better advisors than Robert Travers and Ed Baptist. Ed's support did not end when I graduated. I cannot thank him enough for the faith he has had in me over the years.

I was amazed how many scholars—both in and out of the academy—took the time to read and engage with my work during the past 2 years, most of them dominated by a pandemic. Their generosity represents everything that is still good and worthwhile about intellectual life, despite the endemic crises we find ourselves in. I would like to thank Amy Edwards, Desmond Fitz-Gibbon, Loren Fox, Nils Gilman, Trevor Jackson, Patrick Joyce, Anne Murphy, Maura O'Connor, Chris Otter, and Alexia Yates. A special thanks is due to Paula Vedoveli, Gertjan Verdickt, and Dong Yan, all of whom read far more of this dissertation than they needed to. Their comments shaped its final form immensely. I am glad to call them friends and colleagues and to be a fellow traveler with them in financial history.

The infrastructure that underpins our historical research is the work of archivists. Not only did they constantly assist with the technical difficulties of simply finding stuff, but they also made the drudgery of historical research much more enjoyable. At the Guildhall Library I'd like to thank Peter, Joe, Jason, Ann, Paul, Christopher, Melanie, Isabelle, Ellie, and Lindsey. At the London Metropolitan Archives, I'd like to thank Louise Harrison and Mark Arnold who dealt with my many annoying requests for offsite material. And at the BT Archives, (easily the most fun archive I have ever visited), I want to thank Anne Archer, James Elder, and David Hay. My trip to the archives was, in turn, only made possible thanks to Anne-Marie Hackett who gave me a place to stay in London. I am so deeply thankful that she took me in. Adil, Mel, Zak, and especially Mimi and Marla, all made London feel like home.

I could not have survived my time at Berkeley without my friends. Lizzie Johnson was literally the very first one. Her friendship over so many years and through so many different phases of our lives has meant more than can possibly be expressed here. She also introduced me to Jordan Hendricks and Ulyssa Mello. There cannot be two, more unconditional friends than they are, and I cannot imagine my life without them. Simon Brown, Grace Goudiss, Joseph Ledford, Derek O'Leary, Peter Vale, and Matt Wormer have been the best friends I could have ever wished for through graduate school. They have sharpened my thinking and my politics at every turn. More importantly, they have been the source of far more fun and happiness than I could ever hope to adequately represent.

The mental health community in Berkeley was also a lifesaver in more ways than one. That I was assigned to Matt Goodman during my first appointment at the Tang Center is one of the great strokes of luck I have ever had. The men's support groups run by John Sauvé and Rich Chiovarelli were critical sources of care over the years. It is absolutely impossible to recount in

one short paragraph the amount of thanks I owe to David Riland. The work we have undertaken together is probably more important than anything else I have done during my time in graduate school. I am grateful and lucky that I got to do it with his help.

The best silver-lining of a year of social distancing and remote work has been the ability to move back to Nebraska. Whether I was near or far, my friends from Omaha have always been more like family. To have spent the last year with them is a gift I never thought I would receive. They may not know it, but they shaped this dissertation at every stage and I could not have written it without them. They are: Jeffrey and Karli Bantam, Josh and Alissa Christensen, Jake Clatanoff and Danielle Passaglia, Jordan Dravitski, Patrick Davlin, Alec and Katie Drey, David and Lura Holst, Luke Huber, Adam and Ben Mackenzie, Connor Olberding, Albert Padanilam, Jacob and Falon Pulfer, Will and Katie Sassen, Katie Shalon, James Sinclair, Josh and Liv Smith, and Zander Thornburg.

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Neither my grandma Corky, nor my grandpa, Big John, lived to see me complete this dissertation. I have grandma Corky's love of reading to thank for the purchase of many of my first history books. Big John was my greatest supporter until the very end. Between his weekly Sunday phone calls, his frequent letters, and infrequent visits, he was always there when I needed him. I still miss him every day. I am sad they are no longer here because I know just how happy the completion of this dissertation would have made them. No Aunt or Uncle will ever match up to Jill and Paul. Without Jill, I would not have had a place to stay during my research year. I knew Paul was a good one from the first time he let me beat him in chess while on family vacation. They have been a source of fun and love ever since. Together the two of them provided more meals, gin, wine, cheese, and Smartfood than I can account for, and certainly more than I can ever repay. I hope they consider this paragraph a small start.

My parents were my first teachers. Though neither of them is an academic, (my dad, Marty, is a logistics manager, my mom, Lorraine has worked more different jobs than I can count), they have taught me so much. Perhaps their most important lesson was the power of showing up and trying. Our relationship hasn't always been easy, but they have never stopped trying, never stopped showing up, and never stopped supporting me. I love them and am proud to be their son.

And last there is Isabelle. It is truly a struggle to put into words what she means to me. After years of living and working alone, I had begun to give up hope that there would ever be anything else. She proved me wrong and, in the process, breathed life back into me. She has taught me how to live more fully, with more joy, and with more love than I ever could have imagined. And, of course, she brought Wilson into my life too. I could not have made it to the end of this phase of life without her, and I am so excited to see what the next phase of our life together brings us.

Omaha, July 2021

Introduction:

The Infrastructural Power of Finance

"As soon as the uncertainty of the expectations that guide economic behaviour is admitted, equilibrium drops out of the argument and history takes its place."[1] *Joan Robinson*

"The whole is always inferior to its parts."[2] *Bruno Latour*

Throughout October of 1921, contractors were hard at work installing "large electric lights" throughout the London Stock Exchange. On October 20th, they turned them on. The lights worked but the telegraphs that connected the London Stock Exchange to the Paris Bourse suddenly shut down. Unbeknownst to the stock exchange's engineers and workmen, the bourse-to-bourse telegraphs had been connected to the same electrical circuit as the new lights, which took up so much power that the telegraphs shut off. The arbitrageurs who made their living exploiting the price discrepancies between the two exchanges missed the opening of the market. By 11:10 a.m., ten minutes after the market opened, the lights were turned off and the telegraphs were turned on. Financial harm from the shoddy electrical engineering had been mitigated, but the engineers responsible for the London Stock Exchange's telegraph service worriedly wrote one another discussing the "urgent…matter of supplying reliable energy from some other source."[3] In order to let the London Stock Exchange keep its lights on and send telegraphs at the same time, power was eventually diverted from the British General Post Office's (GPO) Central Telegraph Office a few blocks away.[4] Electrical outages continue to plague stock exchanges, especially in an age of nearly universal electronic trading.[5] The outages today, just like the one that occurred in 1921, are a reminder that the act of exchange is always at the mercy of the infrastructures that underpin it.

Rather than focus on the act of exchange, this dissertation tells the history of the infrastructures that enabled exchange to happen in the first place. In doing so, it provides a different account about how finance capitalism emerged in its modern form and how it exerts power on the world around it. This dissertation begins with the question of mechanical operation: how were the underlying parts of the financial system that facilitated the practice of abstract economic exchange, actually assembled and made to work? Answering this question brings into view a different aspect of financial power than is typically considered. Instead of a story that focuses on the ways finance capital has dis-embedded, lifted-out, and abstracted the process of

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[1] Joan Robinson, *Contributions to Modern Economics,* (New York: Academic Press, 1978) 126.
[2] Bruno Latour, *Inquiry into Modes of Existence: An Anthropology of the Moderns*, (Cambridge, MA: Harvard University Press, 2013) 413.
[3] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Letter from John Lee to Superintending Engineer, October 20, 1921, File III, Post/30/1988B BT.
[4] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Report from Superintending Engineer, October 24, 1921, File III, Post/30/1988B BT.
[5] For a few examples see Annabel Smith, "Tokyo Stock Exchange Chief Resigns Due to Market Outage," *The Trade* December 1, 2020, https://www.thetradenews.com/tokyo-stock-exchange-chief-resigns-due-to-market-outage/; Huw Jones & Tom Westbrook, "London Stock Exchange's Refinitiv Restores Service After New Outage," *Reuters* June 23, 2021, https://www.reuters.com/technology/refinitiv-eikon-information-service-hit-by-outage-2021-06-23/.

exchange, this dissertation is a story about how finance has penetrated and co-opted aspects of our political, economic, and social structures so deeply as to become an indispensable, often invisible part of our everyday lives.[6] This is what the sociologist Michael Mann has called infrastructural power: power exercised *through* society, not over and above it.[7] Recent scholarship has increasingly shown how financial institutions have exercised this type of infrastructural power not only over individuals and societies but over states themselves.[8] Finance has been able to set the "rules of the game" in economic life, in large part thanks to its control of the underlying infrastructures that the act of exchange relies upon. These financial infrastructures span from the human services of professional financial intermediaries, the production and transmission economic information and data, and control over the physical networks through which that information travels. The story of finance's infrastructural power is inseparable from the story of the infrastructures of finance.

To tell the history of how finance came to wield infrastructural power and how the infrastructures of finance were first constructed, this dissertation focuses on the London Stock Exchange during the 19th century. In 1801, when the London Stock Exchange was re-constituted as a formal exchange and moved into new, purpose-built buildings, there were only 6 other formal stock exchanges in the whole world.[9] When WWI brought the first age of financial globalization to a close in 1914 there were over 89, 22 of which were in Britain alone.[10] These exchanges, along with the growing body of banks, insurance companies, and other financial institutions, were connected by a worldwide telecommunications network. Thanks to the

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[6] It would be far too cumbersome to list the books that subscribe to the narrative that financial and economic modernity involved the "lifting out" and "abstraction" of social relations. A few that share narrative assumption, even if they have wildly different political points, are: William Stanley Jevons, *Money and the Mechanism of Exchange,* (London: Kegan Paul, Trench, Trubner & Co. 1908); Karl Polanyi, *The Great Transformation: The Political and Economic Origins of Our Time*, (New York: Beacon Press, 2001); Niall Ferguson, *The Ascent of Money: The Financial History of the World* (New York: Penguin, 2008); Mary Poovey, *Genres of the Credit Economy: Mediating Value in Eighteenth and Nineteenth Century Britain*, (Chicago: University of Chicago Press, 2008); Jonathan Levy, *Freaks of Fortune: The Emerging World of Capitalism and Risk in America*, (Cambridge, MA: Harvard University Press, 2014). James Vernon, *Distant Strangers: How Britain Became Modern*, (Berkeley: University of California Press, 2014).

[7] Michael Mann, "The Autonomous Power of the State: Its Origins, Mechanisms, and Results," *European Journal of Sociology,* vol. 25. no. 2 (1984) 185-213.

[8] There is an important and growing literature that addressed this phenomenon. Most of it deals with fairly recent history or analysis of the present. For a few examples see: Gerald Davis, *Managed by the Markets: How Finance Re-Shaped America,* (New York: Oxford University Press, 2009); Daniela Gabor & Cornel Ban, "Banking on Bonds: The New Links Between States and Markets," *Journal of Common Market Studies* vol. 54 no. 3 (May 2016) 617-635; Daniela Gabor, "The (Impossible) Repo Trinity: The Political Economy of Repo Markets," *Review of International Political Economy,* vol. 23 no. 6 (November 2016) 967-1000; Sarah Quinn, *American Bonds: How Credit Markets Shaped a Nation,* (Princeton: Princeton University Press, 2019); Destin Jenkins, *The Bonds of Inequality: Debt and the Making of the American City*, (Chicago: University of Chicago Press, 2021); Benjamin Braun "Central Banking and the Infrastructural Power of Finance: the Case of ECB Support for Repo and Securitization Markets," *Socio-Economic Review* vol. 18 no. 2 (April 2020) 395-418; Daniela Gabor, "Critical Macro-Finance: A Theoretical Lens," *Finance and Society* vol. 6. no. 1 (May 2020) 45-55; Stephen Collier & Savannah Cox, "Governing Urban Resilience: Insurance and the Problematization of Climate Change," *Economy and Society* vol. 50 no.2 (April 2021) 275-296; Johannes Petry, "From National Marketplaces to Global Providers of Financial Infrastructures: Exchanges, Infrastructures and Structural Power in Global Finance," *New Political Economy* vol 26. No. 4. (July 2021) 574-597.

[9] See Anne Murphy, *The Origins of English Financial Markets: Investment and Speculation Before the South Sea Bubble,* (Cambridge: Cambridge University Press, 2009). The other financial markets operating by the opening of the 19th century were Amsterdam, Paris, New York, Philadelphia, Antwerp, and Bruges

[10] Henry Lowenfeld, *Investment: An Exact Science* (London: Financial Review of Reviews, 1906) 110-128.

telegraph, the ticker tape, and the telephone, financial information and finance capital itself were moving at ever greater speeds across ever greater distances.[11] The London Stock Exchange was the center of this global network. Between 1850 and 1914 the value of securities listed on the London Stock Exchange increased from £1.2 billion to £6 billion, which represented one quarter of the extant financial capital in the world. Over 1/3rd of all the world's negotiable financial instruments were traded on the London Stock Exchange's trading floor.[12] A telegram left the London Stock Exchange for Europe every second of the working day and New York every six seconds by the end of the century.[13] The London Stock Exchange's power in this period derived not just from its infrastructural capacities but also by the widening and deepening of the shareholding class in Britain. More and more excess capital from British savers was channeled into investments through the exchange's services.[14] British investors' savings, mobilized through institutions like the London Stock Exchange, in turn helped establish Britain's financial hegemony in the 19th century.[15] By 1914, Britain was the unrivalled global creditor of the world. Britain's capital exports totaled around £4 billion or 44% of the entire global total, 25% more than their closest rival, France.[16]

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[11] Simone Müller and Heidi Tworek "'The Telegraph and the Bank': On the Interdependence of Global Communications and Capitalism, 1866–1914." *Journal of Global History* vol. 10 no. 2 (2015) 259–283; Not only was "high" capital moving at greater speeds over greater distances, but innovations in postal transfers of money and the wire transfer allowed for migrants to increasingly remit smaller amounts of capital back home in significantly greater volumes than ever before as well. See Gary Magee and Andrew Thompson, *Empire and Globalisation: Networks of People, Goods, and Capital in the British World, 1850-1914,* (Cambridge: Cambridge University Press 2012).

[12] Ranald Michie, *The London Stock Exchange: A History,* (New York: Oxford University Press, 1999), 4-5; Youssef Cassis, *Capitals of Capital: A History of International Financial Centres 1780-2005,* (Cambridge: Cambridge University Press, 2006) 98.

[13] Vernon, *Distant Strangers,* 121.

[14] While an expansion of those involved in the stock market undoubtedly took place, there is still difficulty in exactly quantifying it. The first difficulty is differentiating the rise in small investors from the broader growth of the British population in this period. The second is counting "repeat" shareholders across companies in different sectors. However, the declining nominal share prices, increases in the amount of shares available, as well as increase of excess capital available in saving deposits, all indicate that this shift did take place on a statistically significant level. See Jannette Rutterford, David Green, Josephine Maltby, and Alastair Owens, "Who Comprised the Nation of Shareholders? Gender and investment in Great Britain, c. 1870–1935," *Economic History Review* 64 no. 1 (2011) 157-187; Janette Rutterford and Dimitris P. Sotiropoulos. "The Rise of the Small Investor in the United States and United Kingdom, 1895 to 1970." *Enterprise & Society* 18, no. 3 (2017): 485–535; John Turner "Wider Share Ownership?: Investors in English and Welsh Bank Shares in the Nineteenth Century," *Economic History Review*, 62, no.1 (2009), pp. 167–92. It is important to note that an empirical widening and deepening of the shareholder class did not yet constitute a "shareholder democracy," where full participation in the political life of the nation was equated with participation in financial markets. This is as much a cultural phenomenon as an economic one and does not occur until the 20th century. Julia Ott dates this transformation in America to war bond drives during WWI, Ott, *When Wall Street Met Main Street: The Quest for an Investors' Democracy*, (Cambridge, MA: Harvard University Press, 2011). Amy Edwards points to institutional reforms pushed by the City of London both before and during the Thatcher Era in the mid-20th century. Edwards, "'Financial Consumerism': Citizenship, Consumerism and Capital Ownership in the 1980s" *Contemporary British History* vol. 31 no. 2 (April 2017) 210-229; idem, "'Manufacturing Capitalists': The Wider Share Ownership Council and the Problem of 'Popular Capitalism', 1958–92" *Twentieth Century British History* vol. 27 no. 1 (March 2016) 100-123.

[15] The paradigmatic argument is P.J. Cain and A.G. Hopkins, *British Imperialism 1688-2000,* (New York: Pearson Education, 2002).

[16] Sidney Pollard, "Capital Exports 1870-1914: Harmful or Beneficial?" *Economic History Review* vol. 38 no. 4 (November 1985) 492.

The vast, world-wide financial network of financial markets that had been established by the end of 19th century was built, not born. Studying the history of this financial network as it was first being assembled allows us to excavate the power relations that bring complex social and technical systems into being before those systems are closed off and "black boxed."[17] In the case of financial markets this approach allows us to make two critical moves. The first is to see the how the development of the modern infrastructures of finance are, in many respects, the result of choices made in the relatively deep past of the 19th century. Constructing the first infrastructures that knitted the financial network together was chaotic, contingent, and often incoherent. But over time these small, contingent decisions cumulated into something larger. The seeming coherence and "efficiency" of markets that financial infrastructures provided were the product of power; of how certain financial institutions gradually gained political control over the operations and affordance of infrastructures. Put differently, the globally integrated and "efficient" financial system that had emerged by the early 20th century was a result of the power of financial actors who had managed to co-opt those infrastructures for themselves.

The second benefit to examining the origin of financial infrastructure is that it also allows us to see the persistence of agency throughout the financial system.[18] Power may have been unequally distributed within the financial system but that did not mean the smallest actors were power*less*. In fact, the opposite is true. In complex, distributed systems, technical details matter immensely. Something as small as attaching ceiling lights to the same electrical circuit as telegraphs could have devastating ripple effects throughout the rest of the network. The operation of these seemingly minor technical mechanics gave a host of different actors agency over how the financial system developed, most of whom had little to do with the act of exchange, the imperative of profitability, or the demand of market efficiency.

The Power and Agency of Financial Infrastructure

The power of Britain's financial sector during the 19th century is hardly a new topic. It has been hotly debated and much analyzed since the 19th century itself. But the primary framework that has been used to explain financial power is the degree to which it has been able to capture the state. This framework runs from J.A. Hobson's 1902 work, *Imperialism,* all the way to P.J. Cain and A.G. Hopkin's, 1993 book, *British Imperialism*.[19] Beginning sometime

[17] Bruno Latour, *Science in Action: How to Follow Scientists and Engineers Through Society,* (Cambridge, MA: Harvard University Press, 1987) 21.

[18] For a similar approach see Adam Tooze, *Crashed: How a Decade of Financial Crises Changed the World,* (New York: Penguin, 2018) especially 614.

[19] For a brief sketch of the historiographical genealogy of this debate and its continued reliance on the framework of state capture see: J.A. Hobson, *Imperialism: A Study* (London: James Nisbet & Co, 1902); John Gallagher and Ronald Robinson, "The Imperialism of Free Trade," *Economic History Review* vol. 6 no.1 (August 1953) 1-15; D.C. M. Platt, "The Imperialism of Free Trade: Some Reservations," *Economic History Review* vol. 21 no. 2 (August 1968) 296-306; idem, "Further Objections to an 'Imperialism of Free Trade,' 1830-1860," *Economic History Review* vol. 26 no. 1 (February 1973) 77-91; John Darwin, "Imperialism and the Victorians: The Dynamics of Territorial Expansion," *English Historical Review* vol. 112 no. 447 (June 1997) 614-642; Cain and Hopkins, *British Imperialism*. Contra Cain & Hopkins, Martin Daunton argues that the British state was able to maintain a balance between the interest of financial capitalists and industrial capitalists, yet he argued on the same general terrain of state capture that dominate the field. See Daunton, *State and Market in Victorian Britain: War, Welfare, and Capitalism,* (Rochester: Boydell, 2008). The same goes for the Marxist scholarship of Giovanni Arrighi, who views different cycles of financial accumulation as, in turn, synonymous with different types of financial power wielded by

during the 18th and early 19th century, the argument goes, the rise of capitalism made financiers the most powerful class in Britain and paternalistic politicians and aristocrats in the country gradually incorporated financiers into their social ranks, forging a ruling class of "gentlemanly capitalists." These gentlemanly capitalists ran the state and the British empire (both formal and informal) in the service of the financial sector. The preference the financial sector received could be easily deduced from such obvious imperial actions like the Opium Wars or the seizure of Egypt after its failure to pay its debts, or, less obviously, by measuring aggregate capital exports to countries in the "informal" empire against the gentlemanly capitalists expressed desires for new markets.[20]

Not only does this approach reduce the power of finance to the extent to which it could co-opt the state, but it also traffics in other tropes about how finance works. For one, the "gentlemanly capitalists" that populate these accounts are the usual suspects: the Rothschilds, the Cassels, and the Barings whom one scholar termed the "Sixth Great Power" of the world.[21] The evidence that is marshalled to prove the power of these gentlemanly financiers is usually quantitative aggregations measuring the flow of global capital. [22] The individual agency of great men is juxtaposed awkwardly against the function of seemingly efficient market flows.[23] We should not throw the baby out with the bathwater when it comes to these older approaches of financial history. The Barings and Rothschilds *were* powerful players in global finance, investment in the British Empire *was* undertaken on behalf of the financial sector rather than for development as such. But we should recognize how this approach, by reducing financial power to the interests of a small class measured through abstract forms of quantified evidence, does not actually give us a capacious *enough* understanding of the full range of methods by which financial power reshaped the world.

An infrastructural history of finance gives us a very different view of both financial power and agency. This dissertation is not a history of the great men of finance. Neither is it a macroeconomic history about the global flow of capital nor an econometric study of historical asset pricing. In this dissertation the great men of finance are replaced with a growing phalanx of lower class service workers whose menial labor was the critical connective tissue of the global financial network: the messenger boys who ran orders between brokers and bankers, the waiters

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hegemonic states, like Britain and subsequently America. Giovanni Arrighi *The Long Twentieth Century: Money, Power, and the Origins of Our Times,* (New York: Verso, 1994).

[20] Recent work has greatly deepened our understanding of the ways financial power was exerted in the "informal," empire, especially how conceptions of race and gender, often over and above financial concerns, were paramount. See Peter Hudson, *Bankers and Empire: How Wall Street Colonized the Caribbean,* (Chicago: University of Chicago Press, 2017); Deborah Cohen, "Love and Money in the Informal Empire: The British in Argentine, 1830-1930," *Past and Present* vol. 245 no. 1 (December 2019) 79-115; Quinn Slobodian "World Maps for the Debt Paradigm: Risk Ranking the Poorer Nations in the 1970s," *Critical Historical Studies* vol. 8 no. 1 (Spring 2021) 1-22.

[21] The phrase is from Philip Ziegler, *The Sixth Great Power: A History of One of the Greatest of All Banking Families: The House of Barings, 1762-1929,* (New York: Alfred Knopf, 1988). For a similar approach see Niall Ferguson, *The World's Banker: A History of the House of Rothschild,* (London: Weidenfeld and Nicolson, 2000).

[22] In addition to quantitative evidence at the heart of Hobson and Cain & Hopkins' accounts, see also Ferguson & Moritz Schularick, "The Empire Effect: The Determinants of Country Risk in the First Age of Globalization," *The Journal of Economic History* vol 66. No. 2 (June 2006) 283-312; Ferguson, "Political Risk and the International Bond Market Between the 1848 Revolution and the Outbreak of the First World War," *Economic History Review* vol. 59 no. 1 (2006) 70-112.

[23] Mary Poovey, "Stories We Tell About Liberal Markets: The Efficient Market Hypothesis and Great-Men Histories of Change," in eds. Simon Gunn and James Vernon, *The Peculiarities of Liberal Modernity in Imperial Britain,* (Berkeley: University of California Press, 2011) 199-212.

and porters who opened doors into and out of stock exchanges, the wives and daughters of these men who cleaned financial institutions, cooked meals for financiers, and managed cloakrooms, and of course the clerks who actually processed the deluge of paperwork the new financial system generated. Instead of analyzing the movement of asset prices this dissertation examines the struggle that financial institutions, clerks, journalists, statisticians, and economists faced to produce reliable forms and flows of economic data in the first place. Focus on the global flow of capital is replaced with a focus on the material infrastructure through which that capital travelled: the technically fragile and geopolitically fraught laying of telegraph, ticker tape, and telephone lines alongside the immense bureaucratic and engineering power that went into maintaining these communicative arteries of the financial system. The production of financial data, the communications systems through which that data was transmitted, and the human laborers who operated and maintained these systems, were the key infrastructures that enabled the process of financial globalization and the exercise of financial power.

One of this dissertation's key arguments is that the market-structure of the London Stock Exchange—independent of the imperial state apparatus—was a critical locus of finance's infrastructural power over the 19th century world. In most discussions of both present and past financial capitalism, equity markets and stock exchanges are typically assumed to be substantially less powerful than the banking sector.[24] This is, in part, why so many arguments about state capture and the power of finance have specifically focused on the integration of banking families into the cadre of imperial managers. Banking was undoubtedly crucial for pooling and mobilizing capital in the 19th century, but stock exchanges had infrastructural power over how and where that capital was directed. The technical details of how exchanges facilitated the flow of capital mattered.

The London Stock Exchange had pride of place among global stock exchanges from 1801 to 1914. It was the major infrastructural chokepoint for any organization—private or public, state or corporation— that needed access to financing. Whether or not the London Stock Exchange decided to "officially quote" a certain security, thereby allowing it to be traded and publicly invested in, was a matter of enormous consequence. For instance, in 1875 the state of Louisiana consolidated its state debt, issuing new bonds at a lower interest rate while writing off 40% of the previous principal.[25] Bondholders were incensed. They demanded that their original bonds be paid before the state could access capital markets to fund a new debt issuance. The Louisiana Committee of the Corporation of Foreign Bondholders wrote to every major stock exchange in Britain and Europe urging them to deny Louisiana an official quotation on their exchanges.[26] In October of 1876 the bondholders won a critical victory when the London Stock Exchange took "the view that Louisiana should be made to suffer for her arbitrary action towards the bond holders (and) refused to grant a quotation."[27] Exchanges were thus a key tool for bondholders to exercise punitive oversight over debtor countries.[28] This oversight and power was

[24] Cassis, *Capitals of Capital*, 83; Randall Morck, Andrei Shleifer, Robert Vishny, "The Stock Market and Investment: Is the Market a Sideshow?" *Brookings Papers on Economic Activity* no. 2 (1990) 157-215. A notable exception is Petry, "From National Marketplaces to Global Providers of Financial Infrastructures."

[25] Corporation of Foreign Bondholders, Minute Book for the Committee of Holders of Louisiana State Bonds, 251, MS/15792 LMA.

[26] Corporation of Foreign Bondholders, Louisiana Pressed Copy Book: Out Letters, 3-33, MS/15793/001 LMA.

[27] Ibid. 243.

[28] So as not to overstate the power of exchanges it is important to note that foreign loans were primarily managed by large merchant banks who underwrote loans and brought them to the public market. Exchanges were the mechanism through which bondholders and bankers could punish debtor countries either by increasing the costs of funding

geopolitical as much as economic. Exchanges jockeyed with one another to list and trade the loans of different client states at the expense of their imperial rivals.[29]

The power of exchanges as an infrastructural chokepoint for accessing capital was also crucial to the operation of what Mira Wilkins has termed "free-standing" corporations, or corporations with sprawling, trans-national operations that were headquartered in a particular financial capital but did not actually operate there.[30] These corporations were primarily engaged in either highly extractive industries, like De Beers or Rio Tinto in mining, or in building various physical infrastructures, like railway or utility companies. Whereas London, Paris, and Berlin all regularly competed for the sovereign loans of other states, the London Stock Exchange was the singularly dominant exchange for the trading of free-standing corporations' equity and debt. Free-standing corporations were capital intensive and so access to both the deep, liquid markets of the London Stock Exchange and proximity to other financial services in London were mutually reinforcing and created network effects. The profits of these free-standing companies were never captured by state or imperial tax or regulatory regimes but passed back to shareholders and boards of directors in London.[31] Once again, access to the London Stock Exchange's markets was so vital that any change in the way a security was traded or regulated was hugely consequential.

Lastly, exchanges were critical to the management of money and currency markets during the age of the gold standard. The Bank of England's principal mechanism for managing the flow of gold in and out of the country and maintaining the pound sterling's convertibility to gold was by raising or lowering its interest rate. Yet, in an important example of how infrastructural power superseded economic theory, in order for interest rate adjustments to actually "stick"— to have their desired effect— the Bank of England had to either contract or expand the credit available in the short-term money-market. The liquid markets of the London Stock Exchange, which were deeply integrated with short term money-markets, were "instrumental" to the Bank of England's stable management of the gold-standard in the second half of the 19th century.[32] As Ranald Michie has argued:

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through market operations or denying them access to markets altogether. For a good discussion see Youssef Cassis and Philip Cottrell, *Private Banking in Europe: Rise, Retreat, and Resurgence*, (New York: Oxford University Press, 2015). See also Marc Flandreau & Juan Flores, "Bonds and Brands: Foundations of Sovereign Debt Markets," *The Journal of Economic History*, vol. 69. no. 3 (September 2009) 646-684. While Flandreau and Flores provide a helpful empirical case study of the ways private banks monitored and disciplined debtor countries they do not acknowledge that their central argument is entirely derived from Hyde Clarke, "On the Debts of Sovereign and Quasi-Sovereign States, Owing by Foreign Countries," *Journal of the Statistical Society of London,* vol. 41. no.2 (June 1878) 305.

[29] A good summary of this process is found in Cassis, *Capitals of Capital,* 134. An illustrative case study is Adam Tooze and Martin Ivanov, "Disciplining the 'Black Sheep of the Balkans': Financial Supervision and Sovereignty in Bulgaria, 1902-1938," *Economic History Review* vol. 64 no.1 (February 2011) 30-51.

[30] Mira Wilkins, "The Free-Standing Company 1870-1914: An Important Type of British Foreign Direct Investment," *Economic History Review* vol. 41 no. 2 (May 1988) 259-282. See also Cassis, *Capitals of Capital,* 80-81.

[31] The two best examples of this are Richard White, *Railroaded: The Transcontinentals and the Making of Modern America*, (New York: W.W. Norton, 2011) and A.G. Hopkins, *American Empire: A Global History*, (Princeton: Princeton University Press, 2018). For another example see D.K. Fieldhouse, *Unilever Overseas: the Anatomy of a Multinational 1895-1965*, (Stanford: Hoover Institution Press, 1978).

[32] For the integration of money markets and the London Stock Exchange see Richard Sidney Sayers, *Bank of England Operations, 1890-1914*, (London: P.S. King & Son, 1936) 35-43. A more detailed empirical case study of this is found in Andrew Odlyzko, "Financialization of the Early Victorian Economy and the London Stock Exchange" (May 2016). https://ssrn.com/abstract=2787154.

> the liquidity given to the monetary system by the ability to employ and release funds, virtually at will, through the mechanism of the Stock Exchange…rather than any development of central bank policy by the Bank of England or the developments in a national banking system…was the crucial force at work.[33]

Financial power was unequally distributed. Argentina, for instance, was an export dependent economy. The country's balance of payments was determined by prices paid for exports goods in other countries, like Britain. But Britain's financial ability to manage the gold standard enabled it to set the prices it paid with far more power than Argentina. Argentina's economic weakness was further amplified by an "anarchic" banking sector without a coordinating central bank that could manage money markets.[34] These two factors led to Argentina falling off the gold-standard in 1885. Removed from the gold standard and without a central bank, speculators on both the Buenos Aires and London stock exchanges had far more power to manipulate the prices of Argentinian sovereign debt, which was denominated in paper currency that was no longer backed by gold. This in turn increased costs on the Argentinian government to service that debt, which in turn drove up taxes. As one report on the state of the Argentinian financial sector argued, "all the social mechanism is altered from the national or provincial budget to the smallest income or poorest salary," by speculators "who, on their own account or for others, operate on the stock exchanges which are private associations."[35] In Britain, the London Stock Exchange was a tool that facilitated global financial domination and an ease of operations in money markets. In countries on the financial periphery, stock exchanges could be mechanisms of radical economic destabilization.

All of the above macroeconomic structures—countries and corporations' ability to access financing, alongside the maintenance of the gold standard—were themselves dependent on the market structure of exchanges, and the market structure of the London Stock Exchange in particular. The integration of the London Stock Exchange with short-term money-markets was made possible because of the unique nature of the exchange's jobbers. "Jobbers" were exclusive "market makers" of the London Stock Exchange while stock *brokers* were "market takers." That is, jobbers would stand on the floor of the exchange all day and make prices for securities while brokers would enter the exchange and fill orders for clients by entering into a deal with a jobber. Jobbers derived their profits from the "spread," or the difference between the current price at which a security was bought and that at which it was sold, while brokers derived theirs from commission on each deal they booked. Separating out the market taking function of brokers from the market making function of jobbers was a unique feature of the London Stock Exchange. The specialized function of the jobber was critical for providing ready liquidity across different classes of securities.[36] But it also meant that jobbers had to be prepared to buy or sell an

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[33] Michie, *London Stock Exchange*, 136. Michie is not alone in his assessment. "The unique technical position of London provides much of the explanation of the efficacy of the bank rate in speedily staunching gold losses before 1914." A.G. Ford, "The Working of the Gold Standard Before 1914," *Oxford Economic Papers* vol. 12 no. 1. (1960) 56.

[34] Ford, "The Working of the Gold Standard Before 1914," 62.

[35] *Report on the Finances of the Argentine Republic and on the Effect of Certain Decrees Regulating Stock Exchange Operations*, Foreign Office, Diplomatic and Consular Reports on Trade and Finance, Parliamentary Papers. (June 1889) 5.

[36] Imagine an alternative world without jobbers where Broker X had 100 shares of a certain security to sell. Broker X would wander around a stock exchange along with thousands of other brokers and would have to find Broker Y

unpredictable volume of securities on a daily basis, which made them heavily reliant on short term loans from the joint-stock and merchant banks on Lombard Street to fund their daily positions in the market. The connection between jobbers and the banks of Lombard Street effectively funneled the savings of individuals into the London Stock Exchange, creating the early equivalent of the modern "money market account."

The separation of the market taker and market maker duties created a distinctive culture on the London Stock Exchange. The prices a jobber gave a broker were not just a function of economic interest and "market" mechanisms but were determined through a complicated set of social assessments that brokers and jobbers made about each other. Brokers and jobbers knew the reputations of the firms they dealt with. Brokers tended to prefer jobbing firms with larger capital reserves who they believed were of a "more responsible character."[37] Jobbers, on the other hand, were wary about making prices for any transaction that they suspected was "speculative" in nature for a broker who may not be able to deliver either the security or payment as promised.[38] Jobbers could compete against one another to make a better price for a broker or alternatively they could collude to force a bad price on a broker.[39] Risk assessment was a social process that always shaped the market mechanisms of the London Stock Exchange.

Jobbers and brokers were not alone on the trading floor. As Chapter 1, "Human Infrastructures," shows, the power of the gentlemanly capitalists and high financiers of the London Stock Exchange was always circumscribed by their reliance on lower-class service workers to help them execute the act of exchange. These groups of workers, from the young clerks who settled accounts and checked bargains, to the messenger boys who ran orders in and out of the exchange, to the telegraphists and engineers responsible for maintaining the information systems that transmitted these messages, have all recently be re-centered in the history of finance capitalism.[40] The most important human infrastructure of 19th century London Stock Exchange was the exchange's waiters and their families. Waiters were the communicative links between the financiers of London Stock Exchange and those outside of it. The waiters delivered letters and telegrams. They called financiers into and out of the stock exchange as they were needed. They imposed order on the cacophonous trading floor by removing any outsiders and enforcing rules about where financiers could congregate and talk. The wives and daughters of the waiters were conscripted to clean the exchange, cook meals for financiers, and manage the exchange's cloak room.

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who wanted to buy the exact quantity of shares Broker X was selling. Provincial Exchanges solved this problem by "calling the list" twice a day. All the members of the exchange would gather together and a secretary would read out every security on the price list. If someone wanted to deal in a particular security they would speak up when it was read and engage in business with anyone else who did the same. This was a cumbersome, time consuming process that only happened at certain intervals throughout the day, as opposed to the continuous dealing in all classes of security that happened at the London Stock Exchange thanks to the liquidity provision of jobbers. For a description of the different market structure in the provinces see W.A. Thomas, *The Provincial Stock Exchanges,* (London: Frank Cass, 1973).

[37] *Royal Commission on Origin, Objects, and Constitution of the London Stock Exchange,* Parliamentary Papers, (1878), 44-45.

[38] Ibid.

[39] Bernard Attard, "The Jobbing System of the London Stock Exchange: An Oral History. Interview No. 6: Anthony Jenkins." London: Institute of Historical Research, (1990).

[40] Michael Zakim, *Accounting for Capitalism: The World the Clerk Made,* (Chicago: University of Chicago Press, 2018); *Serving a Wired World: London's Telecommunications Workers and the Making of an Information Capital*, (Berkeley: University of California Press, 2020); Juan Pablo Pardo-Guerra, *Automating Finance: Infrastructures, Engineers, and the Making of Electronic Markets,* (Cambridge: Cambridge University Press, 2019).

While the tasks of the waiters and their families were menial, they were also critical to the basic functioning of the London Stock Exchange. A message delivered too late could be the difference between a profit and a loss for a broker on the exchange. The gentlemanly capitalists of the exchange realized the extent to which their own economic fates were ultimately in the hands of lower-class men who were not concerned with the logics of exchange. Thus, the managers of the London Stock Exchange constantly attempted to discipline and organize the waiters into a subservient workforce. But the waiters knew their own centrality to the operations of the exchange. As often as the financiers of the London Stock Exchange attempted to control and discipline the waiters, the waiters found ways to resist the managerial impulses of upper-class stockbrokers by using the power of the financial infrastructures they controlled.

Information is the second crucial financial infrastructure this dissertation explores. Financial information was never a neutral referent to an existing economic reality. The form information took shaped the ways it was able to be used and interpreted and thus the production of financial information was always subjected to contentious political struggle as different social groups attempted to create information that served their own purposes.[41] As the Corporation of Foreign Bondholders campaign against the state of Louisiana in stock exchanges throughout Europe demonstrated, the decision to list a country or corporation's security was an almost nakedly political decision.[42] But "politics" should be considered in a much broader framework than the geopolitical jockeying between bondholders and states. Mundane concerns like how many listings could fit on a piece of paper, the exigency of printing price lists in time for the publication of the evening news, and the ease of marking certain types of prices but not others, influenced the production of financial information.

Moreover, much in the same way the waiters leveraged their roles as conduits of information to gain monetary and social advantages in the exchange, the clerks who assembled the stock price lists, which informed the investment decisions of countless people both inside and outside the stock exchange, wielded an enormous amount of political power about how "accurate" market prices were determined and circulated. Stock exchanges, financial journalists, economists, and ordinary investors all tried to reform and standardize the practices of these clerks but were opposed by a surprising adversary: the brokers and jobbers who believed that they could leverage their personal relation with the clerks who assembled the price lists into a financial advantage. By the end of the 19th century, the pricing data the London Stock Exchange produced was bifurcated between relatively static, aggregate numbers data that were transmitted to the press, investors, and economists, and more timely, specific numbers that were circulated

[41] Here I am building on a large literature in the history of quantification that has made this point across a variety of quantified genres. For the best account of the contentious political production of economic numbers see Adam Tooze, *Statistics and the German State, 1900-1945: The Making of Modern Economic Knowledge*, (Cambridge: Cambridge University Press, 2001); William Deringer, *Calculated Values: Finance, Politics, and the Quantitative Age*, (Cambridge, MA: Harvard University Press, 2018); Caitlin Rosenthal, *Accounting for Slavery: Mastery and Management*, (Cambridge, MA: Harvard University Press, 2018). For broader surveys see Ian Hacking, *The Taming of Chance*, (New York, 1999); Theodore Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*, (Princeton: Princeton University Press, 1995); Alain Desrosières, trans. Camille Nash, *The Politics of Large Numbers: A History of Statistical Reasoning*, (Cambridge, MA: Harvard University Press, 2002).

[42] In this regard the function of nineteenth century exchanges is somewhat comparable to the power of modern day financial indexers. Unsurprisingly, the London Stock Exchange still manages the largest index in Europe, the Russell FTSE. See Johannes Petry, Jan Fichtner, and Eelke Heemskerk, "Steering Capital: The Growing Private Authority of Index Providers in the Age of Passive Asset Management," *Review of International Political Economy* vol. 28. no. 1 (January 2021) 152-176.

privately among financiers and were unusable to the vast majority of investors in Britain and the world.

Part of the struggle in creating accurate and timely financial data was how it was transmitted. Chapter 3, "Material Infrastructures," examines the struggle to build and ultimately control the telecommunication technology and infrastructure that was introduced to financial markets during the 19th century. Because of the high volume of messages that were sent by stockbrokers, exchanges themselves (both in London and elsewhere) were able to capture and co-opt the construction of public and private telegraphic networks alike. A similar struggle erupted with the introduction of the ticker tape in the early 1870s. Ticker tape companies benefitted from transmitting pricing information as widely as possible to as many customers as they could, but this limited the London Stock Exchange's ability to police what information got out and to whom. During the 1880s and 1890s, the London Stock Exchange weaponized its control over pricing information to control who the Exchange Telegraph Company (Extel), the premier ticker tape company in Britain, could sell ticker tape services to. Working together, the London Stock Exchange and Extel used the physical infrastructures of transmission to limit rather than expand who received pricing information. The material infrastructures through which financial information moved and upon which financial actors relied, constantly enabled and constrained certain forms of economic activity and behavior.[43]

The last of the great telecommunications innovations of the 19th century—the telephone—was the most threatening to financial markets. The telephone's decentralized system allowed brokers and financiers to exchange pricing information and do deals with many who were not officially members of the exchange, and the London Stock Exchange had no recourse to police them. The London Stock Exchange responded by introducing telephonic communications to the floor of the exchange and selling access to the highest bidder. What was more, the exchange once again successfully engaged in a political lobbying effort directed at the GPO to provide preferred telephonic services to the London Stock Exchange and its members at the expense of the public. The material infrastructures of the emergent telecommunications system had been captured by stock exchanges and their most important firms.

The final chapter of this dissertation shows how all of these different infrastructures came to bear on the emergence and practice of arbitrage trading between the 1870s and the early 1900s. Arbitrage trading is the central mechanism by which equilibrium is maintained within markets. An arbitrageur exploits a pricing discrepancy between the same security listed in different markets until that discrepancy is gone and the price in both markets reaches an equilibrium. But arbitrage trading was not a natural phenomenon of iron economic laws. Instead, it was the product of financial infrastructures. Arbitrage traders in London relied on the material infrastructures of the telecommunications systems that connected them to other exchanges around the world. Arbitrageurs also needed specially trained clerks and messenger boys to pull off time-sensitive, complicated transactions. To be able to perform the calculations necessary for an arbitrage transaction, arbitrageurs also heavily relied on access to standardized and reliable pricing data. For much of the 19th century, these infrastructures were captured by the largest and

[43] For work that has explored the agency of material things and how they shape political subjectivity and enable political governance see Patrick Joyce, *The Rule of Freedom: Liberalism and the Modern City,* (New York: Verso, 2003); Christopher Otter, *Victorian Eye: A Political History of Light and Vision in Britain 1800-1900,* (Chicago: University of Chicago Press, 2008) Chandra Mukerji, *Impossible Engineering: Technology and Territoriality on the Canal du Midi* (Princeton: Princeton University Press, 2009). For work specifically on the material constraints within financial markets see Donald Mackenzie, *Material Markets: How Economic Agents are Constructed,* (New York: Oxford University Press, 2008).

wealthiest firms, and by the largest markets, especially the London Stock Exchange. The equilibrium and integration of global markets that was produced by the early 20th century was the product of actions undertaken by these large firms and exchanges.

Arbitrage, in both economic and political practice, was never frictionless. In 1908 a massive regulatory fight broke out between different factions of the London Stock Exchange that brought the issue of arbitrage trading and the infrastructures that facilitated it to the fore. Smaller firms and stock exchanges joined together to limit the power the London Stock Exchange and its large firms exercised over both arbitrage trading and financial infrastructure. Small firms seized power in the managing committees of the London Stock Exchange and passed restrictive regulations that limited the ability of London's arbitrageurs to operate. The smaller exchanges in Britain's provinces likewise formed a collective organization to protect their business against predatory arbitrageurs in London. The battle for control over financial infrastructure within the London Stock Exchange had repercussive effects throughout the operations of the global financial system.

Conclusion

In the past few years, various historiographical schools and turns have returned to the history of capitalism, the history of economics, and the history of economic life with a new vigor. While this work has deeply enriched our understanding of the economic life and practices of the past, it has too often been limited by the claims it has attempted to make on the present. This work can be loosely separated into two schools. The first school is what we might term the "historicist," "contextualist" or "Polanyian" school thanks to its dependence on the early 20th century theorist Karl Polanyi.[44] This school primarily seeks to "*de-naturalize* capitalism, to provide the history of a system that the dominant culture depicts as timeless and irresistible, even in the midst of crisis."[45] The work of denaturalization is achieved through contextualization. By anchoring the actors and action of the past not within a "timeless" market framework of profit-maximizing capitalism, but within far different social, cultural, political, and economic structures that predominated in different times and in different places, the contextualist approach restores agency, contingency and difference into our contemporary consciousness. But in doing so it also, ironically, runs the risk of actually leaving the economic structures it wishes to denaturalize uninterrogated. As Melinda Cooper and Martijn Konings have argued, the contextualist school has "not so much rethought the character of economy but instead circumscribed its relevance by pointing to the importance of externally conceived social, political, and cultural factors."[46] Rather than an internal, critical examination of the operations of capitalism, economics, and finance, we get Polanyian "re-embedding" of the economic into its social and historical contexts.

What we might term the "post-structural" school takes its cues from deconstructive theory rather than Polanyi. Instead of historicizing and contextualizing capitalism and economic life, they begin with the modern of abstractions of the economy and deconstruct their seeming coherence. Once economic and financial abstractions are deconstructed and proved to be nothing

[44] I avoid the. label "New History of Capitalism," here because of its association primarily with American history and I am talking about a more capacious historiographical approach.
[45] Seth Rockman, "What Makes the History of Capitalism Newsworthy?" *Journal of the Early Republic* vol. 34 no. 3 (Fall 2014) 446.
[46] Melinda Cooper and Martijn Konings, "Contingency and Foundation: Rethinking Money, Debt, and Finance after the Crisis," *South Atlantic Quarterly*, vol. 114 no. 2 (April 2015) 241.

more than discursive fictions cobbled together by the operations of power, the second move of the post-structural school is to show how these flawed abstractions and imaginaries misrepresented the "real" economy on the ground, often with devastating effects. Essentially, the post-structuralist approach is a representational one. The critical analytical move is rooted in the hermeneutics of suspicion: that what is natural and taken for granted is actually a tool of power. Once the role of power in "fixing" this abstraction as part of the natural order of things is exposed, we (theoretically) have a new critical purchase through which to rethink and resist the logics of modern capitalist abstraction.[47]

The two schools share much in common. Both are concerned with denaturalizing the shibboleths and assumptions of our modern economic life. One does so by emphasizing the difference of the past, the other does so by demonstrating the incoherence of our present models of making sense of the "economic." But both ultimately struggle to make claims on the present. As Adam Tooze has recently argued:

> Having established (that) "the economy" is a historically constructed thing, it is time to appreciate the full force of history. In the twenty-first century "the economy" is changing before our very eyes. If our purpose is critical, the challenge is not to repeatedly assail a mid-twentieth-century power complex, the challenge is to find some purchase on a reality that is changing with dramatic speed beneath our feet. [48]

Once the abstractions and naturalness of capitalism, finance, and the economy are de-naturalized and understood to be products of historical context and discursive constructions, what next?

An infrastructural history of finance can help bring both of these schools together while also giving us sharper critical tools for addressing the current political and economic conjuncture. A history of the infrastructures of finance foregrounds the technical, messy, contingent and historically distinct processes by which the financial system was first assembled. In doing so it restores agency to our analysis of finance which can so often evacuate agency in exchange for abstraction. At the same time, this approach also underscores the path-dependent nature of financial power. The creation of financial infrastructure may have been a contingent process involving political struggle, but the victories of certain social groups and institutions within these struggles, and the creation of particular forms of financial infrastructure, had long lasting effects which continue to condition the ways financial power operates in the world.

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[47] Perhaps the two most paradigmatic examples of this type of analysis are Timothy Mitchell, *Rule of Experts: Egypt, Techno-Politics, Modernity*, (Berkeley: University of California Press, 2002); Arjun Appadurai *Banking on Words: The Failure of Language in the Age of Derivative Finance* (Chicago: University of Chicago Press, 2015).
[48] Tooze, "Making and Unmaking The Economy," https://adamtooze.com/2018/07/01/notes-on-social-theory-making-and-unmaking-the-economy-pilling-and-mazzucato-reviewed/.

Chapter 1:

Human Infrastructures: The Waiters of the London Stock Exchange

Introduction

On August 30, 1844 the managers of the London Stock Exchange convened an emergency meeting. The Railway Mania was in its early stages, but the meeting had nothing to do with the buying and selling of financial securities. The meeting was called to hear testimony "seriously affecting the character" of Daniel Maynard, one of the stock exchange's waiters—the London Stock Exchange's term for a porter. Rumors had been circulating among the other waiters, local policemen, and nearby street vendors that Maynard's newborn grandchild was the product of an incestuous relationship between him and his daughter, Sarah. Over the next two months the London Stock Exchange launched a laborious investigation into the personal life of Maynard and his family. Testimony was heard from Maynard, his wife, and his daughter, along with their family doctor, a local vestryman, and numerous stock exchange co-workers. A search was launched for Richard Williams, the man Maynard alleged was the real father of his grandchild but who, he claimed, had fled before marrying Sarah. Eventually Maynard was exonerated when multiple witnesses confirmed that Sarah had indeed been made the "dupe" of the "designing" Williams.

Maynard's vindication came at a high price. During the course of the investigation, it came out that both Maynard's daughter and wife had been seen "romping with men in their apartments," which, as a live-in servant of the stock exchange, were on the premises of the London Stock Exchange itself. It was further exposed that Maynard's wife was often not in her "right mind," and verbally abused Maynard. In an attempt to re-assert his personal moral probity, Maynard remanded his daughter to a workhouse. But the managers of the London Stock Exchange insisted on a more grievous punishment. They evicted Maynard's family from their apartments in the stock exchange and "severely reprimanded" him for the "very disorderly manner in which he had permitted his wife and daughter to conduct themselves." The managers also appointed the London Stock Exchange's very first night-watchman, presumably to prevent anymore strange men from "romping" in the exchange.[1]

In the middle of the largest speculative bubble in Victorian financial history, why did the managers of the London Stock Exchange devote so much time and effort to an investigation of the personal life of one of their lowest ranking servants? Until now, the waiters' lower-class status and the menial tasks they were charged with has led to their invisibility in the history of finance. The standard history of the London Stock Exchange does not mention them a single time.[2] The only work that mentions them does so simply to dismiss the scandal surrounding Maynard as a distraction from the "serious business of the City."[3] But if one actually bothers to look, the answer to the question is relatively straightforward. The managers of the London Stock Exchange expended so much energy on investigating Maynard because the waiters and their

[1] These two paragraphs are drawn from London Stock Exchange, Trustees and Managers Minutes, 1842-1852, 70-75; 77-84. MS/19297/6 GL.
[2] Ranald Michie, *The London Stock Exchange: A History,* (New York: Oxford University Press, 1999).
[3] David Kynaston *The City of London: A World of Its Own 1815-1890,* (London: Chatto & Windus, 1994) 132-134.

families were the critical operational backbone upon which all of financial action of the exchange depended. The waiters were the human infrastructure of 19th century finance.

The jobs the waiters did may have been menial, but that does not diminish their importance. Throughout the 19th century and well into the 20th century, the waiters of the London Stock Exchange policed who had access to the trading floor and were also responsible for the flow of financial information, whether that was delivering letters and telegrams to stockbrokers or alerting financiers that they had a waiting telephone call. The flow of bodies and information into and within the London Stock Exchange were controlled by the waiters. The waiters importance extended beyond their professional duties. For most of the 19th century, the majority of the London Stock Exchange's waiters were live-in servants. Their wives and daughters were conscripted into the exchange's labor force. Women cooked meals for the stock exchanges managers, cleaned the exchange after hours, and managed the cloak room where thousands of financiers left their umbrellas and coats every day. The operational infrastructures of the London Stock Exchange rested on the gendered labor of the families who worked and lived in the exchange as domestic servants.

The fact that the London Stock Exchange relied on lower class service workers to perform these key tasks was a significant source of anxiety to upper-class stockbrokers and financiers, as well as an object of intense governmental and disciplinary scrutiny for the managers of the exchange. The necessity of women's work on the stock exchange added another level of cultural anxiety to the worries of the exchange's managers. As we have already seen in the scandal surrounding Maynard, while the London Stock Exchange relied on women to perform key tasks, their presence on the exchange threatened the homosocial, gentlemanly capitalist culture that predominated. Over the course of the 19th century, those in charge of the London Stock Exchange constantly pushed to turn their informal labor force of domestic servants into a professionalized and regulated staff, to make human agency technical, in order to alleviate these anxieties and ensure that the market operated with regularity and integrity.[4] Not only did they largely fail, but in fact, many stockbrokers actively worked to *maintain* the personal and affective relations between stock exchange laborers and financiers. Brokers attempted to cultivate highly personal relationships with the waiters, often built on bribes and gratuities, or sometimes merely just respect, in order to receive preferential treatment in the delivery of messages or timely access to the trading floor.

Rather than an emergent bureaucratic apparatus, the operation of the London Stock Exchange resembled more closely that of a Victorian country house. Waiters were not the financial counterparts to civil servants, but domestic servants. And it was precisely this master/servant relationship that enabled financial laborers to leverage their positions on the Stock Exchange floor into increased economic and cultural gains. Katie Hindmarch-Watson has recently called for histories of 19th century Britain and its liberal forms to re-orient itself to questions around the "centrality of service industries…professional, financial, bodily, and information." "What of the workers who produced the conditions of respectability, who enabled the self-cultivated, rationalized perspective and movement of other social actors," she asks? As we will see, rather than the logic of capital or the actions of great men of finance, the operations of the world's largest financial market very often hinged on how lower class financial laborers

[4] This is drawn from Patrick Joyce's observations about the governmental impulse of liberalism writ-large during the 19th century. Joyce, *The State of Freedom: A Social History of the British State since 1800,* (New York: Cambridge University Press, 2013) 83.

managed the "flow of social capital," between themselves, financiers, and the market.[5] Financial laborers' ability to navigate intimacies with their social betters, to exercise discretion or disclosure, to resist or submit to social pressures, profoundly shaped the emergence of modern financial markets.

Managing and Paying the Waiters

When the London Stock Exchange was reconstituted in 1801 as a new legal and physical entity, it also needed a new labor force. The first waiters were hired in the winter of 1801-1802 yet they were completely unacknowledged in the formal rules and procedures drawn up by the London Stock Exchange's managing committee. Numerous rules and regulations were put in place to manage financial deals and the actions of stockbrokers and jobbers, but no mention was made of the other sources of labor that went into making the stock exchange run. The lack of formal regulation or even recognition within the founding documents of the stock exchange was probably because the waiters themselves were carry overs from the stock exchange's previous location at Jonathan's Coffee House.[6] Indeed, like they had at the coffee house during the 18th century, the stock exchange's waiters continued to wait at taverns or private parties after business hours throughout the 19th century and had to be constantly warned against such behavior.[7] The informal grafting of the stock exchange onto the coffee house in the 18th century was reversed, at least when it came to the labor force, when the stock exchange re-constituted itself in the 19th century.

As the London Stock Exchange expanded and more waiters were needed for its operation, the exchange increasingly began to resemble the system of domestic servitude in early Victorian Britain.[8] In many respects the London Stock Exchange ran like a country house and the exchange's familial nickname, "the House," was particularly apt.[9] In strictly empirical respects, the labor forces between domestic servants and the servants of the stock exchange overlapped, as many waiters and clerks were frequently appointed from the households of the stock exchange managers or their friends.[10] The privacy of the house was also closely guarded. Disputes among

[5] Hindmarch-Watson, "Sex, Services, and Surveillance: The Cleveland Street Scandal Revisited," *History Compass,* vol. 14 no. 6 (2016) 287.
[6] Charles Duguid, *The Story of the Stock Exchange: Its History and Position,* (London: Grant Richards, 1901) 429.
[7] London Stock Exchange, Trustees and Managers Minutes, 1860-1868, 315, MS/19297/005 GL.
[8] Most of the recent historiographical work on domestic servitude has reoriented our conceptions and arguments about the "working class" and its experience in modern Britain, placing domestic servants and service workers firmly within this working-class tradition. The financial laborers of the stock exchange should also be seen in this vein. See in particular Carolyn Steedman, *Labours Lost: Domestic Service and the Making of Modern England,* (New York: Cambridge University Press, 2009); Lucy Delap, *Knowing Their Place: Domestic Service in Twentieth Century Britain,* (New York: Oxford University Press, 2011). Though Steedman and Delap have transformed our understanding of domestic servitude primarily by interrogating periods domestic servitude was seen as less important (the eighteenth and twentieth centuries respectively) the classic account of domestic servitude in the Victorian period remains Pamela Horn's, *The Rise and Fall of the Victorian Servant*, (New York: St. Martin's Press, 1975). As suggested earlier, Katie Hindmarch-Watson's recent work on expanding the purview of labor history to service workers is a key intervention into typical histories of nineteenth century labor (whether domestic or otherwise). See Hindmarch-Watson, "Sex, Services, and Surveillance."
[9] For a brief discussion of the "synecdoche" of the "House" see Juan Pablo Pardo-Guerra, *Automating Finance: Infrastructures, Engineers, and the Making of Electronic Markets* (New York: Cambridge University Press, 2019) 37-44.
[10] See for instance London Stock Exchange, Trustees and Managers Minutes, 1833-1842, 118, 276, MS/19297/002 GL.

brokers and employees were all settled in house and the exchange did everything it could to keep interference from the state and the legal system at a minimum. The market was supposed to govern itself. Waiters were key in this regard, as one of their chief tasks was to prevent any non-members from entering the stock exchange.

If the "House" was determined to keep its affairs private to the outside world, its internal affairs were marked by intimacy. Many waiters were live-in servants. Some waiters and other minor officials were given rooms in the stock exchange and brought their families with them. These rooms however were located in the stock exchange's attic, far from the daily purview of any financiers.[11] Similarly, the waiters were required to use different water closets, changing rooms, and staircases within the stock exchange, firmly demarcating their domestic spaces from those inhabited by upper-class financiers.[12] The domestic space allotted for waiters gave some of them the advantage of a rent-free home, but this was conditional on their wives and daughters contributing their labor to the stock exchange for free. Waiters' wives were frequently charged with managing the cloaks of stockbrokers as they entered the exchange or conscripted to cook meals for the managing committees, while their daughters cleaned and scrubbed the exchange after hours.[13] Eventually the stock exchange managers passed a resolution requiring all waiters to be under the age of 40 so that they would be both healthy enough for the job and provide women from their families for unremunerated work.[14] The separation of waiters and their families into different spaces was similar to the ways large country houses created "spatial and emotional distance," between the family and servants, using "spatial markers and rituals that mitigated the intrusive aspects of living with what were virtual strangers." [15] But the demarcation of different spaces for waiters and stockbrokers did not eliminate intimacy between upper and lower class. In practice, the intimate lives of waiters and their families became intertwined with the everyday operations of 19th century finance.

Women and families were crucial to the labor systems of stock exchanges but they also introduced a cultural threat to the gentlemanly capitalism of the stock exchange, as well as to the morality of the lower class waiters who were deemed more susceptible to the deleterious influence of women.[16] The managers used the presence of women and families in the London

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[11] See London Stock Exchange, Trustees and Managers Minutes, 1801-1833, 287, MS/19297/001; Trustees and Managers Minutes, 1833-1842, 65, 122, 203, MS/19297/002; see also Plans of the Site and Buildings: 1870 Western Addition, MS/2984 GL.

[12] London Stock Exchange, Trustees and Managers Minutes, 1842-1852, 27-28 MS/19297/003; Trustees and Managers Minutes, 1852-1860, 198, MS/19297/004 GL.

[13] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 105-106, 108, MS/19297/004 GL.

[14] London Stock Exchange, Trustees and Managers Minutes, 1842-1852, 274, MS/19297/003 GL.

[15] Judy Giles, "Authority, Dependence, and Power in Accounts of Twentieth Century Domestic Service," in eds. Lucy Delap, Benjamin Griffin, and Abigail Williams, *The Politics of Domestic Authority in Britain since 1800*, (New York: Palgrave Macmillan, 2009) 205.

[16] Women were often viewed as the irresponsible, morally deleterious "other" to the staid and stern visions of a gentlemanly financial capitalism. See, Mary Poovey, *Making a Social Body: British Cultural Formation 1830-1864*, (Chicago: University of Chicago Press, 1995) 155-181; Victoria Thompson, *The Virtuous Marketplace: Women and Men, Money and Politics in Paris, 1830-1870,* (Baltimore: The Johns Hopkins University Press, 2000) 131-169; Audrey Jaffe, *The Affective Life of the Average Man: The Victorian Novel and the Stock Market Graph,* (Columbus: The Ohio State University Press, 2010) 63-80; George Robb, *Ladies of the Ticker: Women and Wall Street from the Gilded Age to the Great Depression,* (Urbana: University of Illinois Press, 2017) 16-39; for the paradigmatic argument about the cultural system of "gentlemanly capitalism" that women were juxtaposed against, see P.J. Cain and A.G. Hopkins, *British Imperialism 1688-2000,* (New York: Pearson Education, 2002) second edition, 38-50, 121-127.

Stock Exchange to expand their disciplinary remit over the waiters. Especially since the waiters were the public face of the Stock Exchange, interacting with members of the public at the doors of the exchange, the managers felt justified in launching invasive investigations into the waiters' personal lives in order to guarantee their morality and proper behavior. The attention devoted to the investigation of Maynard was the rule, not the exception. In 1838, for instance, the daughter of a waiter named Cripps "destroyed herself by poison," and a rumor began circulating among stockbrokers that in her suicide note she had accused her father of attempting to set fire to the Stock Exchange. After an investigation into the Cripps' family life, the managers cleared him of any wrongdoing and posted a notice on the trading floor for all to see proclaiming that he continued "to enjoy their full confidence." Cripps and his family quickly vacated their rooms in the stock exchange all the same.[17] Another waiter who was responsible for picking up and delivering letters to the post-office, carried out his duty one day in 1857 with a black eye. This too drew the ire of the managers who discovered that the waiter's "wife had done it." The managers reprimanded the waiter, informing him that they "could not allow one of their waiters to be going to the post office several times a day in the state in which he was."[18] Maintaining the moral and social order of the "house" was key to performing respectability in public. Thus, the various investigations into the intimate lives of waiters were never done quietly and internally but were spectacles that encompassed the entire stock exchange community. The threats women seemed to pose to the stock exchange's social and cultural order constantly gave the managers an excuse to expand their disciplinary control over the waiters lives.

The organization of stock exchange labor was enforced through payment structures. For the first 30 years of the 19th century, the waiters as well as higher level stock exchange employees like the clerk of the house or the exchange secretary, were all on roughly the same pay scale and had only limited operational oversight. This was largely due to the informal nature of compensation through gratuities. Christmas boxes composed of gratuities from stockbrokers were given to the waiters every year and were quite lucrative. In 1804, the most senior waiter, received £100 in his Christmas box, the second most senior waiter received an extra £80, while the remaining 4 waiters received £40 each, making their yearly earnings, £150, £130, and £90 respectively.[19] Alternatively, the secretary of the London Stock Exchange, ostensibly its highest ranking employee, was given a bonus of fifty guineas yearly by the managers, making his yearly earnings £113.[20] Especially during the early part of the 19th century, this put most of the stock exchange's servants comfortably within the earning ranges of the lower-middle class.[21] Yet, because they were not salaried employees, waiters constantly depended on the good-will of stockbrokers to ensure hefty Christmas gratuities. Payment was personal.

Payment structure began to change in the 1830s alongside what Mary Poovey has called the broader shift towards "disciplinary forms of individualism" characteristic of liberal governmentality in 19th century Britain.[22] In 1834 the managers began automatically removing £10 a year from the waiters Christmas gratuities and placing it into a savings bank because they claimed the waiters did "not (have) the ability or prudence to save anything as a provision in the

[17] London Stock Exchange, Trustees and Managers Minutes, 1833-1842, 183-185; 204, MS/19297/002 GL.
[18] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 200-201, MS/19297/004 GL.
[19] London Stock Exchange, Trustees and Managers Minutes, 1801-1833, 47, MS/19297/001 GL.
[20] Ibid. 162.
[21] For context see Geoffrey Crossick, "The Emergence of the Lower Middle Class in Britain: A Discussion," in ed. Crossick, *The Lower Middle Class in Britain 1870-1914*, (London: Croom Helm, 1977) 34-35.
[22] Poovey, *Making a Social Body*, 112.

event of continued sickness, or death for themselves or families."[23] In 1836 Christmas Boxes were eliminated altogether. The Christmas Box system was deemed "highly objectionable since it falls partially upon those only who are liberal and is evaded by those (stockbrokers) who are not."[24] The Christmas Box system was abolished and the base salary of the waiters was set at £73 10s per year, nearly a £20 *decrease* from the usual figure attained by the most junior waiters some thirty years prior.[25]

New payment structures also necessitated new forms of organizational hierarchy. In the 1830s two new offices were created specifically to manage the waiters. The first was the "superintendent," a position filled by a "person of a rather superior description" that paid £105 per year and whose duties were primarily to "arrange the waiters and to be continually in the house; to see that the waiters do their duty and are at their posts" and to make sure the waiters complied with directives from stockbrokers. Secondly, the position of "head waiter" was established. The head waiter was salaried at £84 per year (which, again, was a substantial reduction from what the most senior waiter had received under the gratuity system a few decades earlier) and served as the rough equivalent of a butler. He managed the day-to-day operations of the waiter staff as well as managing interpersonal disputes and the social dynamics of the group.[26] The new rankings of waiters, and imposition of officials with the specific task of overseeing the waiters, was a marked shift from the non-hierarchical structure that had existed before the 1830s.

The organization of the London Stock Exchange's labor force remained remarkably consistent throughout the 19th century. After multiple petitions from the waiters for pay increases, the managers established a new pay scale in 1871 that allowed the waiters to make more than £75 per year for the first time. The new scale also built in gradual pay increases for time served: waiters would start at £70, after 2 years £75; after 5 years £80; and after 10 years £85.[27] In 1874 the upper end of the scale was expanded to £90 for the most senior waiter.[28] The £90 pay scale remained in place until 1912 when max pay was bumped to £105.[29] By WWI, the top pay the most senior waiter could receive was still less than many had actually received in the early 1800s. From the 1830s until WWI, the salary of the London Stock Exchange's key manual laborers remained essentially stagnant.

Turning the waiters into strictly overseen, salaried employees, did not have the effects the managers of the London Stock Exchange wished. Rather than eliminating malfeasance on the waiters' part, it displaced it. In order to supplement their reduced salaries, the waiters used their position within the ecosystem of the London Stock Exchange to extract gratuities from the members for the performance of their duties. The problem was not just an economic one. The waiters' dependence on private gratuities generated a social and cultural conflict between the

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[23] London Stock Exchange, Trustees and Managers Minutes, 1833-1842, 32-33, MS/19297/002 GL. On the "economic individualism facilitated by commercialized paternalism," that marked the rise of savings banks, see Penelope Ismay, *Trust Among Strangers: Friendly Societies in Modern Britain*, (New York: Cambridge University Press, 2018) 85-118.

[24] London Stock Exchange, Trustees and Managers Minutes, 1833-1842, 82-83, MS/19297/002 GL.

[25] Ibid. 90, 115.

[26] Ibid. 100.

[27] London Stock Exchange, Trustees and Managers Minutes, 1868-1872, 317-318, MS/19297/006. For the various petitions the waiters lodged over the year advocating for better pay see ibid. 154; and Managers and Trustees Minutes, 1842-1852, 270, MS/19297/003 GL.

[28] London Stock Exchange, Trustees and Managers Minutes, 1872-1874, 318, MS/19297/007 GL.

[29] London Stock Exchange, Trustees and Managers Minutes, 1910-1913, 225, MS/19297/021 GL.

waiters and the stockbrokers of the exchange. Waiters' primary method of ensuring the payment of gratuities was to either perform their jobs well or poorly based on the amount of money given to them (or not) as a gratuity. Profitability and loss in financial actions very often hinged on waiters executing their duties in an effective and timely manner and so, these lower-class laborers began to exercise considerable power over their social betters. One compendium of humorous Stock Exchange jokes included a satirical account of the life of a waiter. The story demonstrates less what the experiences of life as a waiter really were, but what stockbrokers thought the waiters thought of them. "I could tell some kurious things if only I was so disposed, which I ain't," the satirical waiter began:

> Secrets with hus is all a matter o'pounds shillings and pence, an'not too much of the pence, an' if we're tipped propper, nothing never passes our lips but wot the gents intended, meaning beer. I've never said nothing about none on 'em as didn't forget me; an them as did, why I've treted 'em as beneath me, which they are…A Stock Exchange waiter ain't arrive at without some inconvenyence…we're looked up to by all them clarks (clerks) and such-like as we orders ware to stand, and don't urry to call out the members (stockbrokers) as they wants; and they 'as to be preshus civil too, or we keeps 'em waitin', like the pleede (police) do the omlibusses…I'm (t)he (he)ad of the Kapel Court lobby, an them as don't like it can go to sum hother door.[30]

The mutual distrust and resentment was as much real as it was imagined. In January 1914, for instance, a London stockbroker named J.L. Erickisson had gone to the stock exchange's library to get stamps and asked a waiter to procure them for him. The waiter told Erickisson that if he wanted stamps, he must get them himself, since it was not the waiter's duty. Erickisson could hardly contain his frustration. "Surely these waiters should realize that they are servants of the members and shareholders and that civility and politeness is a necessity on their part…the man in question is undoubtedly ill-mannered and disobliging and most uncivil." The managers reminded the waiter that "civility and courtesy to members were among (his) principal duties," but otherwise refrained from punishment. [31]

What Erickisson and the managers did not seem to understand was that "civility and courtesy" were not the default attitudes of the London Stock Exchange waiters. They were a product of power struggles between the waiters and the financiers of the exchange. Waiters kept a close watch over which stockbrokers respected them and paid them. Waiters could refuse to perform tasks when they felt disrespected or poorly compensated. In not understanding the cultural economy of stock exchange labor, Erickisson had erred just as much as the waiter he complained about. Respect and civility, payment and performance of tasks— power writ small— were not produced uniformly through top-down organizational structures but were precisely the product of the numerous individual confrontations that took place on the stock exchange floor, confrontations within which the lower-class waiters of the stock exchange had a surprisingly outsized influence. It is to these contestations that the rest of the chapter will turn

Producing Financial Space

[30] George Duckworth, *House Scraps*, (London, 1887) 91.
[31] London Stock Exchange, Trustees and Managers Minutes, 1913-1915, 135, MS/19297/022 GL.

Alex Preda has argued that the "enclosure of stock exchanges, set in place at the start of the 19th century, was meant to endow markets with legitimacy." Preda's argument focuses on the "genres" of "observational devices" that helped create a new, abstract, and separate domain of finance in the public consciousness.[32] But the boundaries of markets had to be constantly made and remade, policed and disciplined, in practice just as much as in discourse. Indeed, the stakes for delimiting access to the physical market were high, and what ultimately became the "real" "market" hung on the policing of bodies attempting to pass into and out of the stock exchange. It was the waiters of the London Stock Exchange who oversaw this boundary making. Their principal duty was to guard the entrances and exits to the trading floor. No strangers (non-stock exchange members), women, investors, messenger boys, or even police officers were allowed in the market (See Figure 1). Even stockbrokers themselves only were allowed access to the exchange at particular points and particular times. As the satirical waiter joked, waiters ran the doors of the Stock Exchange like the police did the omnibuses.[33] The Stock Exchange's lowest paid laborers held the power to discriminate who was allowed into or excluded from, the market.



Figure 1: A waiter at the Capel Court entrance to the stock exchange (*The Graphic*, 1891)

[32] Preda, *Framing Finance: The Boundaries of Markets and Modern Capitalism*, (Chicago: University of Chicago Press, 2009)19-21. Preda insists that these genres do have authors, including "stockbrokers, grand speculators, financial journalists, securities analysts, engineers," but once again he leaves out the waiters who, in fact, did the most to erect these boundaries and author these observational devices than anyone else.
[33] Duckworth, *House Scraps*, 91.

One of the key classes of people that had to be kept outside of 19th century financial markets were strangers: anyone who was not an official member of the London Stock Exchange. Despite a growing economy and society of anonymous strangers, financial markets still relied heavily on personal trust and local social relations. Keeping strangers out of the stock exchange became imperative for a number of reasons. Since they were not known to the managers of the stock exchange and did not sign the legal pledges for entry, the managers had no control over strangers especially if they defaulted or ran disastrously speculative accounts. Moreover, the presence of strangers called into question the market's integrity in more mundane ways. Deals that were marked on the blackboards in the exchange as legitimate prices and ultimately printed in official price lists had to be deals between members. A stranger could hypothetically do deals that fell far outside of whatever the agreed upon market price was, corrupting the information the Stock Exchange presented to both the public and other stockbrokers alike. Ensuring that only authorized stockbrokers could access the market—and even then, only at the appropriate time and in the appropriate place—materially affected how the market functioned and how it came into being at all.

In a satirical story first published in *Punch*, an investor visited his stockbroker to place an order and fell asleep in the stockbrokers' office while waiting for the order to be completed. While dozing, the investor had a dream about visiting the London Stock Exchange with his broker. The investor marveled at the enormity of the room and the figures that popped up like a "Punch and Judy show" including the waiters who reminded him of "puppets (that) jumped up like jacks-in-the box and shouted a name." Before the broker disappeared into the market to execute the deal, he warned the investor that "no strangers (are) admitted here, so be careful, and dissemble to the best of your ability." Quickly, though, the numerous members of the Exchange recognized that the investor was a stranger and set upon him. Surrounded by a "ring of scoffers" the "waiters rushed towards (him)" to remove him from the Exchange, at which point, just before his expulsion, he woke up.[34] The investor's dream was real enough in practice. In 1908 the *Illustrated London News* published a collection of popular Stock Exchange "rags" that included strangers being escorted from the trading floor by the waiters to the great amusement of the members (See Figure 2).

[34] Ibid. 46-50.

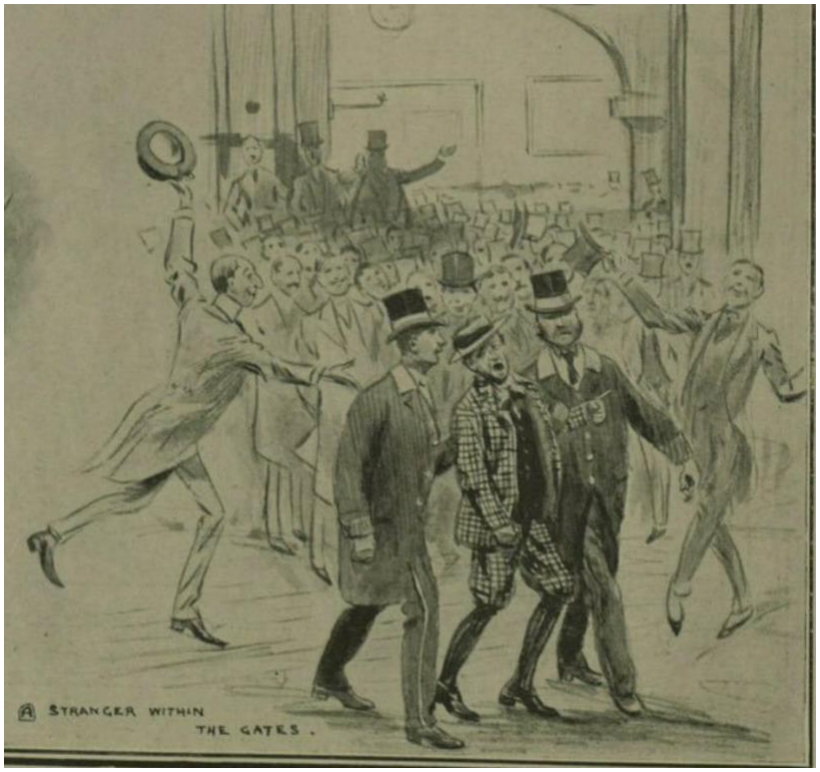

Figure 2: Waiters remove a stranger from the stock exchange (*Illustrated London News,* 1908)

While the expulsion of strangers was a comical social ritual in the London Stock Exchange, it was also serious business. Since the London Stock Exchange was the largest and most liquid market in the world, it was a frequent target of unscrupulous strangers who sought to use their impunity from the Stock Exchange governance to cut illicit deals. One such infraction was snuffed out in 1840, when members of the Stock Exchange recognized a man they knew, but who was not actually a member, within the market. The waiter on duty, Finch, was accused of "neglect of duty…for suffering a W. Sherman to enter the Stock Exchange after 4 o'clock for the purpose of transacting business there." Finch was sternly reprimanded and reminded "not to admit either Mr. Sherman or any other stranger into the house either before or after 4 o'clock."[35] Strictly policing the London Stock Exchange's boundaries and admittance was a key part of ensuring the market operated properly.

The violation of the market by strangers had social and political consequences as much as it did economic ones. Just as the rules were put into place to protect the integrity of the abstract "market" itself, so too were the rules intended to protect stockbrokers and the London Stock Exchange writ-large from oversight. In June of 1852 a serious conflict broke out when two police detectives pursued a suspect into the Stock Exchange, "obtruding (themselves) into the body of the building without sufficient authority." The waiters attempted to stop the detectives but to no effect, and the officers placed themselves in the middle of the English Consol market and began to abuse the gathering stockbrokers and waiters around them with "very disgusting language." George Webb, the secretary at the time, rushed to the trading floor and attempted to explain the logic of the Stock Exchange rules to the officers. "if the (suspect) does not belong to

[35] London Stock Exchange, Trustees and Managers Minutes, 1833-1842, 268-269, MS/19297/002 GL.

the Stock Exchange, you may be sure he has not been allowed to enter for if he had slipped in by accident he would very quickly be turned out and he was not likely to be there now," he explained, "but if the person he was in search of was in any way belonging to or connected with the Stock Exchange that man (the head waiter) is also an officer and he will find him for you at once." Webb eventually relented and allowed the officers to search the Stock Exchange, but he did so under protest. The managers, who had a close working relationship with the London police force, filed a complaint, pressing the police commissioner to open an investigation into the "disgusting" conduct of the officers.[36] Less overt penetration of the London Stock Exchange was often more successful. In 1868 a waiter named Valentine had "let a solicitor's clerk into the Stock Exchange" who had "served (a stockbroker) with a subpoena." Since the clerk blended in with the hundreds of other clerks who were authorized to access the trading floor, Valentine's explanation that he "did not see a stranger enter or he should have stopped him," had some validity.[37] Protecting the market from outsiders did not only ensure the integrity of the "market" itself, but also was key to insulating finance and financiers from outside powers and creating the "market" as a separate legal entity that was self-policing.

Even more grave than the penetration of the stock exchange by legal authorities was its penetration by social inferiors. The control the lower-class waiters had over access to the Stock Exchange floor threatened the social order of the market much the same ways that the presence of women did. In 1851, Thomas Dunman, the waiter who was in charge of the Stock Exchange's strong room where members kept cash, paper securities, and other valuables, was called in front of the managers to answer for his "extreme want of caution…in allowing strangers to see the machinery of fastening the Iron flap that covers the entrance." Representatives from the Committee for General Purposes even attended the meeting to express the "feeling of anxiety which had been raised among the members of the stock exchange who had property in the strong room in consequence of (Dunman's) imprudent conduct." Dunman was stripped of his duties as keeper of the strongroom and his salary diminished. The managers also installed a system whereby the superintendent of the waiters kept a "register in which he should insert the names of those persons who enter the Stock Exchange after the ordinary hours of closing and the object for which they enter."[38] Though Dunman's crime of exposing one of the most sensitive spaces of the Stock Exchange to strangers resulted in punishment and reform, it was not as egregious as the infractions committed by Valentine some 25 years later. One night in November of 1877, Valentine arrived at the Stock Exchange around 6:45 in the evening, well after the exchange had closed. Valentine, who "had been drinking," was "still in uniform with two strangers" and forced his fellow waiter who was manning the door to let him in. The strangers were Valentine's friends: one was a porter at Standard Discount and another a porter at the post office. Valentine "did not think he was doing any harm by showing his friends the house." Bringing his friends back to the Stock Exchange from the public house had apparently become a habit. Another waiter reported that one night "Valentine came in the house in uniform about 7pm and brought in a stranger." The other waiter had not reported the incident because he feared "Valentine's abuse, who…often threatened him."[39] The incident ultimately resulted in Valentine's termination and revealed how sensitive the managers and stockbrokers of the London Stock Exchange were to

[36] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 9-14, MS/19297/004 GL.
[37] London Stock Exchange, Trustees and Managers Minutes, 1868-1872, 6, MS/19297/006 GL.
[38] London Stock Exchange, Trustees and Managers Minutes, 1842-1852, 273-274, MS/19297/003 GL.
[39] London Stock Exchange, Trustees and Managers Minutes, 1874-1878, 304-307, MS/19297/008 GL.

the fact that access to the physical space of the market was controlled by often untrustworthy servants from the lower social classes.

Upper-class stockbrokers' anxieties about the social order of the market boiled into outright conflict when they were the ones subject to the waiters' policing. For stockbrokers, the issue at hand was not access to the market as such, but rather access to the market at the time of their choosing. The London Stock Exchange was officially open for business from 11am till 4pm. Official transactions that were publicly marked and printed in the list had to occur between members, within the stock exchange, and between those hours. Thus, many informal markets sprung up outside of those regulations to accommodate time differences across regions or to make last minute deals. But, the importance of doing a deal that could be *claimed* as official and printed in the price list was great enough to cause many stockbrokers to try and gain access to the trading floor immediately after hours. Some used trickery, some used force, some used bribery. One stockbroker in 1875 "gained admission to the house (after 4pm) under pretense of reaching his umbrella," which he claimed to have forgotten. When the waiter opened the door, the stockbroker "got clear of the waiter (and) darted across the house."[40] The stockbroker admitted "that it was not his object to recover (the umbrella) when he made his way into the house," and incurred the severe censure of the managers and the Committee for General Purposes "for having by misrepresentation to the waiter obtained admission to the Stock Exchange after the time for closing the doors."[41]

The waiters' responsibilities to keep stockbrokers *out* of the London Stock Exchange raised a set of contradictory logics. The waiters were bound by certain class conventions of respectability not to stand in the way of their social betters but were also required by the managers to uphold the physical integrity of the market. Sometimes the waiters were simply over-powered by social and cultural force. In 1837 a defaulting stockbroker named Norman Wilkinson was, by nature of his default, suspended from entering the house. But Wilkinson believed that his default had been unfairly judged and felt "compelled to resist this unlawful resolution and did, in fact, enter the house as usual in spite of the mandate of the committee," and the opposition of the waiters.[42] Another infraction of higher stakes occurred in 1875 when a stockbroker and member of the Committee for General Purposes (CGP), Percival Spurling, repeatedly "forc(ed) upon the waiters a violation of their instructions" by entering the Stock Exchange after 4pm. Spurling claimed that he was merely "exercising his right as a committee member to enter the house after hours." The managers did not press the issue and acknowledged the right of members of the Committee of General Purposes to enter the Exchange after hours, but noted to Spurling and the CGP that "members of the house generally might be inclined to view with distrust such special privilege granted to thirty of their body and added that although such privilege was of necessity vested in the managers it was never used by them for their individual advantage."[43] Though the managers constantly worried that improper access after-hours could be used to corrupt the market for the advantage of a few, they had difficulty empowering their waiters to prevent their social betters from entering.

Even when the waiters stood up to their social betters at the doors of the stock exchange, their actions were tightly circumscribed by their social status. In 1851 a stockbroker named Charles Laurence attempted to "violently…force his way in," at the New Court door, twenty

[40] Ibid. 115.
[41] London Stock Exchange, Committee for General Purposes Minutes, 1875-1876, 174, MS/14600/040 GL.
[42] London Stock Exchange, Trustees and Managers Minutes, 1833-1842, 142, MS/19297/002 GL.
[43] London Stock Exchange, Trustees and Managers Minutes, 1874-1878, 124-125; 136-137, MS/19297/008 GL.

minutes after the stock exchange had closed. Laurence appeared before the managers not as the subject of a complaint, but rather to lodge a complaint against the waiter who had "put up his arms to bar (Laurence's) entrance," and exhibited great "rudeness" and "incivility" in the process. The waiter was called to answer Laurence's accusation and admitted to "stand(ing) before him to prevent," the stockbroker's admittance, but noted the "very gross and insulting epithets" Laurence had hurled at him. Despite Laurence's behavior, it was the waiter who was chastised by the managers for "putting his hands on Mr. Laurence," which "constituted an assault." The managers instructed the waiter that he was "not to repel…any other person insisting or forcing an entrance after the house (closed)…but to give way and report such persons conduct to the managers."[44] Two other stockbrokers named Campbell and Lowy brought a case against a group of waiters in 1891. The stockbrokers believed that the waiters too strictly enforced the "regulations against standing in the lobbies." The two men had only been "engaged in conversation with another," for a few minutes before the waiters had interrupted them and forced them to move. This time the managing committee sided with the waiters, but were as conciliatory as possible to Campbell and Lowy, quietly suggesting that "all well-disposed members must recognize the importance of doing all in their power to avoid causing obstructions to free passage in or out of the house."[45] Any infractions that stockbrokers made against the waiters had to be treated gingerly.

Only upper-class stockbrokers and financiers could get away with disobeying the waiters. The waiters had far more power when it came to disciplining clerks, or various communications workers. It was, after all, the "clarks and such-like," that the fictional waiter from the humorous compendium bragged about ordering "ware to stand," in and out of the market.[46] Waiters were often charged with overseeing areas of the stock exchange used predominately by clerks, like the Settling Room, and monitoring the clerks' "unnecessarily violent" and "riotous behavior."[47] The managers of the stock exchange tended to have far more faith in their waiters than in clerks. During the summer of 1866, one clerk named Aston attempted to enter the Stock Exchange after hours when the waiter "took hold of his wrist and told him he could not go in." Aston shoved the waiter back and tried to force his way in but failed to gain entry. When the incident was reported, this time it was the clerk and not the waiter who was punished. The managers warned the clerk "that he had no right to resist the orders given to the waiters and cautioned him to be careful in future."[48]

Though waiters had the ultimate power to admit or exclude someone from the London Stock Exchange, their place in the social order of the market made them targets of manipulation, force, or simple social strong-arming. The conflicts that arose over access to the market were inflected with conflicts over the social order of stock exchange: this ranged from the waiters letting other lower-class men like themselves into the exchange, or the contradictory imperatives they faced when trying to exclude stockbrokers from the exchange. The creation of a separate space for the "market" that justified its operational and economic integrity was never just the product of a set of rules or discursive domains, but was constantly made, challenged, and remade

[44] London Stock Exchange, Trustees and Managers Minutes, 1842-1852, 275-277, MS/19297/003 GL.
[45] London Stock Exchange, Committee for General Purposes Minutes, 1891-1892, 175, MS/1400/59 GL.
[46] Duckworth, *House Scraps*, 91.
[47] London Stock Exchange, Trustees and Managers Minutes, 1872-1874, 265, MS/19297/007; Managers and Trustees Minutes, 1868-1872, 308, MS/19297/006 GL.
[48] London Stock Exchange, Trustees and Managers Minutes, 1860-1868, 281-282, MS/19297/005 GL.

through social and cultural conflicts over what the social order of the stock exchange would look like, and waiters roll in constituting it.

Facilitating Financial Communication

Waiters' positions at the entrances and exits of the London Stock Exchange not only made than arbiters of who was allowed in or out of the exchange, but also made them crucial communicative links between the exchange and the outside world. The importance of financial information to the functioning of markets was (and remains) crucially linked to the speed at which it was distributed and accessible. Orders to buy or sell received too late, or a price reported that was no longer current, were the differences between profit and loss in financial transactions. The waiters were the key conduits of this financial information. They distributed and sent letters to and from the London Stock Exchange, ran messages into and out of the trading floor, and managed telecommunications on the floor of the exchange on behalf of stockbrokers. Upper-class stockbrokers and financiers were at the mercy of the waiters to move information at high speeds and they used any means necessary to coerce these them into doing so.

While the managers of the London Stock Exchange did not necessarily want to slow down the speed of financial communication, they did endeavor to make sure that information was distributed fairly and equally. To accomplish this, the London Stock Exchange attempted to privatize its financial communication within the "House," to the greatest extent possible. The exchange was constantly looking to limit the influence that other institutions, from the British General Post Office (GPO) to private communications companies, had on the speed and efficiency of financial communications. The waiters played a key role in the effort to privatize stock exchange communications. Though class and social conflicts always inflected the waiters' relationship with stockbrokers, the familial nature of the "House" led the managers of the exchange to trust their waiters far more than the bureaucratized employees of the GPO or other communications companies. Thus, over the course of the 19th century, the London Stock Exchange increasingly forced outside communications to be handled by the waiters of the exchange.

Before the telegraph, the distribution of letters was the primary—and most vulnerable—method of communication in financial markets. Morning letters contained orders to buy or sell at the opening of the market from clients both within and outside of London. Evening letters typically contained reports to clients about successful or failed deals and often included price lists as verification of what the market actually was for particular stocks and shares. The foreign post that was taken on Tuesday and Friday evenings was especially crucial for executing orders for the many foreign clients who dealt on the London Stock Exchange. Ensuring the timely delivery and fair distribution of letters amongst all the members of the stock exchange was a vital task for the managers, especially since the GPO frequently failed to meet the needs and expectations for speed required by stockbrokers. Throughout the 19th century, the London Stock Exchange exerted pressure on the GPO to offer them privatized and hence (they believed) expedited financial communications.

The imperatives of public efficiency within the GPO were often at odds with the demands for speed from stockbrokers. In late 1837 London stockbrokers complained about the delivery method of letters from Liverpool, where one of only two other stock exchanges existed outside of London. Liverpool letters came in two batches: the first with the early morning letters, the second with letters that were supposed to be delivered by 11am. The second batch of letters,

however, was frequently delayed till as late as 2 o'clock in the afternoon. Thus the GPO instituted regulations stating that if the Liverpool letters arrived in London after 2 o'clock, instead of being delivered in the City immediately, they would be lumped in with the delivery of the letters via the two penny post "thereby delaying the delivery of those letters till perhaps 6 o'clock in the evening." Shifting the delivery of Liverpool letters from the normal pool of letters to those sent by the two penny post not only prevented those letters from being delivered in time for business to be done on the London Stock Exchange but also effectively precluded "the waiter of the house who is in attendance to bring them at once to the stock exchange," since the Liverpool letters were not separated from the others.[49]

The GPO was reluctant to turn over its mail to private messengers, even the waiters of the London Stock Exchange. The GPO demurred from allowing a waiter to handle any letters and simply assured the managers that "the arrangement by which the letters are sent to the stock exchange by the letter carriers is better adapted for the convenience of the members of that establishment than if a messenger were sent for them."[50] But this was an ad-hoc response to a structural administrative problem. Given the sheer size of the London Stock Exchange and how long it took to sort and deliver letters to every broker, even small delays in the arrival of the morning letters prevented orders from being placed immediately at the opening of the market and "expos(ed) brokers having orders to transact…to serious responsibilities and animadversion." Numerous petitions from the London Stock Exchange and its members continued to complain about the "inefficient arrangement with the Post Office" until the GPO finally relented in 1840 and allowed a waiter to come to the central Post Office at St. Martin's Le Grand to pick up letters for the stock exchange.[51]

The stock exchange had finally been able to bring some of the mechanisms of postal delivery under their own purview but in doing so, the managers faced a new set of administrative problems and contradictions. In order to pick up, sort, and deliver letters to and from the post office at St. Martin's Le Grand, waiters had to be given a substantial amount of independence and freedom from oversight. This inflamed the anxieties of upper-class financiers who were already nervous about their sensitive communications being handled by lower class people. Stockbrokers lodged "many complaints" about the "long absence(s)" of one waiter named Robert Smith, who was responsible for delivering brokers' letters from the stock exchange to the post office. Stockbrokers were suspicious that Smith used his independence as the postal waiter as an excuse to frequent public houses. Smith countered that he was merely "questioned frequently at the dead letter office, the solicitor's office, and in fact every other office in the post office."[52] When another waiter succeeded Smith in the postal duties, he surreptitiously overcharged brokers for postage. In the wake of the various "miscarriages" of the postal duty, the managers declared that "all foreign letters (must) be delivered into the hands of (the clerk of the house)" and that all inland letters must be pre-stamped before being sent out for delivery, rather than entrusting the waiters to handle postage payments.[53] Bringing the distribution and sending of letters under the control of stock exchange waiters had, inadvertently, made the waiters more difficult to discipline.

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[49] London Stock Exchange, Trustees and Managers Minutes, 1833-1842, 174, MS/19297/002 GL
[50] Ibid. 182.
[51] Ibid. 249-252.
[52] Ibid. 263-264; Some letters Smith was supposed to have delivered were eventually found in the stock exchange's water closets, where Smith had drunkenly fallen asleep. He was promptly dismissed see Ibid. 268-273.
[53] Ibid. 279-281.

Control over letter delivery was only one small part of the broader ecosystem of financial communications. The managers had far more difficulty ensuring fair practices of message delivery at the various doors into and out of the stock exchange through which letters, telegrams and other types of messages had to pass. The waiters stationed at doors had to interact with dozens of stockbrokers, clerks, and clients a day and this made both the social pressure exerted by upper-class financiers on waiters, and waiters' opportunity for financial gain, far greater at these points than anywhere else in the stock exchange. Stockbrokers from particular markets typically used the same doors, which were manned by the same waiters' day after day. Becoming familiar and friendly with the waiter at a door—whether through gratuities, civility, or both—was key to ensuring quick relays of messages, orders, and prices into and out of the stock exchange between brokers and their clients.

Some waiters, like one who retired from his post at the Capel Court door in 1900, were beloved by the stockbrokers who frequented his entrance. He was gifted a clock, a silver snuffbox, and a check for a hundred guineas upon his retirement.[54] Other relationships were not quite as secure. Using the wrong waiter or the wrong door to deliver a message could prove disastrous. On June 8th, 1877 at about 1 o'clock in the afternoon, two telegrams arrived for a stockbroker named Gerald Shipp at the Shorters Court door. Shipp, however, typically used the New Court entrance. The waiter on duty at Shorters Court said that he did "not know" Shipp and handed the telegrams "back to the (messenger) boy." The telegrams were not delivered until 4:30 in the afternoon—after the market had closed—and Shipp was furious. Shipp argued that the waiter should have known to give the telegrams to the waiter on duty at the New Court door, whom he knew. When Shipp broached the subject with both of the waiters involved, they treated it "very lightly, in a tone of anything but conscience."[55] The managers declined to take any action and blamed Shipp's telegraph boy instead.

Various strategies were used to expedite the delivery of messages. In 1876, one stockbroker attempted to by-pass the waiters altogether by throwing a telegram in through an open door towards his stockbroker inside. The stockbroker was sternly reprimanded for his "breach of the rules."[56] More typical was simply knowing how to grease the waiters' palms. In 1855, the Imperial Brazil Mining Company sent a messenger to the door at Hercules Passage with company circulars for various stockbrokers. When the messenger gave them to the waiter on duty, he was told "when you come again, you must bring a fee if you expected these to be delivered quickly." Allen and Harris, the two waiters regularly on duty at the Hercules Passage door, denied that they had said any such thing, though they did admit that "sometimes there is a small bonus given with letters when expected to be delivered in a hurry." [57] The managers reprimanded Allen and Harris and warned them to take no more gratuities though in reality the managers had almost no power to enforce their warnings and the practice continued unabated.[58]

Stockbrokers not only relied on good relations with waiters for the quick delivery of a message and but also for the loud shouting of a name. One of the principal duties for the waiters stationed at the door was to call out the name of any stockbroker or jobber on the inside of the stock exchange who was needed outside of it. "We livs (sic) by our voices" the satirical waiter in

[54] Duguid, *The Story of the Stock Exchange*, 429.
[55] London Stock Exchange, Appendix to Trustees and Managers Minutes, 1875-1881, June 8, 1877, MS/19514/003 GL.
[56] London Stock Exchange, Trustees and Managers Minutes, 1874-1878, 215-216, MS/19297/008 GL.
[57] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 160-162, MS/19297/004 GL.
[58] Duguid, *The Story of the Stock Exchange*, 428.

the compendium of jokes noted.[59] Indeed the principal qualification necessary to be appointed a waiter was the possession strong voice capable of being thrown "to a distance," across the crowded and loud trading floors of the Stock Exchange.[60] Something as seemingly insignificant as shouting a broker's name in a slightly lower voice could make a large difference in the timely execution of orders. In 1855 one stockbroker named Harry Tompkins, complained that his brother, who was not a member of the Stock Exchange, had "frequent occasions daily to call (him) out," at the Capel Court door in order to "transact business." But the waiters stationed at that door were "most importunate in their demands for fees, either in money or ale…and it has now become quite a tax." Harry's brother Charles added that while the "men at the Hercules Passage door," were the "worst," the waiters at the Capel Court door were also difficult to deal with. Unless he gave them a fee, "the name he wanted was called in a very low tone whereas if he gave a shilling the name might be heard all over the house."[61] He added that he frequently tipped the permanent waiter at the Capel Court door, William Dixey, a guinea at Christmas, but the new waiters who serviced the door refused to call loudly because he did not also pay them. Another waiter stationed at the Hercules Court door, upon being asked to call a stockbrokers' name a second time, wryly informed the waiting client that "it was a very hard name," and reminded him that he had not yet received a Christmas gratuity.[62] By delaying messages or lowering their voices, waiters could cause untold disruptions in the everyday operations of the stock market and force upper class financiers to pay them well and treat them with respect.

The Waiters and Telecommunications

The introduction of telecommunications produced a new host of administrative problems when it came to managing financial labor. New workers from messenger boys, to telegraph operators, to various clerks were introduced within and around financial markets and proved a challenge for the financiers and stock exchange managers to control. Yet, much like they had with postal communications, the managers of the London Stock Exchange were largely able to graft new communications systems onto their own private forms of labor. In 1871, after a new postal telegraph office had been erected adjoining the stock exchange, G.C. Smith, the office's manager, petitioned the stock exchange managers "for permission to pass through the house in order to obtain the attention of members without delay in reference to alterations and corrections in telegrams." Smith added that "the introduction of two steady messengers into the house to deliver the telegrams direct or to the waiter placed in any market," would materially decrease the crowds that formed around the telegraph office. The managers considered it "inexpedient" to allow Smith himself to enter the Stock Exchange. However, they did permit the introduction of messengers so long as they only delivered messages to the waiters and not to stockbrokers directly.[63] The logic of such a move was obvious. A mid-ranking postal official like Smith would be far less susceptible to direction from the waiters than boy messengers. The managers trusted their own waiters more than they did the numerous boy runners that various telecommunications firms introduced to the Stock Exchange.

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[59] Duckworth, *House Scraps*, 91.
[60] London Stock Exchange, Trustees and Managers Minutes, 1860-1868, 110, MS/19297/005 GL.
[61] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 164-165, MS/19297/004 GL.
[62] London Stock Exchange, Appendix to Trustees and Managers Minutes, 1875-1881, February 13, 1878, MS/19514/003 GL.
[63] London Stock Exchange, Trustees and Managers Minutes, 1868-1872, 252-253, MS/19297/006 GL.

Around 1875, the waiters began to develop an internal system of communication to process telegrams. The waiters would affix "pieces of paper…to (their) stands" that alerted certain "favored" stockbrokers who had paid them tipped "that there were telegrams" ready to be picked up. The practice was "a comfort and convenience to members" since it was not reliant on "the noise caused by the waiters calling the names of members."[64] Even when waiters were absent from their posts in the various markets, messengers were prevented from delivering telegrams directly to stockbrokers and were instead instructed to leave them at "the Stand in the centre of the house (in) a box with a glass front."[65] Eventually the managers put a stop to the practice, since they rightly believed it favored certain members who paid, and disadvantaged those who did not. In 1890, black boards with pegs and discs were hung over the waiters stands in the market "to indicate to members that there (were) telegrams waiting for them" and no charge was allowed to be made for the service.[66] Eventually the peg and disc system itself was electrified. Each firm on the exchange was given a number and the waiters would light up the number of a firm that had a telegram or phone call waiting to be taken. By the end of the century, telegram delivery and notification of a telephone call had been essentially monopolized by the stock exchange's waiters. One stockbroker noted that if a telegram had ever been "handed to him by a telegraph official, the circumstances would have been so unusual as to have remained in his memory."[67]

The question about what kind of access telecommunications workers should have to the stock exchange came to a head in debates with the GPO over the construction of new telegraphic and telephonic facilities between 1913 and 1915. To prevent telecommunications workers from having direct access to the trading floor, the original office design suggested by the managers of the stock exchange forced the supervisor of the GPO's new telephone rooms to "go outside the stock exchange building and enter through the public office each time that he wished to visit."[68] The stock exchange managers were so adamant that they even prevented telecommunications workers from using the members washrooms that off the trading floor.[69] The GPO stressed that it was "absolutely necessary for the officer in charge of the call office attendants and very desirable for the call office attendants themselves to have the right of crossing from one enclosure to another across the floor of the house practically at will."[70] The GPO argued that allowing their workers to move through the market on their own volition would create a much more efficient system of delivering messages and communications. According to the GPO, the very structure of the Stock Exchange as an open market encouraged such movement. "As the floor of the House is less than an acre in extent without any obstructive doors or barriers it forms a concentrated area enabling the boys to deliver a much larger number of messages within a very short distance…than if they had to deliver them at ordinary addresses."[71]

The London Stock Exchange's concerns about maintaining control over their own labor force were never extinguished through arguments for greater efficiency. The stock exchange

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[64] London Stock Exchange, Trustees and Managers Minutes, 1888-1891, 160, MS/19297/012 GL.
[65] London Stock Exchange, Trustees and Managers Minutes, 1872-1874, 320, MS/19297/007 GL.
[66] London Stock Exchange, Trustees and Managers Minutes, 1888-1891, 167, MS/19297/012 GL.
[67] London Stock Exchange, Committee for General Purposes Minutes, 1891-1892, 328, MS/14600/059 GL.
[68] London Postal Service: Threadneedle Street Branch Office and Stock Exchange Telegraph Office Part 1, Letter from Comptroller, November 5, 1914, File V, Post/30/3044 PM.
[69] London Stock Exchange, Trustees and Managers Minutes, 1913-1915, 17, MS/19297/022 GL.
[70] London Postal Service: Threadneedle Street Branch Office and Stock Exchange Telegraph Office Part 1, Memorandum of Conference, November 10, 1914, File V, Post/30/3044 PM.
[71] London Stock Exchange, Trustees and Managers Minutes, 1913-1915, 91, MS/19297/022 GL.

managers only allowed the various postal workers to cross the floor of the house if they agreed to certain conditions. Postal workers "must be in uniform and must be formally introduced to the waiters in the exchange." Furthermore, the attendants were only allowed to cross when they were "accompanied by the supervisor, otherwise the attendants would have to go to and from the enclosures on the floor of the house direct when going on and coming off duty."[72] In addition to the stock exchange managers insisting on the rights-of-way for all the passages surrounding the post office branch in the stock exchange itself they also pushed to deleted clauses in the final agreement that would have given attendants and messengers "the right to remain in the adjacent portions of the stock exchange premises." Instead, the managers insisted that there should be "little or no occasion (for telecommunications workers) to linger in these parts of the premises."[73] Not only was the operating space of telecommunications workers strictly controlled, but when communications workers were allowed to move around, they had to do so in highly visible and supervised ways.

The last vestiges of GPO controlled labor were eliminated in subsequent negotiations. When the first pneumatic tubes were installed between the GPO's telegraphic office in the stock exchange and different markets on the trading floor, the tube attendants were initially under the split control of the stock exchange managers and the GPO. But by 1914 even the GPO admitted that these "anomalies (in) the duty arrangements of the Tube Attendants and messenger classes," should be eliminated.[74] Even though the move was as much about saving the GPO labor expenses during wartime as it was the managers taking control of communications, the GPO admitted that the stock exchange's own messengers would be much more efficient than "delivering an equal number of telegrams to commercial firms in the ordinary way" through the Post Office.[75]

By forcing various communications companies and the GPO to work through the existing stock exchange labor structures, the managers of the London Stock Exchange thought they were strengthening their own control over the market. In some respects, of course, they were. But they also inadvertently strengthened the power and importance of their own waiters, a group of men who already had control over key operations within the stock exchange and whom the managers had long struggled to adequately discipline. The centralization of telecommunications within the labor structures of the "House" itself, further empowered the waiters of the London Stock Exchange to shape both how the market operated and the social dynamics that defined it.

Conclusion: Between Paternalism and Bureaucracy

The function of the waiters within the London Stock Exchange gradually began to shift in the last quarter of the 19th century as their roles as domestic servants were slowly phased out. While some resident waiters remained on the exchange, in 1877 new regulations were passed shifting many of the waiters' domestic duties to the "housekeeper" and "his wife." The housekeeper was responsible for sprinkling saw dust on the trading floor to make sure it was not

[72] London Postal Service: Threadneedle Street Branch Office and Stock Exchange Telegraph Office Part 1, Memorandum after Meeting with Stock Exchange Solicitor, File V, Post/30/3044 PM.
[73] London Postal Service: Threadneedle Street Branch Office and Stock Exchange Telegraph Office Part 1, GPO Memorandum, File VIII, Post/30/3044 PM.
[74] Pneumatic Tubes Between Threadneedle Street Branch Office and Stock Exchange, Letter from V.M. Dunford, December 7, 1914, File XIV, Post/30/1339 BT.
[75] Pneumatic Tubes Between Threadneedle Street Branch Office and Stock Exchange, Letter from J. Newlands, December 9, 1914, File XIV, Post/30/1339 BT.

slippery for the members. They were also charged with supplying firewood to the various fireplaces, to oil the hinges on the doors, and to supervise any workmen who were employed at the exchange. The housekeeper's wife was delegated the duties of cleaning the offices of all the stock exchange officials.[76] What was more, during the 1870 renovation of the stock exchange's western addition, the housekeeper was allotted the best and largest set of rooms directly above the managing committee's office.[77] By WWI, there were only three sets of live-in apartments in the exchange and they were reserved for two different housekeepers and the resident engineer who looked after the mechanical operation of the exchange's heating, ventilation, and drainage.[78] Instead of expanding its ranks of domestic servants after 1870, the London Stock Exchange replaced them with temporary wage laborers. In 1913, the stock exchange was routinely hiring 10 women a week to come in and scrub its voluminous trading floor.[79] The housekeeper and his wife were in charge of managing these laborers, not the waiters. The waiters remained central to the operations of the trading floor, but the work of both the waiters and their families, shifted away from the model of domestic servitude.

As the number of domestic servants in the exchange decreased, the managers also once again attempted to curb the gratuity system and turn the waiters into strictly salaried employees. Stockbrokers were exasperated with the extent of the gratuity system. In February of 1890 a special subcommittee was appointed to explore possible reforms to the governance of the waiters since the "present system of gratuities to waiters ha(d) assumed such vast proportions that some action…has become absolutely necessary."[80] The managers and stockbrokers alike admitted that they could never really stamp out the informal gratuity system, nor yet police the waiter's behavior at the doors of the stock exchange. While waiters were formally "prohibited from receiving gratuities and members (were) earnestly requested to desist from giving gratuities to the waiters," the managers knew that they had little power to enforce this. Instead of cracking down on gratuities, the managers installed a new system that looked very much like the Christmas Boxes that had been abolished sixty years earlier. Stockbrokers were encouraged to contribute to a "fund for division among the waiters," but with a slight twist. [81] Rather than a uniform, stock-exchange-wide fund, gratuities remained somewhat localized. A subscription book was established at each door "in which book members who wish to subscribe to a waiter fund can enter their names and the amount of their contributions."[82] Stockbrokers could maintain—and financially support—the particular relationships they had cultivated with waiters at individual doors while the managers could check and see if waiters at some doors were paid less than those at others and work to evenly divide gratuities among the entire staff. While the informal gratuity system was never entirely abolished, the new system allowed the waiters to profit from their personal relationships while generally lessening the pecuniary burden on stockbrokers and ensuring some form of mutual assistance to all the waiters. The reinstatement of something that so closely resembled Christmas Boxes was a small but important moment in which the waiters demonstrated their power and necessity to the upper-class men who governed the London Stock Exchange.

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[76] London Stock Exchange, Trustees and Managers Minutes, 1874-1878, 240-244, MS/19297/09 GL.
[77] London Stock Exchange, Plans of Site and Buildings, MS/29836 GL.
[78] London Stock Exchange, Trustees and Managers Minutes, 1913-1915, 69 19297/022 GL.
[79] Ibid. 6-8.
[80] London Stock Exchange, Trustees and Managers Minutes, 1888-1891, 177, MS/19297/012 GL.
[81] Ibid.
[82] Ibid. 266

Waiters continued to work on the floor of the exchange all the way until the Big Bang of electronic trading in 1986. And even though they were no longer actual domestic servants, the paternalistic culture of domestic servitude that had shaped the waiters' role from 1801 forward, remained largely intact. Culture continued even as the actual working conditions changed. What began to erode the "master-servant" relationships of the stock exchange floor—relationships that had inadvertently been the locus of power for the stock exchange's servants—was less automated technologies *as such* but rather the introduction of a new social class to financial markets: engineers. Whereas stockbrokers had previously relied on lower class laborers for the execution of financial transactions and the daily operations of the stock exchange, engineers built up computerized and digital systems for trading *separately* from existing stock exchange social structures. One engineer recalled the social discomfort he caused in the London Stock Exchange. "We recruited…a very sort of competent, high powered team, which caused quite a lot of problems in the Stock Exchange because we basically said 'Well we're going to do things this way. Never mind how you've done it in the past.'" "There was a big difference between the organization we created," the engineer claimed, "and the existing organization of the Stock Exchange, which was very much master/servant."[83] The Big Bang in 1986 was the culmination of this process and ended the older culture for good. By the end of the twentieth century, stockbrokers looked back on the master-servant culture of the mid-twentieth century with a sense of nostalgia. One stock jobber lamented that the stock exchange he knew "seemed to go overnight really, the characters (of the stock exchange) really disappeared."[84]

The social "capture" of financial markets by engineers and coders, as Juan Pablo Pardo-Guerra has put it, should not point to the weakness of the previous labor system but remind us of its strength.[85] Rather than ever turning waiters and clerks into mechanical, bureaucratized labor forces, the "master-servant" social structures of the stock exchange provided lower-class laborers with key levers of power in both the operational and social functioning of the market. Even when the managers of the London Stock Exchange did manage to centralize and discipline some actions—like the communication system—they did so by amplifying the power they gave to their waiters, not by strengthening an impersonal bureaucratic system. The fact that the stock exchange's labor system persisted for so long and was only displaced by a social structure built *outside* of the market, which viewed itself in direct opposition to stock exchange culture, is a testament to the entrenched and critical powers that lower class laborers had carved out for themselves. Just as much as any stockbroker or financier, these laborers too were authors of a new system of finance capitalism

[83] Quoted in Pardo-Guerra, *Automating Finance*, 103.
[84] Bernard Attard, "The Jobbing System of the London Stock Exchange: An Oral History. Interview No. 6: Anthony Jenkins." London: Institute of Historical Research, (1990).
[85] Pardo-Guerra, *Automating Finance*, 84.

Chapter 2:
Information Infrastructures: The Quantification of Financial Knowledge

"Captain Cuttle, surrounded by the instruments, began to feel scientific: and looked up at the stars at night through the skylight, when he was smoking his pipe in the little back parlour before going to bed, as if he had established a kind of property in them. As a tradesmen in the City, too, he began to have an interest in the Lord Mayor, and the Sheriffs, and in Public Companies; and felt bound to read the quotations of the Funds every day, though he was unable to make out, on any principle of navigation, what the figures meant, and could have very well dispensed with the fractions."— Charles Dickens, *Dombey and Son,* (1846-1848, Chapter XXV)

"Another branch of study claimed the attention of Mrs John Rokesmith for a regular period every day. This was the mastering of the newspaper, so that she might be close up with John on general topics when John came home. In her desire to be in all things his companion, she would have set herself with equal zeal to master Algebra, or Euclid, if he had divided his soul between her and either. Wonderful was the way in which she would store up the City Intelligence, and beamingly shed it upon John in the course of the evening; incidentally mentioning the commodities that were looking up in the markets, and how much gold had been taken to the Bank, and trying to look wise and serious over it until she would laugh at herself most charmingly and would say, kissing him: 'It all comes of my love, John dear.'"—Charles Dickens, *Our Mutual Friend,* (1864-1865, Part IV, Chapter V).

Introduction

Between 1845 and 1865, something changed in the way Britons understood financial capitalism. Some differences are obvious. In *Dombey and Son*, the imagined investing subject is a clueless man living off his pension from the navy who read the price lists out of a sense of obligation. 20 years later in *Our Mutual Friend* the investing subject is an intelligent young woman who is adept at managing her household's middle-class finances and who reads the price lists with a sense of detached distance.[1] The biggest difference between the two passages is that finance capitalism was understood at all. While Captain Cuttle poured over the City papers, making neither head nor tail of the stock price lists or the Money Market and City Intelligence column that gave narrative context to the changing prices, the very same columns of prices and financial reporting served as sources of self-instruction to the newly married Mrs. John Rokesmith, née Bella Wilfer. Financial capitalism was abstracted from the physical confines of the stock exchange and the City and made legible to a wider audience via the price lists that

[1] The shift in the legibility of price lists *over distance* is especially notable. Captain Cuttle has literally moved into the square mile of the City and his domicile is both a naval instrument shop in addition to his residence. Only within this physical space does he feel "bound" to read the quotations. Bella Wilfer, on the other hand, has recently moved from the City to Greenwich and undertakes her study of the price lists to fulfill intertwined economic and gendered expectations within her role as a new homemaker as opposed to any strictly economic or profit-seeking motive. For the best reading on the intertwined ideologies of gender and economics in *Our Mutual Friend* see Poovey, *Making a Social Body: British Cultural Formation 1830-1864*, (Chicago: University of Chicago Press, 1995) 164-176. For the ways "detachment" "disinterest" and "distance"—key features of Victorian modernity—were similarly gendered see Amanda Anderson, *The Powers of Distance: Cosmopolitanism and the Cultivation of Detachment*, (Princeton: Princeton University Press, 2001) 34-62.

appeared in newspapers and periodicals throughout Britain. Financial numbers became part of the everyday epistemology of 19th century Britons.[2]

How did this shift happen and what were its consequences? Two major approaches have attempted to explain and analyze the rise of quantified financial knowledge during the 19th century. The first approach is functionalist. The functionalist argument views the proliferation of quantified financial information as a necessary and rational response by different historical actors to make financial information standardized and transportable across distances for a new and expanding set of market participants.[3] In short, economic necessity produced a new type of uniform, rational, quantified knowledge across space and time. The other approach is ideological. The ideological argument insists that the quantification of financial information was a tool to make the new financial system seem like a naturalized part of the order of things. According to Mary Poovey, financial journalists were "apologists for the credit economy," who "transformed the features adapted from existing modes of writing—especially numerical data—into rhetorical devices. The numbers journalists cited…helped create an overall image of financial institutions operating efficiently."[4]

By overly focusing on either the purely functionalist, rational production of financial numbers or by seeing financial numbers as ideological dressing that naturalized financial capitalism, both of these approaches have siloed themselves off from the third major approach to these numbers: economic history.[5] Economic historians have used the financial numbers produced by 19th century stock exchanges and financial journalists to conduct numerous quantitative studies about the historical dynamics of asset pricing and long-run economic trends.[6] In this regard modern day economists are not dissimilar from their 19th century counterparts. As this chapter will show, the abundance of quantified financial data was a foundational prerequisite for the birth of economics as a discipline. But unlike their 19th century predecessors, modern day

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[2] This concept is borrowed from Jamie Pietruska, *Looking Forward: Prediction and Uncertainty in Modern America* (Chicago: University of Chicago Press, 2017).

[3] Alex Preda, "The Rise of the Popular Investor: Financial Knowledge and Investing in England and France 1840-1900," *The Sociological Quarterly,* vol. 42 no. 2 206; see also idem, *Framing Finance: The Boundaries of Markets and Modern Capitalism,* (Chicago: University of Chicago Press, 2009). A similar approach is taken by John McCusker, "The Demise of Distance: The Business Press and the Origins of the Information Revolution in the Early Modern Atlantic World," *American Historical Review,* 110 no. 2 (April 2005) 295-321.

[4] Poovey, *Genres of the Credit Economy: Mediating Value in Eighteenth and Nineteenth Century Britain,* (Chicago: University of Chicago Press, 2008) 244; idem, "Writing about Finance in Victorian England: Disclosure and Secrecy in the Culture of Investment," in eds. Nancy Henry & Cannon Schmitt, *Victorian Investments: New Perspectives on Finance and Culture,* (Bloomington: Indiana University Press, 2009) 46. For similar arguments see also Joan Scott, *Gender and the Politics of History,* (New York: Columbia University Press, 2018) 113-138; Timothy Alborn, "Persuading by the Numbers: The Balance Sheet in Late-Victorian Financial Journalism," in ed. John Davis, *New Economics and its Writing,* (Durham: Duke University Press, 1998) 212-230.

[5] For better or worse, economic historians are simply not concerned with the ideological work of financial numbers. The functionalist approach, on the other hand, actually justifies economic historians' use of financial numbers as a stable referent to a coherent, external reality called the "economy."

[6] For examples of responsible and intellectually generative use of this data see William Goetzmann and Andrey Ukhov, "British Investment overseas 1870-1913: A Modern Portfolio Theory Approach," *Review of Finance* vol. 10 no. 2 (2006) 261-300; Benjamin Chabot, Eric Ghysels, & Ravi Jagannathan, "Price Momentum in Stocks: Insights from Victorian Age Data," working paper 14500 (November 2008) *NBER Working Paper Series*. Working Paper 14500 http://www.nber.org/papers/w1450. For an overview of some of the different approaches to using this data see Richard Grossman, "New Indices of British Equity Prices, 1870-1913," *The Journal of Economic History* vol. 62, no. 1 (March 2002), 121-146.

economists too often have taken the veracity of 19th century numbers for granted and not interrogated the context of their production.

For instance, using the newly digitized database of prices from the *Economist's* monthly supplement, *The Investor's Monthly Manual* (IMM), Richard Grossman has argued that the "total paid-up capital" of the London Stock Exchange "hovered around £3 billion from 1869 until the beginning of the First World War, when it dropped by about a third, before recovering to its prewar level by the beginning of 1929."[7] However, Grossman's figures are catastrophically wrong. He overestimates the paid-up for the period between 1869 and 1890 by between £1 and £2 billion and underestimates the paid-up capital from approximately 1905-1929 by as much as £5 billion. This gross misrepresentation of the paid-up capital on the London Stock Exchange resulted from a failure to accurately understand and contextualize the prices reported in the IMM. Grossman's initial £2 billion overestimate of paid-up capital derives from the fact that the IMM included securities from almost all of the major provincial stock exchanges and not just London. His £5 billion underestimate of paid-up capital after 1905 derives from the fact that the IMM ran out of space and could no longer include the price of every security in Britain. While the official price lists of individual stock exchanges swelled with new companies and an influx of capital, the IMM only had the space to print the major securities that were traded on different exchanges.[8] The context of how these numbers were produced and transmitted mattered enormously.

This chapter presents a different framework for explaining the rise and power of financial numbers in 19th century Britain, one that I call an "operational critique" or what Adam Tooze has called "hermeneutical quantification."[9] Instead of treating numbers as purely ideological fictions on the one hand or direct referents to an external economic reality on the other, this chapter attends to both the contingent, political production of financial numbers and how they were read, interpreted, and used to inform economic behavior.

Focusing on the operations of financial numbers in the 19th century brings to the fore a host of thorny technical questions about how financial numbers were constructed and used that are typically overlooked. Who was responsible for collecting, printing, and circulating the financial data reported in price lists? How did those responsible decide what companies and securities deserved to be included in price lists? How were accurate "market" prices agreed upon and marked in the list? Tracing this story about the *production* of share price lists from the late 18th century until the beginning of the 20th century illustrates a shift in power within financial markets from the expertise of individual brokers who could flexibly respond to changes in the market and reflect these changes in the list towards a focus on the aggregation of more formal modes of data collection undertaken by large, professionalized departments and bureaucrats.

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[7] Grossman, "Bloody Foreigners! Overseas Equity on the London Stock Exchange, 1869–1929," *The Economic History Review,* Vol. 68, no. 2, (May 2015) 475.

[8] For a complete dissection of Grossman's mistakes in contextualizing and interpreting the IMM data see Leslie Hannah, "The London Stock Exchange, 1869–1929: New Statistics for Old? *The Economic History Review* vol. 71. No. 4 (November 2018) 1349-1356.

[9] Tooze, "The Trouble with Numbers: Statistics, Politics, and History in the Construction of Weimar's Trade Balance, 1918-1924," *American Historical Review* vol. 113 no. 3 (June 2008) 681. For similar approaches see also Caitlin Rosenthal, "Seeking a Quantitative Middle Ground: Reflections on Methods and Opportunities in Economic History," *Journal of the Early Republic* vol. 36 no. 4 (Winter 2016) 659-680; Donald Mackenzie, "What's in a Number?" *London Review of Books* vol 30. No.18 (September 2008).

A second set of questions centers around how price lists were read and understood. How did the price list go from a form of knowledge that was confusing to everyday investors, like Captain Cuttle, to an easily legible, everyday piece of information that was instructive to liberal (and financialized) subjects like Bella Wilfer? How did different groups of people, like financiers, investors, and economists, use price lists differently? How did the different assumptions these groups brought to the list impact economic decision making? The operational critique pursued in this chapter shows that the numbers in price lists were never objective representations of the underlying "real value" of a security but were the product of power and technopolitics within financial markets. This approach also insists that just because these numbers were products of politics does not mean that they did not have use for historical actors. Financial numbers may have been technical fabrications, but for those who read and analyzed them, they were all too real.

Fluid Numbers

From 1680s until the mid-19th century, active stockbrokers were the exclusive editors and publishers of price lists. The numbers that appeared in the lists were the product of the personal power that these brokers wielded over the arbitrary inclusion or exclusion of particular prices and particular securities. In almost no exchange was there a formal rule about how a particular price should be marked or whether or not a certain security should be included in the list. In the early years of formal stock markets, numerous technical questions had no easy answer or rule bound solution. What companies or government debt offerings should be printed in the price list? How actively traded did a security need to be for inclusion in the list? How large did a transaction have to be for its price to constitute the "market" price that was printed? How should the price of a security be denoted in the list if deals in that security had been done at different prices throughout the day? The answer to these questions was ultimately decided by the personal discretion of the stockbroker who compiled the list.

The personal nature of financial numbers until the mid-19th century was a feature of the financial system, not a bug. Caitlin Zaloom has made the distinction between two types of financial numbers: firm numbers and fluid numbers. Firm numbers, Zaloom argues, "establish expertise and authority, make knowledge impersonal, portray certainty and universality, and contribute to resolving situations of doubt, conflict, and mistrust." Fluid numbers are more situational, "temporary assessments of market conditions, momentary markers of approximate valuation."[10] While price lists are often used and interpreted by historians as "firm numbers," they were, in fact, primarily a collection of fluid numbers. David Ricardo put it succinctly when the statistician John Sinclair asked him for advice on assembling a data set from which to analyze London's financial markets. "The Stock Exchange is chiefly attended by persons who are unremittingly attentive to their business, and are well acquainted with its details," Ricardo wrote, "but there are very few in number who have much knowledge of political economy, and consequently they pay little attention to finance, as a subject of science. They consider more, the immediate effect of passing events, rather than their distant consequences."[11] Price lists were a product of this attitude. Rather than attempting to represent the accurate market price to

[10] Zaloom, "Ambiguous Numbers: Trading Technologies and Interpretation in Financial Markets," *American Ethnologist* vol. 30 no. 2 (2003) 259.
[11] David Ricardo to John Sinclair (October 31, 1814) ed. Piero Sraffa, *The Works and Correspondence of David Ricardo* (Indianapolis: Liberty Fund, 2005). Vol. 6 1810-1815.

everyone, price lists were tools used by stockbrokers and financiers to transmit fluid numbers to each other. A corollary to this was that price lists had to be assembled by someone who was within financial markets and could respond to their fluid, fluctuating nature. This dynamic was exacerbated by the move to enclose stock exchanges beginning in the early 1800s. Stock Exchanges were closed buildings that only allowed dues-paying, trusted members inside. Thus, the only people who were capable of actually learning the true state of market prices were the brokers allowed within markets. For the 18th century and the first half of the 19th, personal embeddedness was a virtue, not a vice.

The first price list in London appeared in July of 1681. The *Merchant's Rememberer*, was published by a stockbroker and merchant named James Whiston. The list was primarily focused on commodity prices and did not contain the actual prices of financial securities. Instead, it simply noted whether the East India Company or the Royal African Company (the only two companies with tradeable shares) had a higher or lower price and whether or not Whiston himself was a buyer or seller.[12] It was as much a personal advertisement of Whiston's services as it was an objective report of market prices. After the Glorious Revolution of 1688 and its attendant "financial revolution" that made debt financing the central fiscal mechanism of the state, traffic in shares, and subsequently price lists, proliferated.[13] Like so much during the era of the "rage of party," politics was at the forefront of how people interpreted and trusted early price lists. Whiston was closely associated with the Whig Board of Trade and with the promotion of various Whig merchant interests. Stockbrokers John Castaing and John Freke published competing lists which often listed different prices. This was potentially the result of the men reporting the price at different times in the market but it was also a matter of politics. Freke was a "hot Whig," and the prices he reported on the Tory-affiliated South Sea Company were often objected to on the basis of partisan factionalism.[14] Another price list, *A Collection of Letters for the Improvement of Husbandry & Trade* was published by Royal Society member John Houghton. The security prices Houghton printed were embedded within larger datasets and scientific commentary on trade and agriculture making them part of "a distinctive project of fashioning a stock market for a Tory commercial nation."[15] The numbers published in the different lists were thrown into doubt due to the overt political affiliations of their publishers.

Of the early lists, Houghton's was also notable for its focus on appealing to outsiders, not financial insiders. The inclusion of extensive non-financial commentary set his publication apart from the purely quantitative offerings of Whiston, Castaing, and Freke. According to Houghton, those who lived in London could walk down to Exchange Alley and "every Noon and Night on Workingdays…see what Prices the Actions bear of most Companies trading in Joynt-Stocks."

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[12] Larry Neal, "The Rise of a Financial Press: London and Amsterdam, 1681-1810," *Business History* vol. 30 (April 1988) 165.

[13] The classic account of this political and financial transformation is P.G. M. Dickson, *The Financial Revolution in England: A Study in the Development of Public Credit 1688-1756* (London: Macmillan, 1967). A more modern assessment that pays particular attention to the publication, circulation, and use of price lists and information is Anne Murphy, *The Origins of English Financial Markets: Investment and Speculation before the South Sea Bubble* (New York: Cambridge University Press, 2009) especially 89-136.

[14] Miles Ogborn, *Indian Ink: Script and Print in the Making of the English East India Company*, (Chicago: University of Chicago Press, 2008) 171.

[15] Ogborn, *Indian Ink*, 194. Ogborn's account plays a bit fast and loose with the changing political alliances forged around various financial institutions and party ideologies. For a more nuanced approach to the politics of financial institutions see Abigail Swingen, "Security, Stability and Credit: The Hanoverian Succession and the Politics of the Financial Revolution," in eds. Brent Sirota & Allan I. Macinnes, *The Hanoverian Succession in Great Britain and its Empire*, (Woodbridge: Boydell & Brewer, 2019), 100-118.

On the contrary, his list was designed "for those whose Occasions permit not there to see, they may be satisfi'd once a Week how it is, and thereby the whole Kingdom may reap Advantage by those Trades."[16] Houghton's goal was to explain the new stock market "in plain English," to the "Practical Rustic," who could then see how integral the financial system was to England's national prosperity.[17] Unsurprisingly, Houghton's bet that his list would succeed by appealing to an audience of "practical rustics," in the country was a mistake. With revenue falling, Houghton was forced to include a section of paid advertisements in his price list, within which he advertised his own side-job as a chocolate salesman.[18] Houghton ceased printing his list in 1703.

By the end of the South Sea Bubble, only one price list remained: Castaing's *Course of the Exchange*.[19] Though Castaing, like most of his other competitors, was a broker who used the list to advertise his own services, *Course of the Exchange* had several advantages that its competitors did not. *Course of the Exchange* was published twice a week, on Tuesdays and Fridays, whereas Houghton's had been published weekly. The list included the share prices from each previous day as well as foreign exchange rates. Including daily summaries of price and rate fluctuations at three-day intervals was the commercial sweet spot and *Course of the Exchange* flourished. As Jacob Price has argued, these lists were "not primarily for immediate use by the City merchant who had more exact ways of determining the prices of goods in which he was seriously concerned, but rather as a convenience for those City merchants who wished to keep their country and foreign correspondents informed of the general state of the London market."[20] Instead of appealing to financial outsiders who had little stake in the movements of markets, like Houghton, Castaing's list appealed to financial insiders as a way for them to objectively confirm the state of London's financial markets to their distant partners. More than any other list, the *Course of the Exchange* was able to mediate between the immediate, fluctuating dynamics of the person-to-person networks in Exchange Alley and those who had material interest in London markets but lived at a distance. It was a way of making fluid numbers firm.

Castaing's death in 1730 did not interrupt the regular publication of the *Course of the Exchange*. The list was published by various members of Castaing's family until 1786 when it was taken over by the stockbroker Edward Wetenhall (See Figure 3). In 1803, shortly after the London Stock Exchange's formal reconstitution in 1801, Wetenhall was still the editor and publisher of *Course of the Exchange,* but the list bore the official imprimatur and authorization of the stock exchange's governing committee for the first time.[21] By 1807 publication of the list was taken over by Edward's son, James Wetenhall, and in 1811, the list was substantially enlarged to include the prices for numerous government bonds and annuities, alongside those of American securities, canals, docks, insurance companies, and waterworks. It was from this point forward, Larry Neal, argues, that the list took on an "increasingly official character," through the rest of the 19th century.[22]

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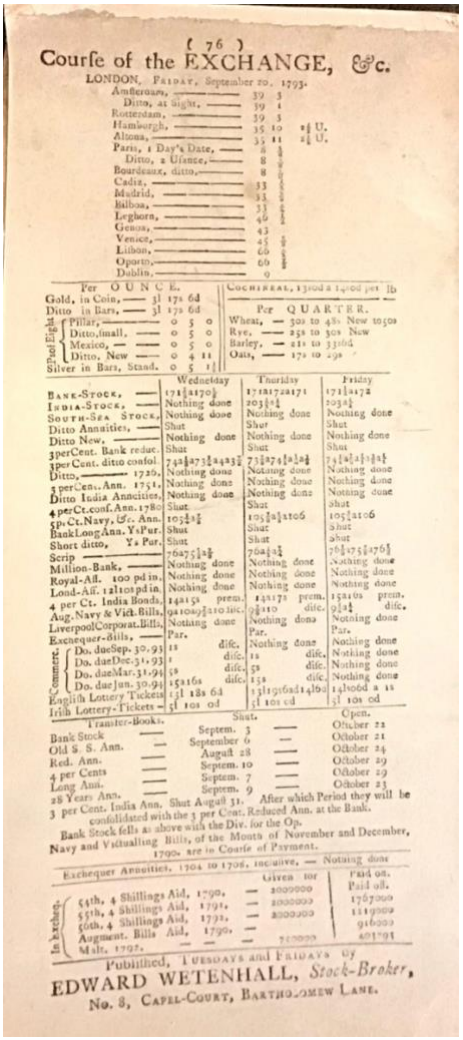
[16] Quoted in Ogborn, *Indian Ink*, 190.
[17] Quoted Ibid. 192, 181.
[18] Neal, "The Rise of a Financial Press: London and Amsterdam," 166-167.
[19] Notably, *Lloyd's List* began its publication of financial security prices and exchange rate in 1735, but it remained a list mostly used by maritime merchants while *Course of the Exchange* was the preferred list of financiers. Neal, "The Rise of a Financial Press: London and Amsterdam," 169.
[20] Jacob Price, "Notes on Some London Price-Currents, 1667-1715," *Economic History Review* vol. 2 no. 7 (1954) 243.
[21] Charles Duguid, *The Story of the Stock Exchange: Its History and Position,* (London: Grant Richards, 1901) 96.
[22] Neal, "The Rise of a Financial Press: London and Amsterdam," 171.



(76)

Course of the EXCHANGE, &c.

LONDON, FRIDAY, September 20. 1793.

Amsterdam,	39 3	
Ditto, at Sight,	39 1	
Rotterdam,	39 3	
Hamburgh,	35 10	2½ U.
Altona,	35 11	2½ U.
Paris, 1 Day's Date,	8 ¾	
Ditto, 2 Usance,	8 ¾	
Bourdeaux, ditto,	8 ¾	
Cadiz,	33 ½	
Madrid,	33 ½	
Bilboa,	33 ½	
Leghorn,	46 ½	
Genoa,	43	
Venice,	45 ½	
Lisbon,	66	
Oporto,	69 ½	
Dublin,	9	

Per OUNCE. — COCHINEAL, 13s 0d a 14s 0d per lb

Gold, in Coin,	3l 17s 6d
Ditto in Bars,	3l 17s 6d
Pistareen,	0 5 0
Ditto, small,	0 5 0
Mexico,	0 5 0
Ditto, New	0 4 11
Silver in Bars, Stand.	0 5 1½

Per QUARTER.

Wheat,	50s to 48s New 105s
Rye,	25s to 30s New
Barley,	21s to 33s 6d
Oats,	17s to 23s

	Wednesday	Thursday	Friday
BANK-STOCK,	171½172½	171½172½	171½172
INDIA-STOCK,	Nothing done	203½¾	203½
SOUTH-SEA STOCK,	Nothing done	Nothing done	Nothing done
Ditto Annuities,	Shut	Shut	Shut
Ditto New,	Nothing done	Nothing done	Nothing done
3 per Cent. Bank reduc.	Shut	Shut	Shut
3 per Cent. ditto consol.	74¾¾74¾¾74¾¾	73¾74¼¾¾	74¼¾¼¾¼
Ditto, 1726,	Nothing done	Nothing done	Nothing done
3 per Cen. Ann. 1751,	Nothing done	Nothing done	Nothing done
Ditto India Annuities,	Nothing done	Nothing done	Nothing done
4 per Ct. conf. Ann. 1780	Shut	Shut	Shut
5 p. Ct. Navy, &c. Ann.	105¾¾	105¾¾106	105¾106
Bank Long Ann. Y. Pur.	Shut	Shut	Shut
Short ditto, Y. Pur.	Shut	Shut	Shut
Scrip	76¾75¾¾	76¾¾	76¾75¾76¾
Million-Bank,	Nothing done	Nothing done	Nothing done
Royal-Aff. 100 pd in.	Nothing done	Nothing done	Nothing done
Lond. Aff. 121 10s pd in.	Nothing done	Nothing done	Nothing done
4 per Ct. India Bonds.	142 15s prem.	142 17s prem.	152 10s prem.
Aug. Navy & Vict. Bills,	94 10s 9¾ 10s 11d.	9¾ 10 disc.	9¾¾ disc.
Liverpool Corporat. Bills,	Nothing done	Nothing done	Nothing done
Exchequer-Bills,	Par.	Par.	Par.
Do. due Sep. 30. 93	1s disc.	Nothing done	Nothing done
Do. due Dec. 31. 93	1 disc.	1s disc.	Nothing done
Do. due Mar. 31. 94	5s disc.	5s disc.	Nothing done
Do. due Jun. 30. 94	1 5s 6d disc.	1 5s disc.	1 4s 6d a 1s
English Lottery Tickets	5l 18s 6d	5l 19s 6d 14 16s	14 16s 6d a 1s
Irish Lottery-Tickets	5l 10s od	5l 10s od	5l 10s od

Transfer-Books.	Shut.	Open.
Bank Stock	Septem. 5	October 22
Old S. S. Ann.	September 6	October 21
Red. Ann.	August 28	October 24
4 per Cents	Septem. 10	October 29
Long Ann.	Septem. 7	October 29
28 Years Ann.	Septem. 9	October 23

3 per Cent. India Ann. Shut August 31. After which Period they will be consolidated with the 3 per Cent. Reduced Ann. at the Bank.

Bank Stock falls as above with the Div. for the Op.

Navy and Victualling Bills, of the Months of November and December, 1790. are in Course of Payment.

Exchequer Annuities, 1704 to 1708, inclusive, — Nothing done

In Bankers.	Given for	Paid off.
54th. 4 Shillings Aid, 1790,	2000000	Paid off.
55th. 4 Shillings Aid, 1791,	2000000	1767000
56th. 4 Shillings Aid, 1792,	2000000	1119000
Augment. Bills Aid, 1790,		916000
Malt, 1792.		403791

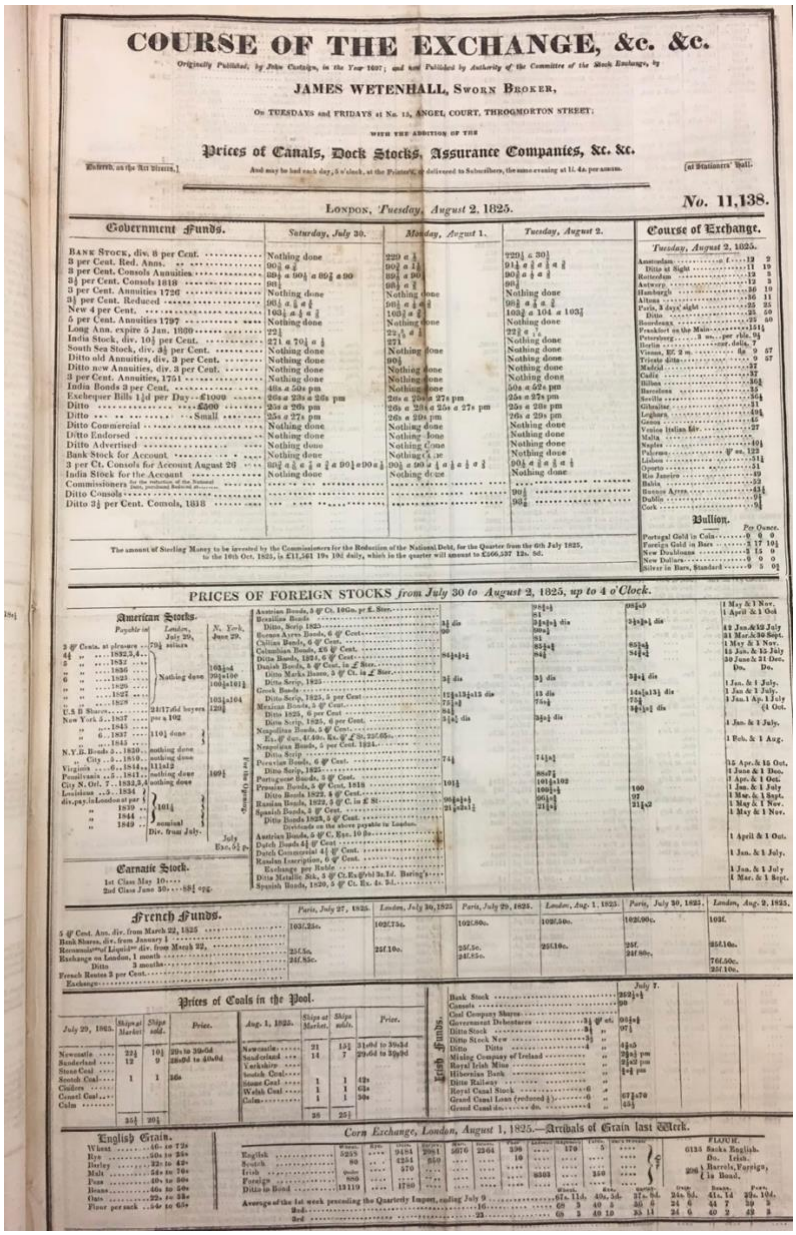
Published, TUESDAYS and FRIDAYS by
EDWARD WETENHALL, *Stock-Broker*,
No. 8, CAPEL-COURT, BARTHOLOMEW LANE.

Figure 3: *Course of the Exchange* from 1793

There was a key shift in how the list was produced beginning in 1811 and 1812, though it is not quite as great as Neal has argued. As a condition of its authorization by the London Stock Exchange, three new rules were passed that governed how prices were quoted in the *Course of the Exchange*. First, any price that was marked and printed in the list was required to be done between two members of the exchange, within the exchange's premises, and during normal business hours. Second, official quotes in the list could only be done if deals were executed in sufficient amounts: over £1000 worth of stock in English consols, Exchequer bills, and East India Stock and over £500 in Bank of England and South Sea Company stock. Third, the stock exchange's Committee for General Purposes (CGP) had final say over which securities to include on the official list.[23] After its authorization, *Course of the Exchange* became increasingly focused on financial instruments and less on the prices of bullion and commodities or exchange rates. But even within the financial securities that were printed in the list there were hierarchies. The front page included the prices of "business done" over the past three days in all of securities

[23] *Rules and Regulations Adopted by the Committee for General Purposes of the Stock Exchange to which is Prefixed the Report of the Subcommittee Upon that Subject*, (London: Stephen Couchman, 1812) 41-42.

representing English sovereign debt and beginning in the 1820s the prices of foreign debts, especially those from the United States of America and the newly independent Latin American states. Financial instruments based on equity in private companies were relegated to second class status. They were printed on the back of the list and only included one price, not the complete record of business done that government debts received (See Figures 4 and 5).



COURSE OF THE EXCHANGE, &c. &c.

Originally Published, by John Castaign, in the Year 1697; and now Published by Authority of the Committee of the Stock Exchange, by

JAMES WETENHALL, Sworn Broker,

On TUESDAYS and FRIDAYS at No. 13, ANGEL COURT, THROGMORTON STREET:

WITH THE ADDITION OF THE

Prices of Canals, Dock Stocks, Assurance Companies, &c. &c.

Entered, as the Act directs.] And may be had each day, 5 o'clock, at the Printer's, or delivered to Subscribers, the same evening at 11. 4s. per annum. [at Stationers' Hall.

LONDON, *Tuesday, August* 2, 1825. *No.* 11,138.

Government Funds. — *Saturday, July* 30. — *Monday, August* 1. — *Tuesday, August* 2.

Course of Exchange. *Tuesday, August* 2, 1825.

Bullion.

PRICES OF FOREIGN STOCKS *from July* 30 *to August* 2, 1825, *up to* 4 *o'Clock.*

American Stocks.

French Funds.

Prices of Coals in the Pool.

Corn Exchange, London, August 1, 1825.—Arrivals of Grain last Week.

Figure 4: Front page of the *Course of the Exchange* from 1825

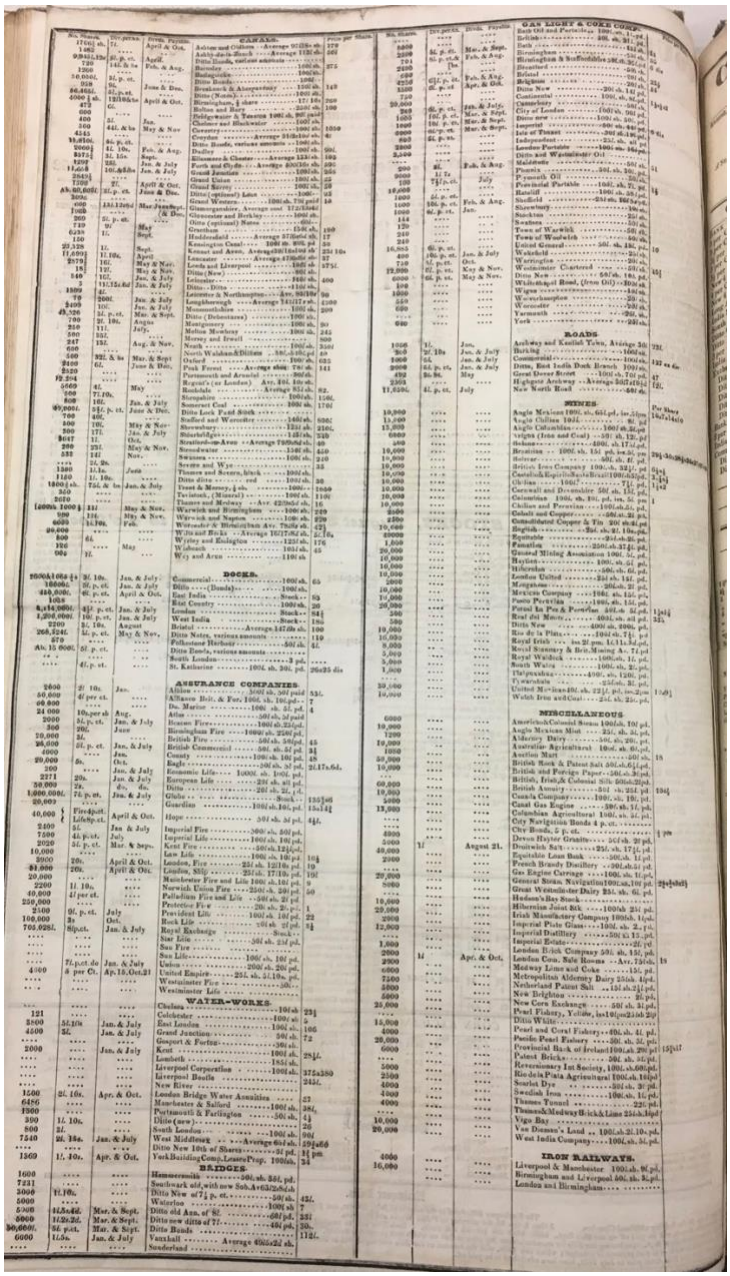


Figure 5: Back page of the *Course of the Exchange* from 1825.

Despite the fact that the list was now authorized by the London Stock Exchange and the reporting of prices were subjected to regulations, there was no systematic enforcement of these regulations other than via the personal discretion of James Wetenhall. Wetenhall's sole control over the list was both a source of immense power and fragility. A clear example of this is an incident from October 1826. On October 6th an anonymous author wrote to the London *Times* expressing his suspicions "of some trick in the quotation" of the price of French *rentes*. The jobbers in the French market claimed that on Tuesday October 3, 1826, French stock "had never been under £98," yet in *Course of the Exchange* the price for that day was quoted at £97. The writer alleged that a "broker having some French (rentes) to sell for an unlucky principal," sold

them to Nathan Mayer Rothschild who paid brokers a commission to deal French *rentes* through him instead of other dealers in the market. In pursuit of commission for himself, the broker sold the shares to Rothschild at "one percent under the price which he might have obtained for it in the market…thus sacrificing his principal's interest to his own."[24] However, in order to convince his client that he had, in fact, made the trade at a fair market price, he managed to have Wetenhall mark £97, not £98, in the list. In short, the prices in the printed list were artificially divorced from the prices in the market by a broker who was trying to prevent his client from finding out he had made a bad trade.

The more facts that were brought to light about the incident, the more damning it became. The broker in question, John Israel, had approached Wetenhall after the market closed at 4 o'clock and asked him to mark £97 for French *rentes*. Wetenhall declined on grounds that it was after hours and such a transaction did not fall within the rules of the exchange. Not taking no for an answer, Israel followed Wetenhall's clerk down to the printing shop where the list was published. Israel handed the clerk a slip of paper that he claimed was from Wetenhall instructing the clerk to print the price at £97. Israel defended himself by claiming that the transaction had been done in exigent circumstances. Instead of selling for a commission to Rothschild, as the *Times* claimed, Israel was actually the buyer. It was not Israel but his counterparty—a man who was not a member of the stock exchange—who requested that "the List (be) altered that he might send it to (his client in the country)." It fell to Israel, as a member of the Stock Exchange, to have the price marked at £97. The CGP censured Israel for his actions and forced him to write a letter clarifying his actions to the *Times*. Israel bitterly complained that the investigation into his actions was a sham, concocted solely "for the purposes of exonerating Mr. Wetenhall and the committee and fixing the blame on himself."[25]

The incident clarifies three key operational aspects of price lists in the early 19th century London Stock Exchange. The first point is that the prices marked in the *Course of the Exchange* were not marked with any systematicity. While the prices in the list were *precise*—they recorded every instance of "business done" in a particular security— these prices were not necessarily *accurate* in depicting what the actual market sentiment of a fair price was. By listing the prices of all the different business done, Wetenhall's list did not clarify what amount of the security was actually traded. A deal executed for the minimum amount of a security was given equal weight in the list as a deal done for 10x that amount. The deal done for 10x the amount of shares would clearly do more to shape how brokers and jobbers fixed their prices than a deal done at the minimum requirement for inclusion in the list. Second, the prices printed in the list were the self-reported prices of brokers who used the list to demonstrate to their clients that they had executed a fair deal, not the product of any objective examination of the market by Wetenhall. Lastly, even though Wetenhall's personal control of the price list was deemed operationally necessary to capture the changing fluctuations in market prices, it was also a weak link in the London Stock Exchange's informational ecosystem. There were no structural and systematic processes for assembling the list outside of Wetenhall himself which meant that the list could be relatively easily manipulated. Israel's bitterness at the investigation is telling in this regard. Although the deal Israel executed technically fell outside of the rules, he clearly felt that Wetenhall should have still marked the price and that he was unfairly treated. Wetenhall's discretionary power over the list meant that one's social relation with him had operational consequences. If

[24] London Stock Exchange, Foreign Stock Market Committee Minutes, 1823-1828, 365, MS/14617/01 GL; *Times* October 6, 1826, 2.
[25] London Stock Exchange, Foreign Stock Market Committee Minutes, 1823-1828, 365-371, MS/14617/01 GL.

Wetenhall liked you he could bend the rules and mark a price. If Wetenhall did not like you, he could stringently keep to the rules or, as we will see, ignore them altogether.

Despite the obvious drawbacks that came with vesting control of the *Course of the Exchange* solely in Wetenhall, his personal dominance over the London Stock Exchange's price lists only grew in subsequent years. One of the most notable indications of Wetenahall's growing power occurred in October of 1829 when Wetenhall, who was still an active stockbroker on the exchange, was declared a defaulter. Typically, "defaulting" or being unable to pay for stock when called upon, resulted in a humiliating social ritual. The defaulter's name was ostentatiously nailed to the main pillar on the trading floor, while their books were turned over to the CGP to ensure that creditors were paid out fairly. Defaulters were expelled from the stock exchange and were prevented from applying for re-admission for two years. However, none of this happened to Wetenhall. Members of the stock exchange quickly sent a petition to the CGP "lamenting the difficulties in which James Wetenhall has recently been involved" but arguing that "the satisfactory manner in which his Publications of the Various Price Lists have been conducted for more than 20 years under your sanction may induce you to consider his case, do earnestly recommend him to the committee for General Purposes as a proper person for re-admission to the Stock Exchange under their dispensing power." Two weeks later, Wetenhall was unanimously re-admitted to the stock exchange, but only as a full-time employee and no longer as a stockbroker.[26] Wetenhall's operational importance gave him impunity from one of the most central mechanisms for disciplining debtors in the exchange.

From the 1820s until the mid-1840s, the *Course of the Exchange*, or "Wetenhall's List" as it became colloquially known, took on a new level of both operational and cultural prominence in British finance. By 1833 the *Course of the Exchange* published around 8,000 copies per year. This was smaller than financial periodicals that provided commentary, like the *Circular to Bankers* or the *Bankrupt and Insolvent's Weekly Gazette*, each of which had a circulation of around 16,000. But it was more than other comparable quantitative price lists like the *Corn Trade Circular* or *Commercial Record* each of which had a yearly circulation of around 5,000.[27] Despite its comparatively low circulation numbers, Wetenhall's list gained prominence because it was the key data source for other publications. Other than *Circular to Bankers*, there was virtually no dedicated financial press that circulated price information in the years before 1845.[28] Additionally, almost every newspaper outside of London operated on a weekly or bi-weekly basis.[29] In both regards Wetenhall's list filled a substantial informational gap. Newspapers publishing once a week replicated the structure of the *Course of the Exchange* by printing the prices of London securities over the course of each previous day in the week, even if they did not directly cite Wetenhall.[30] With limited coverage by the local provincial press and essentially no financial press, many brokers in the provinces took to advertising Wetenhall's prices as their own or selling his lists second hand to local customers. [31] Whether it was through

[26] London Stock Exchange, Committee for General Purposes Minutes, 1829-1831, 49, 52, 57, MS/14600/012 GL.
[27] *Jackson's Oxford Journal, Oxford,* August 24, 1833, 2.
[28] The *Economist* was not founded until 1843, and the *Banker's Magazine* was not founded until 1844. See David Moss, "'Circular to Bankers': The Role of a Prototypical Trade Journal in the Evolution of Middle-Class Professional Consciousness," *Victorian Periodicals Review,* vol. 25 no. 3 (Fall 1992) 129-136.
[29] Andrew Hobbs, *A Fleet Street in Every Town: The Provincial Press in England, 1855-1900,* (Cambridge: Open Book Publishers, 2018) 2-3.
[30] There are many examples of this. For a sampling see: *Bristol Mercury*, October 26, 1826, 3.
[31] For a few examples see: *Caledonian Mercury*, March 12, 1825, 3; *Birmingham Gazette*, November 12, 1827, 2; *Devizes and Wiltshire Gazette*, June 30, 1836, 1.

the newspapers or via the distribution of local brokers, Wetenhall's list was the crucial informational infrastructure that linked London's financial markets to the provinces.

While Wetenhall's *Course of the Exchange* connected financiers in London to financiers in the provinces, enterprising provincial brokers also began printing and circulating their own price lists locally. In an age before there were organized stock exchanges outside of London, the personal services of these brokers, and the information they provided, was what constituted the "market." For instance, the first share price lists appeared in Bristol in 1826, 19 years before the creation of the Bristol stock exchange. These price lists were the creation of a local broker named Lancelot Beck who circulated the prices of canal and mining stocks from Somerset, Gloucestershire, and South Wales.[32] The first Liverpool price list appeared in 1830, six years before the formation of its stock exchange. The list promised to correct the "very inaccurate quotations respecting the price of Railroad shares, Canal shares, &c" and to give weekly prices which could "be implicitly depended upon."[33] The initial share-price list seemed to appear through the somewhat abstracted, anonymous hand of the local newspaper's editors but subsequent lists were signed by a local broker named Thomas Coglan.[34] Most of the early price lists in Manchester were literally just advertisements for the services of certain brokers. One list by a broker named William Seebhom included stocks and shares that he was willing to sell in the top half of the ad and those he was ready to purchase in the bottom half. London brokers, sensing the need for financial information and services in the provinces, also began advertising themselves with price lists. William Trenery was one such London broker who listed not only the shares he was willing to buy and sell but also noted that "parties who may favour (him) with their commands…may rely upon his utmost to promote their interest," in London. Still more brokers, like Alexander Petty, advertised his connections in London which gave him "the most prompt and accurate information as to the state of the Share Market," and that he was available to both buy and sell shares "of every description, without entering into detail."[35] Whether it was Wetenhall or the brokers in the provinces, price lists in the first half of the 19th century were always bound up with personal authority of the broker who produced them.

Personal trust did not always lead to public legibility. Even though Wetenhall's list had a wide geographical distribution its use was still primarily limited to financiers. The editor of *Banker's Magazine* used Wetenhall's list extensively without a second thought. "Wetenhall's list is always spoken of as an accurate publication and is used by us for our monthly comparison of the English funds (and) the state of the foreign funds we quote from a comparison of the list," he wrote.[36] The general public did not feel the same. One newspaper editor bemoaned the "difficulty experienced by our correspondent in determining the meaning of the quotations in the official 'Course of the Exchange.'" The problem, the editor explained, was that many pieces of information, like the different types of currency that exchange rates were denominated in, were "not indicated in the official list because brokers who deal in foreign bills are so familiar with (it)…that the information would be superfluous."[37] Despite the geography of its distribution, the uses of the list remained limited to financial professionals.

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[32] *Bristol Mirror*, Bristol, October 25, 1826. My thanks to Andrew Hobbs for sharing this reference with me.
[33] *Liverpool Mercury*, March 12, 1830.
[34] *Liverpool Mercury*, May 14, 1830; June 4, 1830.
[35] *Manchester Times and Gazette*, May 7, 1836.
[36] *Bankers Magazine and Journal of the Money Market* (March 1845) 359.
[37] *Newcastle Journal*, August 31, 1850, 2.

The pervasiveness of Wetenhall's list alongside its relative unintelligibility among the public led the *Course of the Exchange* to become culturally symbolic of all the ills of finance capitalism writ large. According to the *Times* "Wetenhall's List" was the complete "receptacle for every description of security which has ever become in the remotest degree an object of gambling or speculation."[38] The Anglican cleric Sydney Smith likewise indicted what he saw as the new civic religion of finance that seemed to dominate public life. "If Caesar were to reappear upon earth," Smith argued, "Wetenhall's list would be more important than his commentaries; Rothschild would open and shut the temple of Janus; Thomas Baring or Bates would probably command the tenth legion, and the soldiers would march to battle with loud cries of 'Scrip and Omnium Reduced, Consols and Caesar."[39] Wetenhall and his price lists even came in for criticism in early Victorian fiction. As the epigraph of this chapter indicated, Charles Dickens juxtaposed the morally upright yet financially illiterate Captain Cuttle against the morally reprobate yet financially literate clerk, James Carker.[40] Another story satirized the fleeting fortunes gained through speculation in fictious companies during the Railway Mania. The story mocked those rich in "paper wealth" who had their pockets "invariably crammed with share-lists; and…quoted, (even) if he did not comprehend, the money article from the *Times*."[41] The financial information in Wetenhall's list was at once culturally ubiquitous and simultaneously illegible to the general public.

The financial numbers produced by Wetenhall and individual brokers in the provinces came to a crisis during the Railway Mania of 1844-1847. The passage of the Railway Regulation Act in 1844 prompted a furious spate of railway company applications for parliamentary approval. Upon receiving parliamentary sign-off, these companies then applied to stock exchanges so that they could raise capital to fund their operations. In 1845 alone, over 1,200 new railway projects were floated. Additionally, many of the shares issued by new railway companies were only "partially paid-up." That is, a share nominally worth £20 could be purchased by an investor for as little as £1. The dramatic increase in the amount of railway companies coupled with the decrease in the initial price of shares prompted a speculative frenzy in stock exchanges throughout Britain. Investors flocked to invest in shares which in turn created an "influx of members and clerks," within stock exchanges themselves.[42] Many railways were based in the provinces which also created more business in the country than a few disorganized brokers could handle. While stock exchanges in Liverpool and Manchester had been in operation since 1836, new exchanges were opened in Glasgow, Edinburgh, Aberdeen, Bradford, Bristol, Birmingham, Hull, Huddersfield, Leeds, Leicester, Newcastle, Nottingham, Sheffield, and York between 1844 and 1846.[43]

As companies, shares, brokers, jobbers, clerks, and transactions proliferated during the Railway mania, the London Stock Exchange's operational infrastructures came under an immense strain. Wetenhall was especially affected. In November 1844 one stockbroker

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[38] "Money-Market and City Intelligence," *Times*, November 2, 1836, 5.
[39] "American Affairs," *Times*, November 10, 1843, 3.
[40] See Gillian Gane, "The Hat, the Hook, the Eyes, the Teeth: Captain Cuttle, Mr. Carker, and Literacy," *Dickens Studies Annual* vol. 25 (1996) 91-126.
[41] W.E. Aytoun "How we got up the Glenmutchkin Railway and how we got out of it," *Blackwood's Edinburgh Magazine*, (October 1845) 461.
[42] London Stock Exchange, Trustees and Managers Minutes, 1842-1852, 94, MS/19297/003 GL. For a good summary of the Railway Mania see William Quinn and John Turner, *Boom and Bust: A Global History of Financial Bubbles*, (New York: Cambridge University Press, 2020) 58-76.
[43] W.A. Thomas, *The Provincial Stock Exchanges*, (London: Frank Cass, 1973) 28-71.

requested that the Cambridge-Lincoln Railway be officially included in the price list. The CGP authorized its inclusion but Wetenhall simply refused. When called in front of the committee, Wetenhall proffered a number of different answers as to why he had not included the railway in the list: first he claimed that there was not enough business done in the stock to warrant its inclusion in the list (an assertion the broker refuted); and second he claimed that "there was no room" left in the list. The committee reproached Wetenhall and informed him that "as their authorized publisher of the Stock Exchange List, he should produce it in a perfect state, for the credit of themselves and the house generally, if therefore there was not sufficient space at present he must enlarge his list," and "that he be reprimanded for this neglect and that he be directed in future to insert in all lists published under the authority of the committee the names of all the companies and the quotations of all the prices ordered to."[44] Though dealings had in fact been done in Cambridge-Lincoln stock before Wetenhall had listed the company, Wetenhall's various refusals to mark the price prevented the creation of a knowable and public market for the stock and hampered a fair assessment of the company's value.

Not only did Wetenhall face increased pressure to constantly update his list and mark new prices, but he also faced distributional pressures as more brokers and investors wanted his lists than ever before. On March 7, 1845, during the middle of the Railway Mania, the operational pressures facing Wetenhall, stockbrokers, and their clerks, exploded into violence. That night as Wetenhall was compiling the *Course of the Exchange*, the hallway outside his office was flooded with "a lot of boys waiting in the passage for the lists." The young clerks "were a nuisance to everyone," and prevented Wetenhall from moving "into or out of his office" as he assembled the day's price list. After attempting to clear the hallway, Wetenhall began shouting at the clerks who refused to leave, even calling one clerk a "damned impertinent puppy." Wetenhall dragged the clerk "by the collar…with considerable violence," out of the hallway and perhaps most egregiously refused to give any price lists to that clerk until after 7 o'clock at night. [45] Despite the fact that Wetenhall was severely censured by both governing committees of the stock exchange for his "extremely reprehensible" behavior, Wetenhall continued to refuse to supply price lists to the clerk in question.[46] "His father had other clerks in his office whom he might send, but that he (the son) never should have them in consequence of his former conduct," Wetenhall defiantly told the stock exchange's managers.[47]

The managers of the London Stock Exchange faced a conundrum. On the one hand, they had delegated the operational responsibilities of assembling and distributing the price list to Wetenhall for so many years that he had, in effect, built up institutional impunity to oversight.[48] On the other hand, it was clear that Wetenhall was both personally and operationally no longer up to the task.[49] Too many key decisions about what to include in the list and who the list should

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[44] London Stock Exchange, Committee for General Purposes Minutes, 1842-1845, 431-433, MS/14600/018 GL.
[45] Ibid. 497-498. Wetenhall admitted that the events transpired as recounted, but denied that they constituted either "assault," or use of "coarse language."
[46] Ibid. 498.
[47] London Stock Exchange, Trustees and Managers Minutes, 97, 1842-1852, MS/19297/003 GL.
[48] In addition to stock exchange members interceding on his behalf to prevent him from normal discipline after he defaulted in the 1820s, the managers of the exchange still felt compelled to invite him to yearly, celebratory meals with the other officers of the exchange, even after the incidents of March 1845. See London Stock Exchange, Trustees and Managers Minutes, 150 1842-1852, MS/19297/003 GL.
[49] In addition to his outburst of violence in March of 1845, Wetenhall was also arrested for assaulting another stock exchange employee in September of 1845. *Times* (September 25, 1845) 8. The news article claims that the altercation was between George Street and "George" Wetenhall but given that Wetenhall is repeatedly referred to as

be distributed to had been centralized in the hands of Wetenhall and complaints about his performance only increased.[50]

In November of 1846, the CGP convened a special session to discuss the "present defective state of the Share List." In addition to the numerous mistakes in the list that brokers complained about, the CGP was also worried about London's competitiveness in new railway securities. Numerous "Provincial Share Lists," were displayed at the meeting, all of which "exhibit(ed) much more extensive information on matters connected with railway shares than the London list."[51] The London Stock Exchange decided to create a "Railway Department," under the supervision of a man named Mihill Slaughter.[52] Slaughter's charge was to forge a minor bureaucracy within the stock exchange that collected railway company data like dividends, calls on shares, when annual shareholder meetings were, and traffic receipts, in addition to publishing new weekly "Railway Lists." He was also charged with revamping the "Daily Railway List" that had previously been published by Wetenhall since the beginning of the Mania. Slaughter quickly won over the esteem of his colleagues. By 1847 the managers of the exchange "were so satisfied with (the) utility," of Slaughter's new Railway Lists that they scrapped the gradual introduction of the list and instructed him to begin its production immediately.[53] (See Figures 6 & 7). In an ironic twist of fate, James Wetenhall died later the same year.[54] Wetenhall's descendants continued to publish the *Course of the Exchange* into the twentieth century but after 1847 neither he nor his list had a monopoly on financial information in Britain.

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the printer of "Wetenhall's Stock and Sharebrokers' List," this seems like a mistake as James Wetenhall was the publisher of the list in 1845.

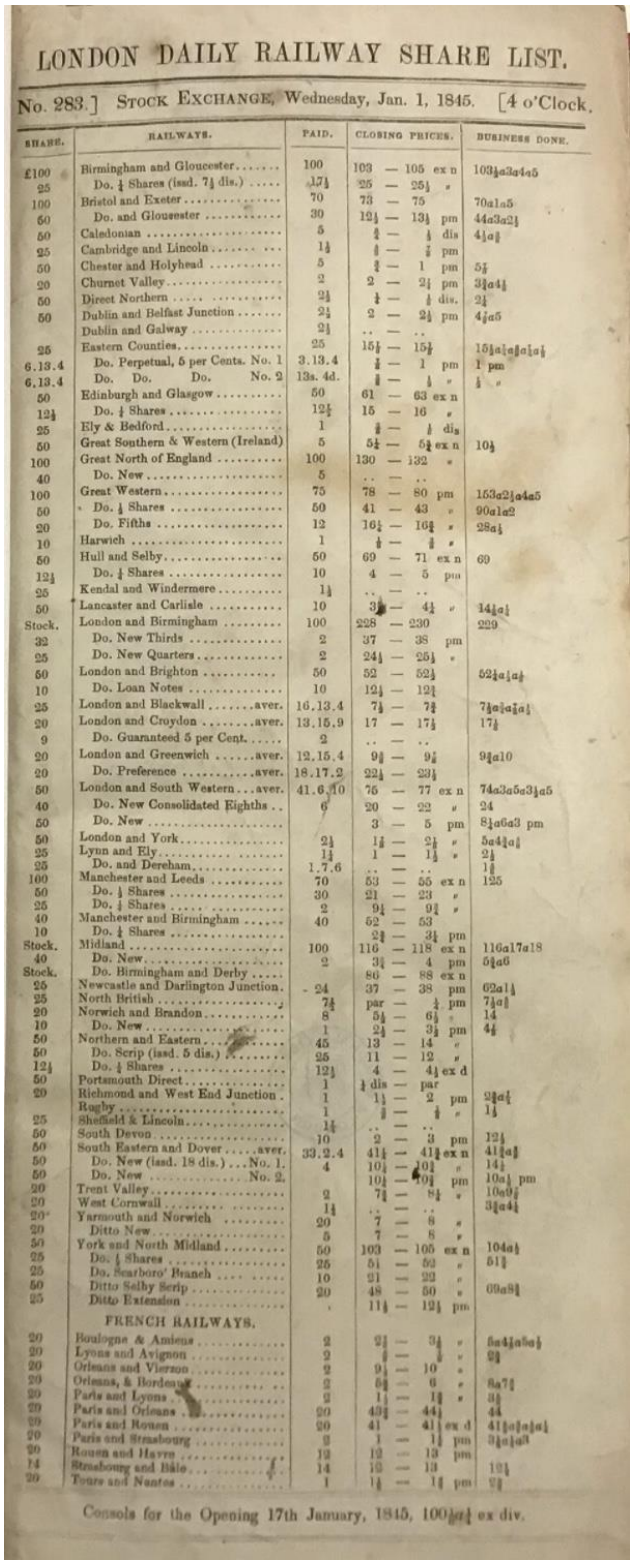
[50] For a sampling of complaints see London Stock Exchange, Committee for General Purposes Minutes, 1842-1845, 23, 335, 382 MS/14600/018 GL.

[51] London Stock Exchange, Committee for General Purposes Minutes, 1842-1845, 62, MS/14600/020 GL.

[52] For the best biographical sketch of Slaughter see, Laurie Dennett, *Slaughter and May: A Century in the City* (Cambridge: Granta, 1989) 1-20.

[53] London Stock Exchange, Trustees and Managers Minutes, 168, 1842-1852, MS/19297/003 GL.

[54] Ibid. 175.



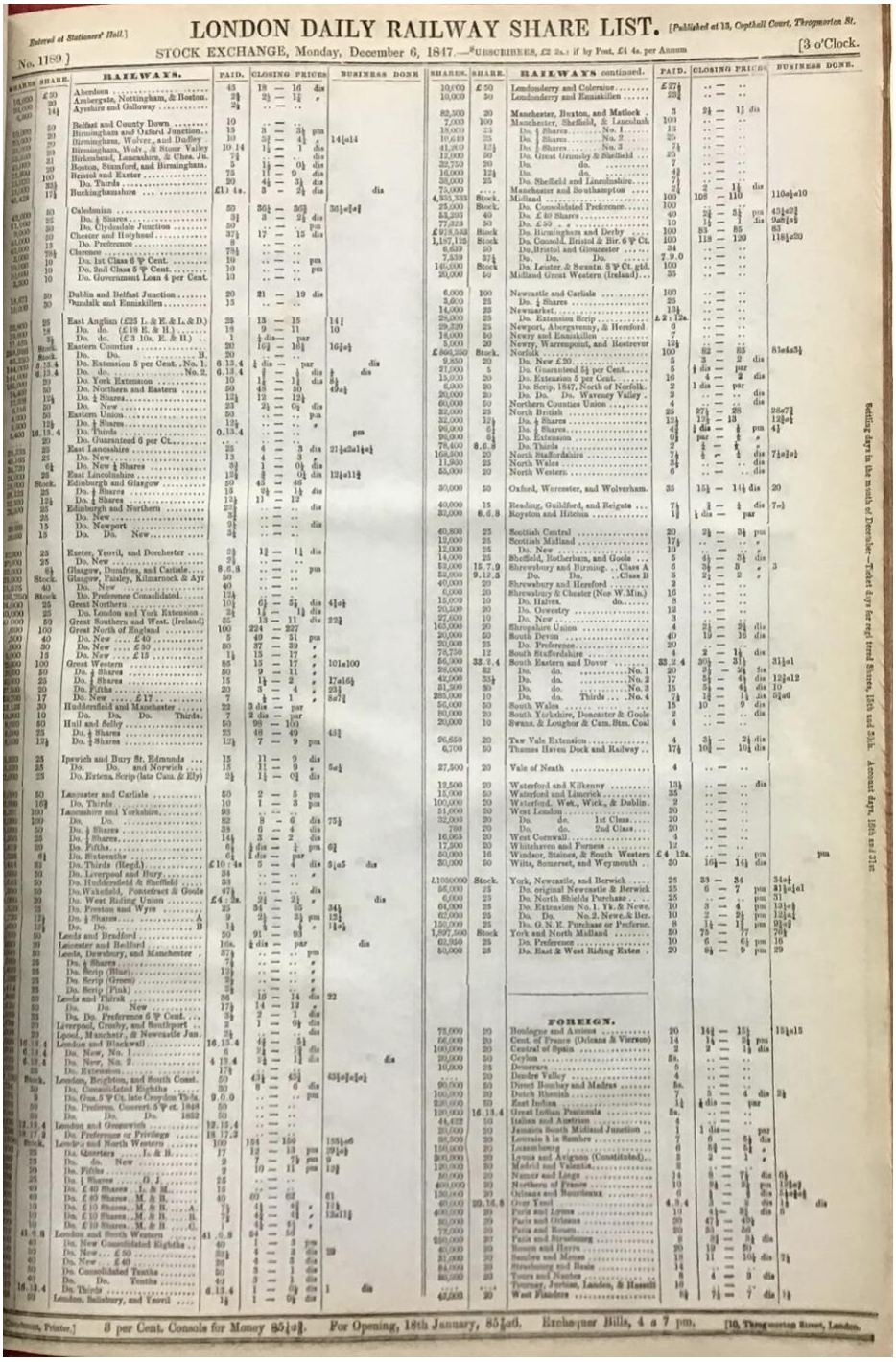
LONDON DAILY RAILWAY SHARE LIST.

No. 283.] STOCK EXCHANGE, Wednesday, Jan. 1, 1845. [4 o'Clock.

SHARE.	RAILWAYS.	PAID.	CLOSING PRICES.	BUSINESS DONE.
£100	Birmingham and Gloucester	100	103 — 105 ex n	103¼a3a4a5
25	Do. ½ Shares (issd. 7½ dis.)	17½	25 — 25½ "	
100	Bristol and Exeter	70	73 — 75	70a1a5
50	Do. and Gloucester	30	12½ — 13½ pm	44a3a2½
50	Caledonian	5	¾ — ¼ dis	4¼a¾
25	Cambridge and Lincoln	1¼	⅜ — ½ pm	
50	Chester and Holyhead	5	¾ — 1 pm	5½
20	Churnet Valley	2	2 — 2½ pm	3¾a4¼
50	Direct Northern	2½	¼ — ½ dis.	2¼
50	Dublin and Belfast Junction	2½	2 — 2½ pm	4¼a5
	Dublin and Galway	2½	.. — ..	
25	Eastern Counties	25	15½ — 15½	15¼a1⅛a¼a1a1¼
6.13.4	Do. Perpetual, 5 per Cents. No. 1	3.13.4	¾ — 1 pm	1 pm
6.13.4	Do. Do. Do. No. 2	13s. 4d.	⅜ — ½ "	½ "
50	Edinburgh and Glasgow	50	61 — 63 ex n	
12½	Do. ½ Shares	12½	15 — 16 "	
25	Ely & Bedford	1	⅜ — ½ dis	
50	Great Southern & Western (Ireland)	5	5½ — 5¾ ex n	10¼
100	Great North of England	100	130 — 132 "	
40	Do. New	5	.. — ..	
100	Great Western	75	78 — 80 pm	153a2¼a4a5
50	Do. ½ Shares	50	41 — 43 "	90a1a2
20	Do. Fifths	12	16½ — 16¾ "	28a¼
10	Harwich	1	⅜ — ½ "	
50	Hull and Selby	50	69 — 71 ex n	69
12½	Do. ½ Shares	10	4 — 5 pm	
25	Kendal and Windermere	1¼	.. — ..	
50	Lancaster and Carlisle	10	3¾ — 4¼ "	14¼a¼
Stock.	London and Birmingham	100	228 — 230	229
32	Do. New Thirds	2	37 — 38 pm	
25	Do. New Quarters	2	24½ — 25½ "	
50	London and Brighton	50	52 — 52½	52¼a¼a¼
10	Do. Loan Notes	10	12¼ — 12½	
25	London and Blackwall aver.	16.13.4	7⅛ — 7⅜	7⅛a¼a⅛a¼
20	London and Croydon aver.	13.15.9	17 — 17½	17½
9	Do. Guaranteed 5 per Cent.	2	.. — ..	
20	London and Greenwich aver.	12.15.4	9⅜ — 9½	9¼a10
20	Do. Preference aver.	18.17.2	22¼ — 23¼	
50	London and South Western aver.	41.6.10	75 — 77 ex n	74a3a5a3¼a5
40	Do. New Consolidated Eighths	6	20 — 22 "	24
50	Do. New		3 — 5 pm	8¼a6a3 pm
50	London and York	2½	1⅜ — 2¼ "	5a4¼a¼
25	Lynn and Ely	1¼	1 — 1½ "	2¼
25	Do. and Dereham	1.7.6	.. — ..	1⅜
100	Manchester and Leeds	70	53 — 55 ex n	125
50	Do. ½ Shares	30	21 — 23 "	
25	Do. ¼ Shares	2	9¼ — 9½ "	
40	Manchester and Birmingham	40	52 — 53	
10	Do. ¼ Shares		2⅜ — 3¼ pm	
Stock.	Midland	100	116 — 118 ex n	116a17a18
40	Do. New	2	3¼ — 4 pm	5¼a6
Stock.	Do. Birmingham and Derby		86 — 88 ex n	
25	Newcastle and Darlington Junction	24	37 — 38 pm	62a1¼
25	North British	7½	par — ¼ pm	7¼a¾
20	Norwich and Brandon	8	5¼ — 6¼ "	14
10	Do. New	1	2¼ — 3¼ pm	4¼
50	Northern and Eastern	45	13 — 14 "	
50	Do. Scrip (issd. 5 dis.)	25	11 — 12 "	
12½	Do. ½ Shares	12½	4 — 4¼ ex d	
50	Portsmouth Direct	1	½ dis — par	
20	Richmond and West End Junction	1	1½ — 2 pm	2¾a¼
	Rugby	1	⅜ — ½ "	1¼
25	Sheffield & Lincoln	1¼	.. — ..	
50	South Devon	10	2 — 3 pm	12¼
50	South Eastern and Dover aver.	33.2.4	41¼ — 41¾ ex n	41¾a¼
50	Do. New (issd. 18 dis.) No. 1.	4	19¼ — 19¾ "	14¼
50	Do. New No. 2.		19¼ — 19¾ pm	10a¼ pm
20	Trent Valley	2	7¾ — 8¼ "	10a9¾
20	West Cornwall	1¼	.. — ..	3¾a4¼
20	Yarmouth and Norwich	20	7 — 8 "	
20	Ditto New	5	7 — 8 "	
50	York and North Midland	50	103 — 105 ex n	104a¼
25	Do. ½ Shares	25	51 — 52 "	51¾
25	Do. Scarboro' Branch	10	21 — 22 "	
50	Ditto Selby Scrip	20	48 — 50 "	49a8¼
25	Ditto Extension		11¼ — 12¼ pm	
	FRENCH RAILWAYS.			
20	Boulogne & Amiens	2	2¼ — 3¼ "	5a4¼a5a¼
20	Lyons and Avignon	2	⅜ — ½ "	2¾
20	Orleans and Vierzon	2	9¼ — 10 "	
20	Orleans, & Bordeaux	2	5¾ — 6 "	8a7¾
20	Paris and Lyons	2	1¼ — 1¾ "	3¾
20	Paris and Orleans	20	43¾ — 44¼	44
20	Paris and Rouen	20	41 — 41¼ ex d	41¼a¼a¼a¼
20	Paris and Strasbourg	2	1 — 1¼ pm	3¼a¼a¾
20	Rouen and Havre	12	12 — 13 pm	
14	Strasbourg and Bâle	14	13 — 13	13¼
20	Tours and Nantes	1	1¼ — 1¾ pm	2¾

Consols for the Opening 17th January, 1845, 100¼a¼ ex div.

Figure 6: Daily Railway Share List published by Wetenhall in 1845



LONDON DAILY RAILWAY SHARE LIST. [Published at 15, Copthall Court, Throgmorton St.

Entered at Stationers' Hall.] STOCK EXCHANGE, Monday, December 6, 1847.—SUBSCRIBERS, £2 2s. if by Post, £4 4s. per Annum [3 o'Clock.

No. 1180

SHARE.	SHARE.	RAILWAYS.	PAID.	CLOSING PRICES	BUSINESS DONE.
	£ 50	Aberdeen	45	18 — 16 dis	
	20	Ambergate, Nottingham, & Boston.	2½	2½ — 1½ "	
	14½	Ayrshire and Galloway	2½	.. — ..	
		Belfast and County Down	10	.. — ..	
	50	Birmingham and Oxford Junction..	15	3 — 2½ pm	
	20	Birmingham, Wolver., and Dudley	10	5½ — 4½ "	14¼14
	20	Birmingham, Wolv., & Stour Valley	10-14	1½ — 1 dis	
	50	Birkenhead, Lancashire, & Ches. Ju.		¾ — .. dis	
	20	Boston, Stamford, and Birmingham.	5	1¼ — 0¾ dis	
	100	Bristol and Exeter	75	17 — 9 dis	
	33½	Do. Thirds	20	4¾ — 3½ dis	
	17½	Buckinghamshire	£1:3 4s.	3 — 2½ dis	dis
	50	Caledonian	50	36½ — 36⅝	36½¼¼
	25	Do. ½ Shares	31	3 — 2½ dis	
	20	Do. Clydesdale Junction	20	.. — .. pm	
	50	Chester and Holyhead	37½	17 — 15 dis	
	13	Do. Preference	8	.. — ..	
	70½	Clarence	70½	.. — ..	
	10	Do. 1st Class 6 ℘ Cent.	10	.. — .. pm	
	10	Do. 2nd Class 5 ℘ Cent.	10	.. — .. pm	
	10	Do. Government Loan 6 per Cent.	10	.. — ..	
	50	Dublin and Belfast Junction	20	21 — 19 dis	
	50	Dundalk and Enniskillen	15	.. — ..	
	25	East Anglian (£25 L. & E. & L. & D.)	25	13 — 15	14¦
	18	Do. do. (£18 E. & H.)	18	9 — 11	10
	5½	Do. do. (£3 10s. E. & H.)		¼ dis — par	
	Stock.	Eastern Counties	20	10½ — 10¾	16¦e¾
	Stock.	Do. Do. B	20	.. — ..	
	8 13.4	Do. Extension 5 per Cent. No. 1.	6 13.4	¼ dis — par dis	
	6 13.4	Do. do. No. 2.	6 13.4	¼ — ¼ dis ¼ dis	
	20	Do. York Extension	10	1¼ — 1⅛ dis 8½	
	50	Do. Northern and Eastern	50	48 — 50 49¼¦	
	12½	Do. ½ Shares	12½	12 — 12½	
	50	Do. New	25	2½ — 0¾ dis	
	50	Eastern Union	50	.. — .. pa	
	12½	Do. ½ Shares	12½	.. — .. "	
	16 13.4	Do. Thirds	0 13.4	.. — .. pm	
	20	Do. Guaranteed 6 per Ct.		.. — ..	
	25	East Lancashire	25	6 — 5 dis	21¼21¼¼¦
	25	Do. New	13	4 — 3 "	
	6¼	Do. New ½ Shares	3¼	1 — 0¾ dis	
	25	East Lincolnshire	12½	4 — 0¾ dis	12¼11¾
	Stock.	Edinburgh and Glasgow	50	45 — 46	
	25	Do. ½ Shares	15	2¾ — 1½ dis	
	12½	Do. ¼ Shares	12½	11 — 12	
	25	Edinburgh and Northern	20	.. — .. dis	
	25	Do. New	5¼	.. — .. "	
	15	Do. Newport	3¼	.. — .. dis	
	15	Do. Do. New	3¼	.. — .. "	
	25	Exeter, Yeovil, and Dorchester	25	1¾ — 1¼ dis	
	25	Do. New	2¾	.. — .. "	
	6¼	Glasgow, Dumfries, and Carlisle	8 6.8	.. — .. pm	
	Stock.	Glasgow, Paisley, Kilmarnock & Ayr	50	.. — ..	
	40	Do. New	40	.. — ..	
	Stock	Do. Preference Consolidated	100	.. — ..	
	25	Great Northern	100	6¾ — 5¾ dis	41¦¾
	25	Do. London and York Extension	2¾	1¼ — 1⅛ dis	
	50	Great Southern and West. (Ireland)	25	13 — 11 dis	22¦
	100	Great North of England	100	224 — 227	
	40	Do. New £40	5	49 — 51 pm	
	30	Do. New £30	20	37 — 39 "	
	15	Do. New £15	1¼	15 — 17 "	
	100	Great Western	85	15 — 17 "	101a100
	50	Do. ½ Shares	50	9 — 11 "	
	25	Do. ¼ Shares	15	1¾ — 2 "	17a16¾
	20	Do. Fifths	20	3 — 4 "	23¦
	17	Do. New £17	7	¼ — 1 "	8a7¦
	30	Huddersfield and Manchester	22	3 dis — par	
	10	Do. Do. Do. Thirds.	7	2 dis — par	
	50	Hull and Selby	50	98 — 100	
	25	Do. ½ Shares	25	48 — 49	48¦
	12½	Do. ¼ Shares	12½	7 — 9 pm	
	25	Ipswich and Bury St. Edmunds	15	11 — 9 dis	
	25	Do. Do. and Norwich	15	11 — 9 "	8a½
	25	Do. Extens. Scrip (late Cam. & Ely)	2½	1¼ — 0¾ dis	
	50	Lancaster and Carlisle	50	2 — 5 pm	
	10¾	Do. Thirds	10	1 — 3 pm	
	100	Lancashire and Yorkshire	93	.. — ..	
	100	Do. Do.	82	8 — 6 dis	75½
	50	Do. ½ Shares	28	6 — 4 dis	
	25	Do. ¼ Shares	14½	3 — 2 dis	
	20	Do. Fifths	6¼	½ dis — ¼ pm	6¦
	6¼	Do. Sixtenths	6¼	1 dis — par	
	80	Do. Thirds (Regd.)	£10 : 4s	5 — 4 dis	5¼a5 dis
	50	Do. Liverpool and Bury	34	.. — .. "	
	50	Do. Huddersfield & Sheffield	30	.. — .. dis	
	50	Do. Wakefield, Pontefract & Goole	47½	.. — .. "	
	20	Do. West Riding Union	£4 : 3s.	21 — 23 "	dis
	25	Do. Preston and Wyre	25	34 — 35 "	34½
	12½	Do. ½ Shares A	9	2½ — 3½ pm	12½
	12½	Do. Do. B	12½	¼ — .. "	11¦½
	50	Leeds and Bradford	50	91 — 93 "	
	39	Leicester and Belford	16a.	½ dis — par	dis
	50	Leeds, Dewsbury, and Manchester	37½	.. — .. pm	
	25	Do. ½ Shares	7½	.. — .. "	
	25	Do. Scrip (Blue)	13½	.. — .. "	
	25	Do. Scrip (Green)	2½	.. — .. "	
	25	Do. Scrip (Pink)	2½	.. — .. "	
	50	Leeds and Thirsk	26	16 — 14 dis	22
	50	Do. Do. New	17½	14 — 12 "	
	25	Do. Do. Preference 6 ℘ Cent.	3½	2 — 1 dis	
	20	Liverpool, Crosby, and Southport	2	1 — 0¾ dis	
	20	Lpool, Manchstr., & Newcastle Jun.	2¼	.. — .. dis	
	16 13.4	London and Blackwall	16 13.4	4¾ — 5¼	
	6 13.4	Do. New, No. 1	6	2¾ — 1¾ dis	
	6 13.4	Do. New, No. 2	4 13.4	2¾ — 1¾ dis	dis
	25	Do. Extension	17½	.. — ..	
	Stock.	London, Brighton, and South Coast.	50	43¼ — 43¾	43¦e¦e¦
	50	Do. Consolidated Eighths	50	6 — 6 dis	
	9	Do. Gns. 5 ℘ Ct. late Croydon Thds.	9 0.9	.. — .. pm	
	50	Do. Preferen. Convert. 5 ℘ ct. 1848	50	.. — ..	
	50	Do. Do. Do. 1852	50	.. — ..	
	12 15.4	London and Greenwich	12 15.4	.. — ..	
	18 17.2	Do. Preference or Privilege	18 17.2	.. — ..	
	Stock.	London and North Western	100	155¼ — 156	155¼e6
	25	Do. Quarters L. & B.	17	12 — 13 pm	29¦e¾
	25	Do. do. New	9	7 — 7½ pm	9
	50	Do. Fifths	9	10 — 11 pm	12¾
	25	Do. ½ Shares O. J.	25	.. — .. "	
	40	Do. £40 Shares L. & B.	16	.. — .. "	
	40	Do. £40 Shares M. & B.	40	60 — 62 "	61
	10	Do. £10 Shares M. & B. A.	7¾	11 — 11¾ "	11¾
	10	Do. £10 Shares M. & B. B.	7¾	11 — 11¾ "	12a11¾
	10	Do. £10 Shares M. & B. C.	7¾	11 — 11¾ "	
	41 6.8	London and South Western	41 6.8	34 — 35	
	50	Do. New Consolidated Eighths	40	7 — 8 pm	
	50	Do. New £50	32½	4 — 3 dis	29
	50	Do. New £40	25	4 — 3 dis	
	50	Do. Consolidated Tenths	50	3 — 1 dis	
	40	Do. Do. Tenths	40	3 — 1 dis	
	16 13.4	Do. Thirds	6 13.4	1 — 0¾ dis	1 dis
	50	London, Salisbury, and Yeovil		¼ — .. dis	

SHARES.	SHARE.	RAILWAYS continued.	PAID.	CLOSING PRICES	BUSINESS DONE.
10,000	£ 50	Londonderry and Coleraine	£27½	.. — ..	
10,000	20	Londonderry and Enniskillen	20¦	.. — ..	
82,500	20	Manchester, Buxton, and Matlock	5	2¾ — 1¾ dis	
7,000	100	Manchester, Sheffield, & Lincolnsh	100	.. — ..	
10,000	25	Do. ½ Shares ....No. 1	13	.. — ..	
10,640	25	Do. Shares ....No. 2	25	.. — ..	
41,950	12½	Do. ¼ Shares ....No. 3	7¼	.. — ..	
12,000	50	Do. Great Grimsby & Sheffield	25	.. — ..	
32,750	20	Do. do.	7	.. — ..	
16,000	12½	Do. do.	2¾	.. — ..	
38,000	25	Do. Sheffield and Lincolnshire	7¼	.. — ..	
75,000	....	Manchester and Southampton	2¦	2 — 1¾ dis	110e¼e10
4,303,333	Stock.	Midland	100	108 — 110	
25,000	Stock.	Do. Consolidated Preference	100	.. — ..	
43,293	40	Do. £40 Shares	40	5¾ — 5½ pm	45¼e2¾
77,323	50	Do. £50 ... " ...	10	1¼ — ⅝ dis	9a8¼¦
£978,533	Stock	Do. Birmingham and Derby	100	83 — 85	83
1,187,125	Stock	Do. Consold., Bristol & Bir. 6 ℘ Ct.	100	118 — 120	118¼e20
6,639	50	Do. Bristol and Gloucester	34	.. — ..	
7,539	87½	Do. Do. Do.	7 9.0	.. — ..	
146,000	Stock	Do. Leeder & Semtn. 8 ℘ Ct. gtd.	100	.. — ..	
20,000	50	Midland Great Western (Ireland)	35	.. — ..	
6,000	100	Newcastle and Carlisle	100	.. — ..	
3,600	25	Do. ½ Shares	25	.. — ..	
14,000	25	Newmarket	10¾	.. — ..	
28,000	25	Do. Extension Scrip	£2 : 12s.	.. — ..	
29,320	25	Newport, Abergavenny, & Hereford	6	.. — ..	
18,000	50	Newry and Enniskillen	7	.. — ..	
5,000	20	Newry, Warrenpoint, and Rostrevor	12½	.. — ..	
£896,350	Stock.	Norfolk	100	82 — 85	83e¼a3½
9,850	20	Do. New £20	3	3 — 2 dis	
21,000	5	Do. Guaranteed 5½ per Cent.	5	¼ dis — par	
15,000	20	Do. Extension 5 per Cent.	16	4 — 3 dis	
6,000	20	Do. Scrip, 1847, North of Norfolk.	2	1 dis — par	
20,000	20	Do. Do. Do. Waveney Valley	3	.. — .. dis	
60,000	50	Northern Counties Union	4	.. — .. dis	
32,000	25	North British	25	27¼ — 28	28e7¾
32,000	12½	Do. ½ Shares	13½	12¾ — 13	12¾¼
96,000	6¼	Do. ¼ Shares	6¼	¼ dis — ¼ pm	4¦
90,000	6¼	Do. Extension	0¾	par — ¼ "	
78,400	8 6.8	Do. Thirds	2	¼ — ¼ "	
156,000	20	North Staffordshire	7¼	¼ — ¼ dis	7¼e¦
11,900	25	North Wales	3¼	.. — .. dis	
50,000	20	North Western	6	.. — .. dis	
30,000	50	Oxford, Worcester, and Wolverham.	35	15¼ — 14¼ dis	20
40,000	15	Reading, Guildford, and Reigate	7¼	¾ — ½ dis	7¦
32,000	6 6.8	Royston and Hitchin	1¦	¼ dis — par	
40,800	25	Scottish Central	20	2¾ — 3¼ pm	
12,000	25	Scottish Midland	17½	.. — .. "	
12,000	25	Do. New	10	.. — .. "	
14,000	25	Sheffield, Rotherham, and Goole	5	4½ — 5¼ dis	
52,000	15 7.9	Shrewsbury and Birming. ..Class A	6	3¾ — 3 "	3
52,000	9 12.3	Do. Do. ..Class B	3	2½ — 2 "	
40,000	20	Shrewsbury and Hereford	2	.. — ..	
6,000	20	Shrewsbury & Chester (Nos W.Min.)	16	.. — ..	
15,000	10	Do. Halves do.	8	.. — ..	
20,500	20	Do. Oswestry	12	.. — ..	
27,500	10	Do. New	3	.. — ..	
165,000	20	Shropshire Union	4	2½ — 2¼ dis	
20,000	50	South Devon	40	19 — 16 dis	
20,000	25	Do. Preference	20	.. — ..	
78,750	12	South Staffordshire	4	2 — 1½ dis	
56,300	33 2.4	South Eastern and Dover	33 2.4	30¾ — 31¾	31¦a1
28,000	32	Do. do. ....No. 1	27	3 — 2¾ dis	
42,000	35¼	Do. do. ....No. 2	17	5¾ — 4¾ dis	12¦a12
31,500	30	Do. do. ....No. 3	15	8¾ — 6¾ dis	10
285,000	10	Do. do. Thirds ....No. 4	7¼	1¾ — 1¼ dis	6¦e6
56,000	20	South Wales	15	10 — 9 dis	
80,000	20	South Yorkshire, Doncaster & Goole	2	.. — .. dis	
20,000	10	Swans. & Loughor & Cam. Stns. Coal	8	.. — ..	
26,650	20	Taw Vale Extension	4	3¼ — 2¾ dis	
6,700	50	Thames Haven Dock and Railway	17½	10¦ — 10¼ dis	
27,500	20	Vale of Neath	4	.. — ..	
12,500	20	Waterford and Kilkenny	13½	.. — .. dis	
15,000	50	Waterford and Limerick	35	.. — ..	
100,000	20	Waterford, Wex., Wick., & Dublin	2	.. — ..	
51,000	20	West London	20	.. — ..	
32,000	20	Do. do. 1st Class	20	.. — ..	
760	20	Do. do. 2nd Class	20	.. — ..	
16,065	20	West Cornwall	4	.. — ..	
17,500	20	Whitehaven and Furness	12	.. — ..	
80,000	16	Windsor, Staines, & South Western	£4 12s.	.. — .. pm	pm
30,000	50	Wilts, Somerset, and Weymouth	30	16¼ — 14¦ dis	
£1050000	Stock.	York, Newcastle, and Berwick	25	33 — 34	34¦
56,000	25	Do. original Newcastle & Berwick	25	6 — 7 pm	31¦a¦e1
6,000	23	Do. North Shields Purchase	25	.. — .. pm	31
64,000	25	Do. Extension No. 1. Yk. & Newc.	10	3 — 4 pm	13¦e¦
62,000	25	Do. Do. No. 2. Newc. & Ber.	10	2 — 2½ pm	12¦a¦
125,000	25	Do. G. N. E. Purchase or Preferen.	8	1¾ — 1¦ pm	9¦e¦
1,897,500	Stock	York and North Midland	50	78 — 77	76¾
62,950	25	Do. Preference	10	6 — 6¼ pm	16
80,000	20	Do. East & West Riding Extens	20	8¾ — 9 pm	29

FOREIGN.

72,000	20	Boulogne and Amiens	20	14¦ — 15¦	15¦a15
66,000	20	Cent. of France (Orleans & Vierson)	14	1¾ — 2¼ pm	
100,000	20	Central of Spain	2	2 — 1¾ dis	
20,000	20	Ceylon	5s.	.. — ..	
10,000	25	Demerara	5	.. — ..	
		Dender Valley	4	.. — ..	
90,000	50	Direct Bombay and Madras	8s.	.. — ..	
160,000	20	Dutch Rhenish	7	5 — 4 dis	3¾
200,000	50	East Indian	1¼	¼ dis — par	
120,000	16 13.4	Great Indian Peninsula	5s.	.. — ..	
44,422	10	Italian and Austrian	4	.. — ..	
25,000	20	Jamaica South Midland Junction	1	1 dis — par	
90,000	20	Leewain à la Sambre	2	1 — ¾ dis	
150,000	20	Luxembourg	6	8¾ — 6¾ "	
200,000	20	Lyons and Avignon (Constituted)	8	2 — 1 "	
120,000	50	Madrid and Valencia	3	.. — ..	
80,000	20	Namur and Liege	14	8 — 7¼ dis	6¦
400,000	20	Northern of France	10	9¾ — 8¾ pm	13¦a¦
150,000	20	Orleans and Bordeaux	6	1¾ — ¾ dis	14¦a14¦
40,000	20 16.8	Orey Yssel	4 3.4	3 — ¾ dis	1¦ dis
400,000	20	Paris and Lyons	10	6¼ — 6¾ dis	6
80,000	20	Paris and Orleans	20	47 — 47¾	
72,000	20	Paris and Rouen	20	8¾ — 8¾	
250,000	20	Paris and Strasbourg	5	¾ — ¾ dis	
40,000	20	Rouen and Havre	20	10 — 10	
80,000	20	Sambre and Meuse	18	11 — 10¾ dis	7¼
84,000	20	Strasbourg and Basle	14	.. — ..	
80,000	20	Tours and Nantes	8	4 — 3 dis	
		Tramway, Jurisse, Landen, & Hasselt	10	.. — ..	
42,000	20	West Flanders	¾	½ — ¼ dis	1¼

Bedding days in the month of December—Ticket days for regr'stered Stocks, 15th and 30th. Account days, 16th and 31st.

Cowderoy, Printer.] 3 per Cent. Consols for Money 85¼⅜. For Opening, 18th January, 85⅛⅜. Exchequer Bills, 4 a 7 pm. [10, Throgmorton Street, London.

Figure 7: Daily Railway Share List after Slaughter took over its supervision in 1847

Firm Numbers

Though the bubble in railway securities had burst by 1847, the broader changes that it had ushered into financial markets did not go away. Smaller investors were here to stay, as was the cultural centrality of finance capitalism.[55] The passage of the Limited Liability Acts between 1855 and 1867 allowed companies to be formed without the explicit consent of the government and, as the name indicated, prevented shareholders from being held personally liable for the failure of a company.[56] With limited liability laws in place, smaller companies issued shares (an advantage that had previously been reserved for large banking or railway companies) and nominal share prices dropped. The drop in nominal share prices, in turn, allowed for a wider participation in the market by a new category of "small investors."[57] Small investors' participation in financial markets was aided by the proliferation of daily newspapers in both London and the provinces which published stock exchange price lists in their pages. A dedicated financial press also developed in this period, including notable publications like the *Economist* (1843), *The Investors Chronicle and Money Market Review* (1860), *The Statist* (1878), and the *Financial Times* (1888). The stock price list in newspapers and the periodical press became not only a culturally ubiquitous aspect of finance capitalism but also a more trusted and legible source of information to a much wider swathe of investors and the public than ever before. Knowing the market came to mean reading the price list.[58] But the centrality of the price list had ambivalent effects. While many investors increasingly relied on price lists to guide their investment decisions, financiers tried harder and harder to find ways to manipulate which prices were reported. This put the institutions responsible for reporting and transmitting financial information, like stock exchanges and financial journalists, in a bind. By the end of the 19th century these institutions increasingly reported the aggregates of financial markets—firm numbers—rather than attempting to capture the everyday fluctuations of fluid numbers.

The growth of small investors participating in the market alongside the ubiquity of stock price lists in the press created a secondary market for publications explaining how to read and understand the deluge of financial information readers encountered. Francis Playford's 1855 book *Practical Hints for Investing Money* became one the most popular guidebooks of the century. Playford assured his readers that "in the buying or selling of the funds, the public have

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[55] For good overviews of how finance impacted Victorian culture in this period see ed. Francis O'Gorman, *Victorian Literature and Finance,* (New York: Oxford University Press, 2007); eds. Henry & Schmidt, *Victorian Investments*.

[56] See Timothy Alborn, *Conceiving Companies: Joint Stock Politics in Victorian England,* (New York: Routledge, 1998); James Taylor, *Creating Capitalism: Joint-Stock Enterprise in British Politics and Culture, 1800-1870,* (London: Boydell, 2006); Boyd Hilton, *The Age of Atonement: The Influence of Evangelicalism on Social and Economic Thought 1795-1865,* (New York: Oxford University Press, 1988).

[57] Janette Rutterford, David Green, Josephine Maltby, Alastair Owens, "Who Comprised the Nation of Shareholders? Gender and Investment in Great Britain, c. 1870–1935," *Economic History Review* 64 no. 1 (2011) 157-187.

[58] Peter Knight has claimed that in America "Reading the market came to mean reading the ticker tape." Knight, *Reading the Market: Genres of Financial Capitalism in Gilded Age America,* (Baltimore: Johns Hopkins University Press, 2016) 60. Perhaps this is true in America but it certainly wasn't in Britain. By the end of the 19th century there were only about 1,000 ticker tapes in service and most were used exclusively by financial professionals. Unlike in America, ticker tape access was strictly limited. See John Handel, "The Material Politics of Finance: The Ticker Tape and the London Stock Exchange 1860s-1890s," *Enterprise and Society* (2021). Moreover, numerous scholars have explored the explosion of literacy, especially of newspaper literacy in the nineteenth century. This is decidedly where the majority of people encountered share price lists. See for instance Richard Altick, *The English Common Reader: A Social History of the Mass Reading Public, 1800-1900,* (Columbus: Ohio State University Press, 1998); Hobbs, *A Fleet Street in Every Town*.

every security against fraud," in no small part because "the prices of all stocks usually dealt in are published in the daily papers, the prices so stated being the rates at which bargains were actually effected."[59] Similar advice was also doled out by Samuel Orchart Beeton, the husband of the famous Isabella Beeton who was the author of *Mrs. Beeton's Guide Book to the Stock Exchange and Money Market* in 1870. "A man may invest his money in land, in houses, in a private business, or he may lend his money for so many years on all sorts of property," but, Beeton informed his readers, "in each and all of these different ways it will be found there is some disadvantage to the small capitalist, which would be avoided if his money were invested in a security dealt…on the Stock Exchange." Like Playford, Beeton argued that the visibility of the prices that appeared every day in the newspaper made the securities traded on the stock exchange the safest investment for small investors. "An investor can realise his capital at any moment at the market price (which he can ascertain for himself by looking at any daily newspaper) without any trouble." The publicity of price lists meant that "the investor…can always know what his investment is worth without trouble or expense…if it is improving in value, or if it is falling in value…he can keep it or change his investment…at any minute."[60] Charles Duguid's book, *How to Read the Money Article*, was written on the assumption that "the amateur financier has become so numerous in the land that it is high time somebody stopped to show him how to read the money article." Duguid set out to show the "pecuniary profit" that was could be "derived from a perusal of the dry money page."[61] By the mid-late 19th century, understanding financial markets had become synonymous with reading the price list.

Flattening the perception of the market into the public price lists had operational consequences for investor decision making. The strategies small investors deployed were premised not on deep research into what we would call the market "fundamentals" of a particular company or security, but rather on reading and interpreting the price list. One chapter of Duguid's book showed investor's how to understand the "spread" or the difference between the buying and selling price of securities in the list. Calculating the "width of the margin," gave one an "idea of the condition of the market," for a particular security: a small spread meant an active confident, market, a large spread meant an inactive and nervous market.[62] *Beeton's Guidebook* went further and actually gave its readers strategies for picking stocks. A strategy Beeton encouraged was to compare price differentials between different stocks within the same sector. "This difference is sometimes caused by ignorance on the part of the investing public as to the real value and particulars of certain securities," the guidebook informed its readers, "the investor, therefore, should be careful to select the cheapest stock of that class…(which) may be similar in every other respect."[63] This stock-picking strategy was frequently derided by those within financial sector. One financier mocked the "small investor" for looking "through the Share List and select(ing) for his investments those securities which were of the lowest amount." [64] Premising investments entirely on analyzing the price list meant only that small investors were clueless as to the actual practice of the stock exchange.

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[59] Playford, *Practical Hints for Investing Money with an Explanation of the Mode of Transacting Business on the Stock Exchange*, (London: Virtue Brothers & Co, 1855) 10.
[60] Beeton, *Beeton's Guidebook to the Stock Exchange and Money Market with Hints to Investors and the Chances of Speculators*, (London: Ward, Lock & Tyler, 1870) 5-8.
[61] Duguid, *How to Read the Money Article*, (London: Effingham Wilson, 1905) 2-3.
[62] Duguid, *How to Read the Money Article*, 66.
[63] Beeton, *Beeton's Guide Book to the Stock Exchange and Money Market with Hints to Investors and the Chances of Speculators*, (London: Ward, Lock & Tyler, 1870) 67.
[64] "Submarine Telegraph Company," *Daily News*, London, March 4, 1858, 3.

A second major stock picking strategy was based on the pursuit of high dividends or bond yields. "There are two things of which it is said the British lion…is proverbially fond," David Morier Evans wrote, "his dinner and his dividends."[65] The "small investor," another commentator wrote, "will invest in anything that promises a reasonable dividend." But by only reading the price list the small investor had "no means of distinguishing between working companies and speculative companies," and could easily be tricked into a bad investment purely based on seeing a high promised dividend or bond yield.[66] "Generally speaking, shareholders in public companies never take the least interest in their affairs so long as they receive good dividends on their investments. Only when dividends decline or disappear do they wake up and then it is usually too late," another investment guide warned.[67] Price lists were never simple representational tools that provided accurate information to rational investors. The form price lists took actively shaped the strategies small investors used to assess information and make investment decisions.

Because small investors relied so heavily on price lists, financiers developed tactics to manipulate the prices that were printed and publicized. In 1871, for instance, a case came to trial in London alleging widespread fraud in the London Stock Exchange. The practice in question, "puffing," was when a broker and a jobber, both engaged by the same company, would continually buy and sell that company's stock back to each other at increasingly higher prices. The judge in the case surmised that the sole purpose behind such an endeavor was to artificially inflate the stock's price "in order that (it) may be quoted in the public papers as bearing a premium."[68] Puffing was even tougher to detect for the securities of companies that were located overseas. The small investor, one guidebook warned, was "even more likely to be tempted into investing in worthless stocks and bonds," when deceived by puffed up prices in the newspapers, "which invariably heralds the introduction of a new security on the European markets."[69] The way price lists seemed to artificially render distance irrelevant to investors was a key concern for Walter Bagehot. Usually considered one of the greatest advocates of financial capitalism in the 19th century, Bagehot cautioned his readers *against* trusting the prices they saw in newspapers and periodicals like his own. "A clerk in Dorestshire cannot practically speculate in cotton or in tea," Bagehot wrote, yet that same clerk could "speculate in stocks and shares, for the necessary acquaintance with them is brought home to his door by unnumbered City articles and financial newspapers." The quantified financial information in price lists was easily portable and made financial markets legible to small investors at a distance, but the same ease and transparency price lists facilitated also made them vulnerable to fraud. Though the "daily rising in value," of shares the newspapers might seem attractive to readers who believed the market was reducible to the numbers reported in the price list, those numbers were manipulated "by far abler and more

[65] Morier Evans, *Speculative Notes and Notes on Speculation, Ideal and Real*, originally published in 1864, (New York: Burt Franklin, 1968) 170.
[66] "The Hail of Prospectuses," *Pall Mall Gazette,* April 9, 1881, 1335.
[67] A.J. Wilson *Practical Hints to Investors and Some Words to Speculators*, (London: C. Wilson, 1897) 38-39.
[68] Sir R.C. Malins, Rubery vs. Grant (1871) quoted in Marc Flandreau, *Anthropologists in the Stock Exchange: A Financial History of Victorian Science,* (Chicago: University of Chicago Press, 2016) 85-86.
[69] John Abbott, *John Abbott's Manual of American Railways: An Examination of the Position of the Twenty Companies Best Known on the London Market,* (London: John Abbott, 1884) 1. This is, of course, the central plot device of Anthony Trollope's *The Way We Live Now* (1875).

skilled persons than (the small capitalist)."[70] The transparency and transportability of financial numbers over distances was, in many ways, an illusion.

Not only were the prices in printed lists often manipulated for the gain of financial insiders, but they were frequently just wrong or unhelpful. For instance, the prices of small mining companies that were listed on the London Stock Exchange and which had very illiquid, inactive markets, were often publicized and printed with the same frequency as those in active, liquid markets. Because these quotations gave a false impression about the nature of the market to readers and investors "such quotations…are, of course, worse than none at all," the *Financial Times* complained.[71] The accuracy of the prices reported in the list was so bad that one commentator argued they should be regarded as nothing more than the price lists in the newspaper could be considered "a record of bad bargains:"

> There is no compulsion on brokers to record their bargains but it is clearly in their interest to do so if they do not show well: and many a client complains daily of the execution of an order, which really reflects great credit on the cleverness of his broker, merely because some other broker not so competent has sold stock absurdly cheap or bought it at an exorbitant price and has rushed to the marking board to record the bargain so that his client may see it in the newspapers the next morning.[72]

What was more, the printed numbers could vary widely between different papers who used different sources. "All the daily papers give a report of stocks and shares and make up a list of current prices," one investment guide noted, but "not two of them will agree as to the actual ruling prices at the close of the day's market."[73] Trust in financial numbers was hard to come by.

Price lists were critically important to both financial outsiders and insiders alike. But rather than implicitly trusting the prices that were printed and circulated, each group fought to make the prices that were reported more amenable to their particular economic and financial needs. Rather than a neutral representation of market activity, price lists became sharply contested tools that different financial actors used against one another. For instance, on July 23rd, 1859 an editorial in the *Birmingham Journal* criticized the Birmingham Stock Exchange for engaging in duplicitous practices when it came to reporting price information. "Referring last week…to the business transacted in the share market, it was remarked that there was not a single transaction in Railway Shares reported," the editorial stated. But in fact, there had been "several" transactions none of which were reported in the newspaper stock price list. The rules of the stock exchange, the editorial complained, "entirely justify the course which some members of the exchange have taken—that of completely suppressing, even to the extent of a single transaction, the record of any business in this market for a whole week." In order to keep prices out of the list, a number of brokers had simply done deals off the trading floor and not reported them to the compiler of the price list. Any practice, like off-floor trading, that deprived "the public of the knowledge of the exact state of the market, from knowing not merely the quoted prices but the

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[70] "Why the Stock Exchange is Likely to Have More and Greater Frauds in It Than Any Other Market," *Economist*, March 27, 1875, 362.
[71] *Financial Times* (October 29, 1888) 2.
[72] *Financial Times* (July 20, 1890).
[73] William Cordingley, *Cordingley's Guide to the Stock Exchange: Being an Explanation of Every Mode of Speculating in Stocks and Shares and Illustrating the Manner in Which Transactions are Carried Out*, (London: Wilson, 1901) 25.

prices at which transactions take place (was) a matter of public concern and interest," which, if not corrected, would also "result in the ruin of the market" the editorial warned.[74] What good were the official price lists and structures of the stock exchange if brokers could easily circumvent reporting practices and keep transactions out of the public eye?

Criticism in the local press led directly to operational changes in the Birmingham Stock Exchange. The managing committee of the Birmingham Stock Exchange initially responded to the accusations by claiming that it was not due to negligence that they allowed illicit trading to occur, but rather because they had no way to adequately police and check bargains done off the trading floor. "The motive of the committee in not opening the official list to these quotations is to be found in the difficulty…in devising a plan to check their accuracy," the committee reported.[75] Yet over the next five years, the Birmingham Stock Exchange experimented with different practices meant to control the flow of pricing information. One such attempt limited the number of price lists each broker received to 3 each day. Not only would this hard cap on the lists limit brokers' ability to send information to the press, clients, or brokers not in the stock exchange, but the supplied lists would also "have the members name plainly stamped thereon." If anyone outside of the stock exchange was caught either with a list that had not been stamped, or with lists "from more than one member…all future lists to the outside broker," would be "immediately stopped."[76] A similar practice was also adopted in the London Stock Exchange.[77] In 1865 the secretary of the Birmingham Stock Exchange was given substantially increased duties. For the first time he was explicitly instructed "to supply the press with all proper information as to prices which they may require," and was also enabled to supplement his annual £50 salary by "charging," the press for "services rendered."[78] Neither reform was aimed at reporting more accurate prices but at centralizing the channels through which the press received their information, essentially limiting the press's ability to criticize the exchange based on what was *not* in the lists. The exchange did undertake one reform that was intended to introduce more transparency and accuracy in their price lists. This was including the marking of intermediate prices at which business had been done during the day alongside the closing prices (which had previously been the only price reported).

The Birmingham Stock Exchange was far from alone. During the same period, the London Stock Exchange also faced numerous calls for both inside and outside its walls to reform its informational infrastructures. In many respects the London Stock Exchange was worse off because had to reconcile the affordances of its legacy informational infrastructures with the demands of a new informational ecosystem. When the London Stock Exchange set about improving and reforming its price lists during the Railway Mania it did so by creating increasingly specialized lists that were designed to accurately represent discrete segments of the market. Segmentation resulted in the production of better financial information about specific markets, like Slaughter's railway lists, but this accuracy had come at the cost of undermining the operational integrity of the rest of the lists. Without Wetenhall's singular control, the production

[74] Birmingham Stock Exchange Association: Minutes of Annual and Monthly Meetings of Members, 1845-1892, 159, MS/1598/1/1/1 LB; see also *Birmingham Journal,* July 23, 1859.
[75] Ibid.
[76] Ibid. 177.
[77] For one example see The London Daily Stock and Share List, December 29, 1898, GL.
[78] Birmingham Stock Exchange Association: Minutes of Annual and Monthly Meetings of Members, 1845-1892, 181, MS/1598/1/1/1 LB. The stock exchange committee most likely allowed the Secretary to charge the press for services rendered because, on a small salary, he was most likely already taking bribes from the press to release information.

of financial information was decentralized and dispersed to such a degree that it created numerous operational mistakes and failed to represent the financial activity of the stock exchange as a whole. Few examples are clearer than the London Stock Exchange's production of price lists between the mid 1840s and 1860s. Instead of one authorized list—as had been the case during the age of Wetenhall's personal rule—by the mid-1860s the London Stock Exchange published five different lists: the "British and Foreign Share List," the "Foreign Stock List," and the "Daily Railway Share List," all of which appeared daily, in addition to the *Course of the Exchange* and the "London Weekly Railway Share List" which appeared at longer intervals. Control over the lists was split between J.B. Wetenhall—James Wetenhall's son—and Slaughter.[79]

Each list had some overlapping information and some information that was entirely different. The "British and Foreign Share List," for instance, contained a curious amalgamation of prices: all the prices done the day before the publication of the list from 1pm until 3pm were included as were all prices done the day of publication from 11am to 1pm. The "Daily Railway Share List" included not just the price of railway companies but, 2/3^{rds} of the list was occupied by "banks, mines, and miscellaneous companies." The "Foreign Stock List" was perhaps the most coherent of the daily lists. One version was published at 1pm and contained the morning prices while a second version was published in the afternoon which contained the closing prices.[80] Every list dealt with a particular set of securities and published prices from various times of the day. None of the lists marked prices at the same time or followed the same schedule of publication. There was no single list that provided an overview of the day's transactions. In 1864 David Morier Evans complained that the lists were such a "maze of securities" that they did not actually inform the public but simply "bewildered" the "steady and legitimate investor," and that it was "almost a positive relief to cast aside the paper." Morier Evans' solution was simply to "shorten" and "condense" the lists. [81] The production of fluid numbers had grown so fragmented that they were barely helpful to the average reader or investor.

Small investors and journalists were not alone in their anger with the disorganization of the London Stock Exchange's price lists. Financiers were frustrated by the inefficiency of the stock exchange's informational infrastructures. For instance, many bankrupt companies continued having their official quotations marked even though they should have been struck from the list.[82] Clerks complained of the "grievous vexation" they suffered by having to wait in the open air "30 minutes every day wet or shine" in order to receive lists in a timely fashion. According to one clerk, this was because Wetenhall distributed lists to those who paid extra before he made the lists publicly available to all the members of the stock exchange.[83] Prices were also routinely marked inaccurately. The prominent brokerage firm Heseltine Powell & Co argued that Wetenhall and Slaughter's refusal to mark "1/16ths" in the price lists "caused great "inconvenience to brokers." It was "notorious," Heseltine Powell & Co claimed, that "incorrect marks are frequently put on the board in consequence of a mark at 1/16th above…and below the true price…other exchanges make no difficulty of marking sixteenths and we are at a loss to

[79] London Stock Exchange, Appendix to Committee for General Purposes Minutes, November 21, 1866, MS/19515/001 GL.
[80] Ibid.
[81] Morier Evans, *Speculative Notes and Notes on Speculation*,144-145.
[82] London Stock Exchange, Appendix to Committee for General Purposes Minutes, November 5, 1866, MS/19515/001 GL.
[83] Ibid. September 15, 1866.

conclude why….it should have been hitherto forbidden."[84] Another brokerage firm argued that any price reported in the list should by "vouched" for by brokers and jobbers "as being an actual price of business done since the last publication. A very false impression is often given by the carelessness of bringing forward the same price," regardless of market activity."[85] By the mid-1860s, it was clear to the managers of the London Stock Exchange that some reform of the lists had to be undertaken for the good of both financial insiders and outsiders.

Many of the reforms that brokers proposed were accepted by the London Stock Exchange, including the marking of 1/16^{ths}, as well as increased supervision of the lists to make sure old prices were not merely recycled and that bankrupt companies were promptly struck off. But finding a balance between specialization and consolidation of the price lists was a difficult task. Following Morier Evans' advice, the first instinct of the London Stock Exchange's managers was to consolidate the lists as much as possible. Their suggestions were to end the differentiation of lists based on the type of security listed and to issue only one daily list and one weekly list.[86] While reasonable enough in theory, the proposed reforms attracted objections, in particular because it would eliminate the twice weekly publication of the *Course of the Exchange.* For one, eliminating the *Course of the Exchange* would deprive the Wetenhall family of one of their key sources of income, as the younger Wetenhall's salary was supplemented by commission from the sale of the list.[87] The more important objection came from Slaughter who testified to the continued operational importance of the *Course of the Exchange* in the financial community. "However desirable it may appear in theory to confine the committee's sanction to…one daily and one weekly (list), I fear this would be found inconvenient in practice," Slaughter wrote. The daily list was designed to represent what happened in the stock exchange on a day-to-day basis, meaning that many securities which were not frequently traded were not included in the daily list. The weekly list also served different aims, meaning to "convey information rather than value," according to Slaughter. That is, the weekly list not only included prices, but also contextual evidence like railway traffic receipts, dividend announcements, or recent calls on shares to be paid up. But there was still a need for a list to "include the various undertakings either unimportant in themselves or seldom dealt in, but which are nevertheless officially recognized and exhibited for quotation." Thanks to its particular operational function and "special though numerous class of subscribers in all parts of the world," the London Stock Exchange continued the publication of the *Course of the Exchange* alongside the new daily and weekly lists.[88] There was no easy way to condense lists and information on behalf of small investors while still maintaining the specialization of information that benefited financial insiders.

From the 1860s onward, stock exchanges increasingly gave up on the production of fluid numbers. The production of fluid numbers shifted instead to private networks of financial firms. In part, this was a product of technological change. As we will see in the next chapter, the introduction of the ticker tape and the adoption of the telegraph and telephone within financial markets, allowed financial insiders to share fluid numbers with each other at much faster speeds.[89] But small investors were, for the most part, unable directly access ticker tapes. As one

[84] Ibid. September 13, 1866.
[85] Ibid. October 19, 1866.
[86] Ibid. November 21, 1866.
[87] Ibid. October 16, 1866.
[88] Ibid. September 20, 1866.
[89] Again, as the next chapter will demonstrate, the numbers on the ticker tape were hardly more accurate than those in the price lists.

investment guide put it, "speculators living at a distance (and) unable to see the tape for themselves must, of necessity trust their daily newspapers to give them the information required."[90] In addition to the ticker tape, brokerage firms also began privately assembling their own price lists for circulation to clients with numbers that were often far more accurate than prices on the ticker tape or in the official prices. This was largely because "the lists which brokers send out to their clients…contain quotations collected at a later hour than those of the official list and represent more accurately the prices at which business can be done."[91] Private lists also included more specialized prices that were never found in official lists, like the prices of puts and calls on certain securities alongside information about when those options would expire.[92]

To the extent that fluid numbers were publicized, they were of limited operational importance to either small investors or professional financiers. For instance, the *Financial Times* published two sets of numbers in addition to the official closing prices: "Tape Quotations" and "Street Prices." "Tape Quotations" were a record of the different prices of certain securities that were sent out via the ticker tape over the course of a day. It usually ran two columns long and included no extra contextual notes from the editors. "Street Prices," were the prices from the unofficial trading in American securities that took place in Throgmorton Street after the London Stock Exchange was closed, due to the time difference between New York and London. Both sets of prices are helpful descriptors of the economic action that occurred but were not usable prices once you read them in the paper. They represented fast fluctuations in price movement that were outdated within minutes, let alone by the time the newspaper went to press. Small investors could see these fluid numbers after the fact but could never act on them.

Stock exchanges essentially had no way of representing these fluid numbers to small investors so they turned their attention to the production of firm numbers instead. Since 1849, the London Stock Exchange, under the supervision of Slaughter, had been publishing a twice-yearly volume entitled *Railway Intelligence*. The book did not actually track changes in share prices, but it did aggregate the total outstanding capital of each railway company, the amount of shares they had issued and in what denomination, and how much was actually paid-up. These figures were buttressed with commentary on the operation of each railway company, noting the region they operated in, the amount of track laid, and the type of service performed.[93] Like the price lists, Slaughter's Railway Department underwent a substantial overhaul in the middle of the 1860s. In light of the variety of new companies being floated under limited liability laws, the Railway Department was renamed the "Share and Foreign Loan" department and charged with collecting similar data on the amount of capital raised and shares issued on every company listed

[90] Cordingley, *Cordingley's Guide to the Stock Exchange*, 24-25.
[91] Duguid, *How to Read the Money Article*, 61. It is tough to accurately document the extent of this shift because price lists were ephemeral documents circulated among private networks of brokers and their clients. Some examples, however, can be found. See for instance, James Capel & Co, Xerox Copies of Printed Material Relating to the Company, MS/15097 LMA.
[92] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, James Shepherd & Co Share Price List, December 8, 1906, MS/15123 LMA.
[93] Slaughter, *Railway Intelligence*, vol 1. (London: W.H. Smith and Son, 1849). Volumes replicating *Railway Intelligence* for different types of securities in different countries proliferated. See for instance Abbott, *John Abbott's Manual of American Railways*; Anonymous, *South African Companies Analysed: A Reliable Serial Guide for Investors and Brokers*, (London: Winchester House, 1908).

in the London Stock Exchange, not just railways. Moreover, Slaughter was also allowed to hire a new clerk, bringing the total number of employees in the Share and Loan Department to 3.[94]

As new companies and share issuances continued to grow, so too did the Share and Loan Department. By 1890 the department employed a total staff of 34 and managed an array of services, from assisting the Treasury in applying the stamp tax to share transfers, to publishing the weekly share price lists, to compiling a colossal yearly volume of financial information titled *Burdett's Official Intelligence.*[95] Named after Henry Burdett, the secretary of the Share and Loan department who took over for Slaughter in 1880, the *Official Intelligence* was a massive endeavor that attempted to provide an account of "every security which is quoted in any list issued by any Stock Exchange in Great Britain and Ireland," alongside a history of their price movements throughout the year "so that any one interested may be able to see at a glance where there is a Market."[96] The *Official Intelligence* not only provided the complete history of every security's price movements over the course of the year, but also provided extensive descriptions of company activities alongside maps and updates on political and legal changes in the business landscape. Burdett referred to the book as his "child," and its publication was so strenuous that it caused near "fatal risks" to his health.[97]

Burdett's extreme labor was rewarded handsomely. He was the highest paid employee of the London Stock Exchange, earning a staggering salary of £4000 a year in 1891. His *Official Intelligence* was widely hailed as the benchmark work of financial information in Britain.[98] The *Financial Times* praised Burdett's work as "indispensable to every stockbroker either in London or the provinces," for its consolidation of all the financial information available into one book, "instead of having to hunt for it through reports, prospectuses and old newspaper files."[99] In compiling such a complete "statistical condensation" of every important piece of information related to financial markets, Burdett's book often exceeded 20000 pages. One commentator noted that the book became so large that "lifting (it) from a table for purposes of consultation will…become a recognized entry in athletic competitions."[100] By aggregating the price data of every financial security in Britain over the course of an entire year into one place alongside contextual information, *Burdett's Official Intelligence* was the culmination of the London Stock Exchange's production of firm numbers.

The production of firm numbers undertaken by Burdett and the London Stock Exchange was replicated elsewhere. In 1864, the same year the Share and Loan Department was established, the *Economist* launched a new monthly supplement entitled the *Investor's Monthly Manual* (IMM). The first edition of the *IMM* included no commentary. It was simply a list of every security available to investors in Britain and included the highest price and lowest price that security had been traded at that month, along with the most recent price reported. The *IMM* also reported the amount of the last 4 years of dividends a given security had paid out.[101] Beginning in January of 1865 the *IMM* also included a section titled "events of the month" that gave context to the prices and trends reported in the rest of the volume. Typically, the "events of the month" would include important bits of economic and political news, like government

[94] London Stock Exchange, Trustees and Managers Minutes, 1860-1868, 193, 195 MS/19297/005, GL.
[95] London Stock Exchange, Trustees and Managers Minutes, 1888-1891, 245-263, MS/19297/012, GL.
[96] *Burdett's Official Intelligence,* vol 1. (London: Spottiswoode, 1882) vii.
[97] London Stock Exchange, Trustees and Managers Minutes, 1888-1891, 198, 192 MS/19297/012, GL.
[98] Ibid. 257, 285-286.
[99] *Financial Times*, March 7, 1891, 4.
[100] *Financial Times*, February 24, 1896, 2.
[101] *Investor's Monthly Manual* vol I no. 1 (October 15, 1864).

issuances of debt or changes in the bank rate both in Britain and in continental Europe. Alongside narrative news, "events of the month" also included sections that noted which securities had been the most volatile within their particular sectors and provided the price ranges between which they swung. Finally, this section also included sector aggregates, like the total amount of traffic, gross revenue, and gross revenue per mile of track for the entire British railway sector, or it compared aggregates between different sectors, like the total amount of capital created, offered for subscription on the stock market, and actually on deposit between railways, insurance companies, and banking companies.[102] This was in stark contrast to the "Money Market and City Intelligence," column that appeared daily in the London *Times* which tended to narrate price movements, but give little context as to who was making prices move or why.

Ultimately, it was not small investors who benefitted from the production of firm numbers, but two new professions: economists and statisticians.[103] The firm numbers produced by London Stock Exchange and at the *Investor's Monthly Manual* were the crucial raw data that fueled the twin revolutions of econometrics and macroeconomics. In 1871, William Stanley Jevons, the economist and founder of marginal utility theory, published his landmark work, *The Theory of Political Economy*. Jevons' goal was to establish political economy not a philosophical endeavor but rather as "an exact mathematical science," that could be applied to many different problems in managing the economy. Key to his mission was putting to use the vast "numerical data," that was available from the "great ledgers of merchants and public offices, the share lists, prices lists, bank returns, monetary intelligence, Custom-house, and other Government returns," which were "more abundant and precise (in economics) than those possessed by any other science."[104] Any small inaccuracies in this data were ultimately inconsequential to Jevons because, "in a wide average…all individual discrepancies will be neutralized."[105] Robert Giffen, a sometime editor at the *Economist* who went on to become the president of the Royal Statistical Society in the 1880s, argued that his goal, like Jevons before him, was to demonstrate the "applications of political economy to the real world by means of statistics."[106] Giffen's work ranged widely from analysis of trade and banking to the movement of security prices. Key to his effort were the "official publications" of the London Stock Exchange which owed their "origin distinctly to popular demands…which is the best evidence of their actually being required for daily business." Use in daily business was proof that the financial data published by the London Stock Exchange was "entirely trustworthy," and that that data could, in turn, be practically applied by the science of political economy and statistics.[107] To the extent that "special prices have sometimes to be made," which were not included in the official list, these prices were nothing more than "niceties to which the student of economics as a rule needs to give little attention because his business is mainly with the more important securities which are dealt in on a large scale."[108] For economists and statisticians, trust in numbers was created by their

[102] *Investor's Monthly Manual* vol I. no. 4 (January 14, 1865).
[103] Though it was less pronounced, accountants too were taught the importance of learning to read the official price lists. See Hugh Smith, "Wetenhall's List Explained," *The Accountant* vol. xxiv no. 1205 (January 8, 1898) 47-49.
[104] William Stanley Jevons, *The Theory of Political Economy,* (London: Macmillan, 1871) 12-13.
[105] Idem, *Investigations in Currency and Finance,* (London: Macmillan & co. 1884) 58. However, economists and statisticians had vigorous debates about the different ways in which these differences were to be smoothed over. See, Theodore Porter, *The Rise of Statistical Thinking 1820-1900,* (Princeton: Princeton University Press, 1986) 261-269.
[106] Robert Giffen, *Essays in Finance*, (New York: G.P. Putnam's Sons, 1886) 276.
[107] Idem, *Statistics,* (London: Macmillan & Co. 1913) 293-294
[108] Ibid. 339-340.

methodological discipline and the mistakes and omissions in the numbers produced by financial institutions could easily be explained away.

The work of early "macro" economists and statisticians and the data they employed found its way back into practical finance through the creation of index funds which sprang up with regularity during the 1870s and 1880s.[109] The central challenge these funds faced was one of weighting: how did you correctly balance what the index fund held across different classes of security, different securities within those classes, and across different geographical regions? This became a crucial and hotly debated question for economists and practical financiers alike and scrutiny of price lists became the terrain on which the debate was had. One major effort was by a statistician named Arthur Ellis who attempted to "make up something like the Index Numbers formulated by the 'Economist'…(but) more completely."[110] Ellis' goal was to link the price movements of certain securities with the price movements of commodities and changes in trade balances so as to show which types of securities were actually representative of the "economy" and should be included in an index fund. This meant creating an index that was not "distorted by the undue attention given to 'lively' stocks enjoying speculative favor."[111] Like Jevons and Giffen, Ellis's calculations were based on the numbers published in *Burdett's Official Intelligence*. "No statistics can be better for the purpose of showing the variation in the amount of securities admitted officially upon the London market," Ellis wrote.[112] With the advent of index funds and the methodological debates about how to construct them, price data was transformed from something that could be read by individual investors to help them "pick" stocks into aggregates that had to be weighed and balanced against other aggregate economic statistics. In short, the firm numbers produced by financial institutions did not so much aid the small investor but instead were key to the development of professional economics and its drive to understand the "economy," at a much larger scale.

By the 1890s, the widespread adoption of statistical approaches to financial numbers and the cultural success of Burdett and his *Intelligence* spurred the managers of the London Stock Exchange to try and root out the last vestiges of fluid numbers within the formal informational infrastructures of the exchange. Their target was the Wetenhall family, who had continued to be responsible for the publication of the daily lists. In 1893, Henry Horatio Wetenhall, the youngest son of James Wetenhall, died. His son, J. Granville Wetenhall applied for to replace his father in the job. But the managers used the opportunity to place control of the daily lists within the supervision of Burdett and the Share and Loan Department. Split control of the different lists "worked badly," one manager argued, as between Wetenhall and the Share and Loan Department "it was almost impossible to get the list correct (and) no one was responsible for mistakes."[113] What was more, the managers argued that Wetenhall's job no longer took any skill but that that he was "a mere machine. He cannot alter anything in the list." The managers, then "only wanted

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[109] See for instance "The Boom in Trust Companies," *Economist*, April 6, 1889, 433-434. Very little historical work has been done on investment trust companies. For one example see Neil McKendrick and John Newlands, *F & C: A History of the Foreign and Colonial Investment Trust*, (London: Foreign Colonial and Investment Trust, 1999). For important research on the earliest instantiation of an investment trust fund see Jan Annaert & Gertjan Verdickt, "Go Active or Stay Passive: Investment Trust, Financial Innovation, and Diversification in Belgium's Early Days," (September 20, 2020) *SSRN* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3466063.

[110] Ellis, "The 'Quantitation' of Stock Exchange Values," *Journal of the Royal Statistical Society* vol. 51 (September 1888) 567.

[111] Ibid. 568

[112] Ibid. 574

[113] London Stock Exchange, Subcommittee on Waiters, July 19,1894, MS/19305 GL.

to stand in the place of Wetenhall, to become only the machine to publish the list."[114] The idea that the best financial numbers were firm numbers—that they were simply a referent to an external empirical truth about the market—was used to render Wetenhall's labor superfluous and simply "mechanical" in the minds of the managers.

But Wetenhall was not bereft of defenders. The brokers and jobbers of the exchange vociferously came to his aid and prevented the managers from seizing control of the lists. If the managers subsumed the daily lists under the purview of the Share and Loan Department, the exchange's members argued:

> (Wetenhall's) position will be materially altered. Now the committee (of general purposes) had to deal with an individual. In future they would have to deal with a paid servant of the managers. (They) saw no reason for extending what (was) considered to be an evil in the case of the weekly official list…There ought to be a close relation between the man who marks bargains and the compiler of the list and it would be difficult and pernicious to divide the functions.[115]

As unruly as the Wetenhalls' had proven to be, dealing with one man nominally under the power of the committee of brokers and jobbers was an entirely different affair than having to deal with a routinized and regulated bureaucracy under the control of the exchange's managers. It was this vision of fluid numbers—numbers produced by someone embedded in the market itself who had social relations with the other members and could use his own personal discretion to create the numbers that were circulated—that the brokers and jobbers of the exchange sought to preserve. Eventually the two sides reached a compromise. Wetenhall was divested of his duties as the house broker, where he had executed "buying-in" and "selling-out" orders for the stock exchange. A separate department devoted to this function was set up under the authority of the managers.[116] Wetenhall and his family, however, continued to serve as clerk of the house in the foreign market and publish the list into the twentieth century. In a regime increasingly dominated by the bureaucratic production and public circulation of firm numbers, the members of the exchange and found a way to protect the more personal infrastructures that facilitated the production of fluid numbers as well.

Conclusion

The financial numbers that were produced during the second half of the 19th century had asymmetric portability. When moving out of the stock exchange and towards a new marketplace of small investors, the stock price list was a problematic tool at best. Small investors were, in many ways, trapped and limited in their analysis by the information provided in price lists. What was more, financial insiders found new ways to manipulate price reporting and publishing practices for their own ends. Ultimately, with the help of telecommunications, the fluid numbers of daily price transactions were increasingly removed from the public sphere and circulated within private networks, as we will explore more thoroughly in the next chapter. The firm numbers that stock exchanges and financial journalists began producing as an alternative to fluid

[114] Ibid. December 13, 1893.
[115] Ibid. July 19,1894.
[116] See, London Stock Exchange, Subcommittee on Buying-In and Selling Out Department, 1896-1935, MS/14607/001 GL.

numbers did not much help the small investor either. Firm numbers were easily abstracted upwards into the realm of increasingly professionalized and highly mathematical disciplines like economics and statistics. Supported by statistical theories that could increasingly account for errors as long as the aggregate data was large enough, the weaknesses of the stock price list that so troubled the journalists like Bagehot were of little consequence to statisticians like Jevons or Giffen.

The story of financial numbers over the course of the 19th century also forces us to reconsider our typical narratives about the broader the rise and use of quantified forms of knowledge. Numbers, so the story goes, were a way for bureaucrats and experts to justify their decisions with referents to a stable, objective, external reality that could not be questioned.[117] The 19th century is an especially key moment in this development, as liberal social reformers, statisticians, economists, bureaucrats, politicians, and journalists, all sought to understand aspects of social and economic life as self-sustaining, natural, and legible. They did so by quantifying them. By quantifying various aspects of public life, the state could rule at a distance, making decisions based on transportable numbers as opposed to personal assessments *in situ*.[118] This is a powerful narrative that has shaped and transformed much of our understanding of what modernity is and how it emerged. Yet, in many respects, it has overstated its case.

While financial numbers were fixed and wedded to new forms of authority and objectivity by economists and statisticians, this was hardly their only use. As this chapter has demonstrated, the production and use of financial numbers was contested at every step, from the trading floor to the pages of newspapers and periodicals. Numbers were wielded as tools of accountability and transparence by small investors and journalists and manipulated for private gain by financiers. Trust in numbers was incredibly fragile and always questioned.[119] The use and understanding of particular numbers was highly situational and depended on the context of both the production and reception of different types of numbers. Attending to this operational middle ground of financial numbers allows us to see how their meaning and use was contingently fixed by power struggles but does so without setting aside the utility of quantification altogether.

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[117] Theodore Porter, *Trust in Numbers: The Pursuit of Objectivity in Science and Public Life*, (Princeton: Princeton University Press, 1995).

[118] The key texts that make this argument are Porter, *Rise of Statistical Thinking*, Patrick Joyce, *The Rule of Freedom: Liberalism and the Modern City*, (New York: Verso, 2003) 24-34; Mary Poovey, *A History of the Modern Fact: Problems of Knowledge in the Sciences of Wealth and Society*, (Chicago: Chicago University Press, 1998) 307-325.

[119] Here I am following the argument of William Deringer, *Calculated Values: Finance, Politics, and the Quantitative Age*, (Cambridge, MA: Harvard University Press, 2018)

Chapter 3:
Material Infrastructures: Telecommunications and Financial Markets

Introduction

At midday on March 6, 1876, an investor in Edinburgh attempted to sell £16,000 of English consols on the London Stock Exchange. Thirty years earlier, this transaction would have taken at least a week if not longer. The investor would have mailed a letter with his order to a broker in London, the broker in London would have purchased the shares whenever he received the letter and sent a confirmation letter back to the investor with the day's price list enclosed to verify the price at which the transaction took place. But by the mid-1870s the London Stock Exchange was fully outfitted with multiple telegraph offices and large stockbroking firms had begun connecting themselves via private wires to important clients. On the day in question, the Edinburgh investor received telegraphic confirmation that his order had been successfully executed just eighteen minutes after he first telegraphed his London brokers. origins

As the minutes ticked by the Edinburgh investor realized something had gone wrong. When placing an order as big as £16,000, it was common practice to split it between numerous stockbrokers.[1] The Edinburgh investor had sent simultaneous orders to sell £4000 worth of English consols to four different stockbrokers, three of whom had completed the order successfully. As the confirmation telegraphs came across the wires from the three brokers, a telegraph from the fourth, the London brokerage firm of Vivian and Grant, arrived stating that they had only managed to sell £2000 of English consols before the market price dropped precipitously. While all the other firms had managed to sell the Edinburgh investor's holdings at between £109 and £110 per share, the market price dropped to between £102 ½ and £103 ½ by the end of the day.

The mishap was not an easy one to fix. On the one hand, the telegraph itself provided concrete evidence of the investor's order, the time he placed it, and what the price of English consols was at that time. All of the other firms had been able to execute the order, why couldn't Vivian and Grant? When Vivian and Grant were called before the Committee of General Purposes, they did not blame liquidity issues on the part of jobbers but their own reputation in the market. Their firm, they claimed, had recently been doing extensive business in English consols and had very often been "right" about predicting market fluctuations. That afternoon, jobbers in the English consol market were waiting for the dividend to be announced and, given Vivian and Grant's recent success at predicting market trends, "no dealer would make (them) a price." The jobbers "were afraid of us," Vivian and Grant testified, and while they dealt with

[1] There are two principal reasons for this. The first is that an order of £16,000 was quite substantial. The average consol account in mid-Victorian Britain was approximately £3,000. The average amount of a consol fund transaction was approximately £1,800. The second reason was that jobbers often had limited liquidity, both in terms of capital and in terms of shares they dealt in. Different jobbers had vastly different liquid resources. In the consols market, jobbers held on average anywhere from £940 to £20,800 worth of consols, and average transactions undertaken by particular jobbers ranged from £190 to £1700. Thus, sending one broker with an order of £16,000 into the market meant that he almost assuredly would not be able to book the deal with one jobber alone. The market of jobbers would then realize they could bid the broker down, and he could not refuse without risking the completion of the order. Splitting the order meant that there was less of an opportunity for the jobbers to realize how big of a sale was going on in the market. For the figures used here and a good discussion about the mechanics of the consol market in mid-Victorian Britain see, Andrew Odlyzko, "Financialization of the Early Victorian Economy and the London Stock Exchange" (May 2016). *SSRN*: https://ssrn.com/abstract=2787154.

"other brokers whom they think less well informed," they "shunned" Vivian and Grant until the dividend had been announced and prices dropped. Telegraph or not, the social dynamics of the trading floor made Vivian and Grant's execution of the order an impossibility. The telegraph may have quickly connected investors in Edinburgh to brokers in London, but it did not fundamentally reshape the relationship between brokers and jobbers on the stock exchange floor.

The Committee of General Purposes was split. How responsible could the governing committee of the London Stock Exchange be to investors in far flung cities? Should a telegraph order be given more security simply because it was specifically time-stamped, unlike a letter? To what degree should the social dynamics of the stock exchange floor be superseded by technological affordances? The chairman of the committee moved that Vivian and Grant owed their Edinburgh client the difference in the price of stock they had lost by not completing the order, but he was challenged by a series of counter-motions and amendments, including one resolving "there is not sufficient evidence that it was practicable to sell the £2000 pounds stock as ordered." The chair's original motion eventually passed, but only just.[2]

The expansion of telecommunications during the 19th century, from the telegraph to the ticker tape to the telephone, forced financiers to directly confront the contradictions these new technologies brought to the operations of financial markets. The stock exchange floor was no longer strictly enclosed and local.[3] Brokers, jobbers, and managing committees of stock exchanges in Britain and throughout the world had to deal with the ways telecommunications was expanding the institutions and people who could participate in financial markets at higher and higher speeds. Telecommunications infrastructures transformed the social problem of *who* had access to markets into a technical problem of *how* people had access to markets, a problem that was ostensibly solved by the introduction of faster and more efficient communications technologies, like those that allowed investors in Scotland to place and complete orders in London in under twenty minutes. Yet, the technicization of these fundamentally social questions over market access primarily served to reanimate older social fights in new languages and idioms.[4] Instead of conflicts over access to markets revolving around questions of trust between brokers, jobbers, and clerks, or questions of power between financiers and the waiters and lower class servants who manned the stock exchange's day to day operations, the introduction of telegraphic communications shifted power struggles into a more material politics. The technical

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[2] All quotes from London Stock Exchange, Committee for General Purposes Minutes, 1875-1876, 371-372, MS/14600/040 GL.

[3] Of course, trading between markets had been occurring for years, as Peter Koudjis has shown in a study of asset pricing between the London and Amsterdam Stock Exchanges in the 18th century. However, this trading occurred via intermediaries. A letter or news was sent from one exchange to the other and was received by a local broker who executed the order. Telegraphic communication was allowing investors to place orders directly with brokers in a different city in close to real time, dramatically expanding the temporal and spatial dimensions of the market. See Koudjis, "The Boats That Did Not Sail: Asset Price Volatility and Market Efficiency in a Natural Experiment," *Journal of Finance* vol. 71 no.3 (June 2016) 1185-1226.

[4] I borrow the idea of the dialectical relationship between the "social" being made technical and the "technical" becoming social from Patrick Joyce. My use of the concept is admittedly more limited than Joyce's, who is attempting to make sense of how states deployed liberal techniques of governance and discipline on populations. While the social dynamics of a stock exchange floor are necessarily different than the "social" realm of governing populations, the similarities of their transformations over the course of the nineteenth century should be noted. By the late nineteenth century a host of disciplinary techniques, especially the use of quantified financial information and the material infrastructures of telecommunications led financiers and economists to begin to render markets simultaneously closed systems yet also view them as "free" and "efficient." See, Joyce, *The State of Freedom: A Social History of the British State Since 1800,* (New York: Cambridge University Press, 2013); idem, *The Rule of Freedom: Liberalism and the Modern City,* (New York: Verso, 2003).

question of *how* to design communications systems within and between financial markets became a fundamentally social one. Telegraphic offices within stock exchanges were designed to keep people *out*, not provide easier access. Internecine struggles broke out over where telegraph wires should be laid and who benefitted from network designs. The placement of telegraphs, ticker tapes, and telephones themselves were highly policed and became contentious sites of confrontation between stockbrokers, financial institutions, and communications companies (whether private or public). Mundane technical questions about material infrastructures became the language and practice of how social questions around market access were resolved.

The birth of a material politics of finance had economically consequential effects.[5] Rather than communications technologies ushering in an age of more globally interconnected and efficient financial markets, as so many have argued, telecommunications systems were contentious sites of politics and power that different institutions and actors constantly tried to shape for their own advantage.[6] By the beginning of the 20th century, the proliferation of new communications technologies had helped turn Britain into a "nation of shareholders."[7] But the material infrastructures that facilitated this expansion were also used to create exclusive advantages for well-placed financial intermediaries. Particularly powerful stockbrokers had amassed infrastructural monopolies over their rivals with whom they had previously competed on the relatively equal playing field of the trading floor. Stock exchanges throughout Britain wrested concession after concession from the General Post Office (GPO) and turned themselves

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[5] Donald Mackenzie has recently defined "material political economy," or in my terms, the material politics of finance, as "the economically consequential material orderings (of financial markets) to which there are alternatives." See Mackenzie, "'Making' 'Taking' and the Material Political Economy of Algorithmic Trading," *Economy and Society* (2018) vol. 47 no. 4 501-523.

[6] Ranald Michie has argued that "as electrical impulses could travel much faster than any known form of transport the result was revolutionary. Delays between the transmission and receipt of information could now be reduced to minutes rather than hours and days. This made possible the interaction between geographically separate markets continuously in the courses of the trading day rather than periodic adjustment. As a result, the integration or merging of markets was now possible." Michie's analysis is only made possible by operating at an irresponsible level of analytical abstraction. Essentially, Michie compares the volume of telegraph and telephone messages against price differentials in different financial markets. Michie does not exam in any capacity *who* was using communications technologies, nor yet does he examine how the material structures of communications encoded new forms of politics within financial markets. Michie, "Friend or Foe? Information Technology and the London Stock Exchange since 1700," *Journal of Historical Geography,* 23, 3 (1997) 309. Michie's analysis has been widely parroted, see for instance, David Kynaston, *The City of London: A World of its Own, 1815-1890,* vol I. (London: Chatto & Windus, 1994) especially 175; 258; Simone Muller and Heidi Tworek, "'The Telegraph and the Bank': On the Interdependence of Global Communications and Capitalism, 1866-1914," *Journal of Global History* (2015) 10, 268-9. The analytical abstraction of this approach has resulted in not only empirical mistakes littering historians' operational description of nineteenth century telecommunications but also in theoretical confusion. Thomas Philippon has recently shown that the "unit cost of financial intermediation"—or the average cost of financial services as related to the value of the assets those services managed—from 1880 until 2012 has not become cheaper or more efficient. Philippon expresses his surprise that "improvements in information technologies do not appear to have led to a significant decrease in the unit cost of intermediation." See Philippon, "Has the US Finance Industry Become Less Efficient? On Theory and Measurement of Financial Intermediation," *American Economic Review* (2015) 105 (4): 1408-1438. As this chapter will argue, answering Philippon's question requires a different scale and method of analysis than abstractions pursued by other historians and social scientists.

[7] Technology was one aspect of this change, but there were many others, in particular the creation of limited liability laws and a proliferation of companies offering shares at low par prices. See George Robb, *White Collar Crime in Modern England: Financial Fraud and Business Morality, 1845-1929,* (New York: Cambridge University Press, 2003) 3; see also Janette Rutterford, David R. Green, Josephine Maltby, and Alastair Owens "Who Comprised the Nation of Shareholders? Gender and Investment in Great Britain, c. 1870–1935," *Economic History Review,* 64 1 (2011) 157-187.

into key telecommunications hubs. The GPO found its public telecommunications infrastructure hopelessly intertwined and dependent upon the telecommunications infrastructure of the financial system. The London Stock Exchange even assumed veto power over who some telecommunications companies could take on as clients. Finance tamed telecommunications and in doing so secured the benefits of telecommunications' speed and efficiency for an elite set of financiers and financial institutions. This was accomplished through the slow accretion and construction of material infrastructures that locked in the advantages of some markets and financiers at the expense of others.

"Peculiar" Deals and the Problems of the Telegraph

The telegraphic system in the 19th century was, as Christopher Otter has argued, "stratified and knotty, typified by points of concentration, junctions, and lines of interconnection, leaving vast swathes of space simply ignored."[8] This nodal system made early telegraphy deeply dependent on particular financial centers and institutions to drive its business and the very first telegraph companies were specifically designed to cater to finance. After William Fothergill Cooke and Charles Wheatstone invented their model of the electric telegraph in 1837 it took almost ten years for their invention to be put to commercial use in Britain. In 1845, the Electric Telegraph Company was formed. The company's flotation was led by the famous Ricardo family who had deep ties to the City and especially to the London Stock Exchange. The Electric Telegraph Company's City ties were reflected in the business they specialized in. The company's first office was located in Lothbury, directly behind the Bank of England and only a few minutes' walk from the London Stock Exchange.[9] Early telegraphic rates were so high and the telegraphic centers in the country so few that the Electric Telegraph Company's early traffic was not between individuals but between institutions. The company aggregated news that was then passed to institutions like newspapers, governmental agencies, and stock exchanges. One Electric Telegraph employee recalled the "two great events," that occurred each weekday, namely, telegraphing the "mid-day and closing prices of the London Stock Exchange," to newspapers throughout the country.[10] Without widespread telegraphic infrastructure, the aggregation of institutional news forced individuals to cluster around central telegraphic nodes. Stockbrokers and clerks had to congregate at the Lothbury office to send and receive any personal telegrams, as well as to wait for institutional news and prices to arrive. The company bet that making institutional information available at telegraphic speeds to "public bodies such as the Stock Exchange," was a way of eventually inducing more "individuals to use their wires," and eventually widen their client base.[11] By catering specifically to financial institutions, telegraph companies hoped to eventually convince individual financiers of the worth of telegraphic facilities and then expand the telegraphic network.

Financial institutions also saw the benefit in working alongside telegraphic companies. When the Electric Telegraph Company first approached the London Stock Exchange with an offer to directly telegraph the French prices from the Paris Bourse, the managers of the stock exchange rejoiced. They believed a close alliance with the Electric Telegraph Company could

[8] Christopher Otter, "Making Liberal Objects: British Techno-Social Relations, 1800–1900," *Cultural Studies* vol. 21 no. 5 (September 2007): 575.
[9] See "The Electric Telegraph Company," *Illustrated London News*, January 22, 1848, 34-36.
[10] F.E. Baines, *Forty Years at the Post-Office: A Personal Narrative*, (London: Richard Bentley and Son, 1898) 158.
[11] London Stock Exchange, Trustees and Managers Minutes, 1842-1852, 309, MS/19297/003 GL.

ensure both a cheap and reliable flow of financial information and prices to members of the stock exchange. Since one of the managers' primary duties was to "protect the Stock Exchange and the Public from the frauds so frequently practiced by other parties gaining a priority of intelligence," the telegraph seemed the perfect technological fix to this social problem. Reliable information distributed equally to members of the stock exchange "could now be accomplished by means of the Electric Telegraph from Dover which could convey the French prices to the Stock exchange before ten o'clock in the morning."[12] But schemes for telegraphing prices directly to the stock exchange neither prevented fraud nor produced a reliable flow of accurate information. Indeed, the Electric Telegraph Company's services were so overpriced and unreliable that the stock exchange canceled the direct service within a month.[13]

The nature of telegraphic communication exacerbated the opportunity for fraudulent information to spread. Before the telegraph, financial markets and those who governed them had various techniques for sniffing out fraud, from comparing the handwriting of different letters or suspect orders, to actually compelling witnesses to appear in person before the exchange.[14] But the telegraph cut off the body and writing of the sender from the message. Though stockbrokers receiving orders and information still had to enter the scrum of bodies and social relations on the stock exchange floor, there was no way to know who actually sent telegraphs.[15] On July 27, 1849, for instance, "false reports of rebellion in Ireland," were "promulgated by means of the Electric Telegraph Company." Rumors turned into economic action and "peculiar deals" proliferated throughout the stock exchange. Armed with the "news" from Ireland, one broker sold over £100,000 of English consols "at the highest prices," and precipitated a flood of other sellers behind him. By mid-afternoon, however, the market swung back up as other brokers received telegraphs from their friends throughout the country saying that the "news was not believed." When the stock exchange managers launched their investigation into the day's trading, their ire was firmly focused "entirely against the Telegraph Company." William Cooke himself was brought in to testify and admitted that while he and his operators had done their best to authenticate the information and prevent any malfeasance, "no one, however, could vouch for it."[16] While the stock exchange dropped its investigations into the peculiar trading of that day, criminal charges were in fact filed (and ultimately dismissed) against the Electric Telegraph Company.[17] It was difficult, and in many cases impossible, to check the veracity of telegraphic information or impose any discipline on the sender of messages. Instead of providing reliable, trustworthy information, telegraphy exacerbated the problem of who to trust on the stock exchange in a way that proved difficult for financial markets to police.

Financial markets found themselves caught between ensuring the transmission of reliable information or obtaining information quickly and on the cheap. They tended to opt for the latter. In 1853, the London Stock Exchange allowed the Electric Telegraph Company to set up a special office within the stock exchange itself. The office was given to the company for free but immediately came with expectations of preferred services. A few months after the office had opened, the Paris Bourse approached the committee of the London Stock Exchange with another

[12] Ibid. 184.
[13] Ibid. 186.
[14] See for instance, London Stock Exchange, Foreign Stock Market Committee Minutes, 1823-1828, 43-49; 133-135, MS/14617/01 GL.
[15] See Richard Menke, *Telegraphic Realism: Victorian Fiction and Other Information Systems*, (Stanford: Stanford University Press, 2008) 10-11.
[16] London Stock Exchange, Committee for General Purposes Minutes, 1846-1849, 429-434, MS/14600/020 GL.
[17] "Court of Queen's Bench, Westminster," *Times*, May 7, 1850, 7.

offer to formally exchange prices twice a day. The offer was attractive because the Bourse "had the privilege of making (their) messages take priority of all others by the French Telegraph." The Electric Telegraph Company on the other hand, refused to provide the same services to the London Stock Exchange. In response, the London Stock Exchange's managers declined to exchange messages with the Paris Bourse because "no regularity could be depended on (in their) transmission." A year later, while a massive re-design and re-construction of the London Stock Exchange began, any advantage the Electric Telegraph company might have wished to gain by getting to the London Stock Exchange first was dashed. The stock exchange managers passed a resolution wherein "all telegraph companies, English and foreign, that may be desirous of establishing an office within the precincts of the Stock Exchange be allowed the privilege of doing so." The Submarine Telegraph Company, the British and Irish Magnetic Telegraph Company, and the Anglo-American Telegraph Company were all allocated space within the London Stock Exchange in subsequent years.[18] The provincial stock exchanges adopted a different strategy. The Manchester and Liverpool stock exchanges played off the rivalry between the Electric Telegraph Company and the Magnetic Telegraph Company, constantly switching between their services in hopes they could extract more favorable terms.[19] The strategies the various stock exchanges in London and the provinces pursued were different but their aims were the same: competition between telegraph companies could be leveraged to provide cheaper service for stockbrokers.

Indiscriminately opening up the London Stock Exchange's physical premise to telegraph companies alleviated the technical problems of communicating financial pricing information over a long distance and allowed the London Stock Exchange and its members to obtain cheaper rates, but it also introduced even more social problems to the management of the market. London stockbrokers dealing in French *rentes* claimed to the managers of the exchange that acquiring the Paris prices would "not (be) done for the purpose of relieving the French Market of the expense of procuring the prices," but was in fact "for the benefit of the whole Stock Exchange."[20] Much like the English consol market, the brokers believed that the prices of a major country's principal debt impacted the prices of the rest of the securities traded on the London Stock Exchange. Brokers requested that the managers acquired the opening prices of French *rentes* shared them with the whole exchange. The managers declined this request, arguing that this would unfairly benefit those who dealt in French securities at the expense of everyone else. Yet, this move effectively shifted the onus to acquire prices onto private individuals and firms. Forcing brokers to procure the prices on their own naturally favored larger and wealthier firms who had more resources to obtain prices through the telegraph and left others at the whims of a market about which they knew far less.

The failure of the London Stock Exchange to create a regular channel for the telegraphic transmission of prices, coupled with the nodal nature of telegraphic communication, created opportunities for well-placed, informational arbitrageurs, like George Webb, the secretary of the London Stock Exchange from 1845 to 1857. When Webb died in 1857, the managers of the London Stock Exchange received a surprising message from their counterparts at the Paris Bourse. Apparently, Webb had been using his authority as secretary to charge Paris for "transmitting the English Prices to Paris daily" and vice versa. Webb had indicated to the Paris

[18] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 63, 83; see also 40-41, 104, 247, MS/19297/004, GL.
[19] W.A. Thomas, *The Provincial Stock Exchanges,* (London: Frank Cass, 1973) 102-103.
[20] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 208, MS/19297/004, GL.

Bourse that he was "acting under the authorization of the (London Stock Exchange) committee." Webb's actions and had considerably lessened expenses for those dealing in French shares on the London market in addition to providing a lucrative source of income for himself. The managers resolved that Webb's fees were "most improperly made and appropriated to his own use and that the character of the London Stock Exchange is compromised thereby."[21] Yet, it was not until 1871, a full fourteen years after Webb's death and twenty-three years after the first attempt at transmitting Paris-London prices, that the London Stock Exchange formally began acquiring the Paris prices and making them available to all of the brokers of the London Stock Exchange equally.[22]

Attempts at gaming the telegraphic system were not limited to well-placed insiders. Dishonest members of the public and outside brokers all tried to gain illicit access to the financial telegraph system. Some unscrupulous outside brokers would simply have their telegrams addressed to the London Stock Exchange's offices as an excuse to enter and use the telegraphic facilities.[23] Still others pilfered London Stock Exchange telegram forms and sent them from non-stock exchange offices, giving the impression that the communication was coming from an official broker of the exchange itself.[24]

The nodal system of the telegraph, especially from the late 1840s until the early 1870s, resulted in a host of social problems in governing the market that were not easily solved with technical fixes in telegraphic transmission. Rumors were easily spread and slowly stopped. Well placed intermediaries leveraged the nodal system of the telegraph for their own advantage. Dishonest outsiders infiltrated telegraphic offices. Most importantly, however, in an attempt to secure the financial business for themselves, telegraph companies had turned stock exchanges into critical centers of telegraphic communication. As the century progressed, this allowed stock exchanges and private stockbroking firms to exert more and more control over the telegraphic system in an attempt to monopolize its public infrastructure for the financial world.

Taming the Telegraph

The initial agreement of the Electric Telegraph Company with the London Stock Exchange promised telegraphic instruments and lines "for the convenience exclusively of the members of the stock exchange."[25] This language was parroted in most of the agreements between stock exchanges and private companies and even after the GPO took over the domestic telegraph service in 1870. Yet, making telegraphic instruments and wires "exclusive" was far from an easy task. From the mid-19th century onward, stock exchanges specifically designed their telegraphic offices to facilitate the *de facto* privatization of public wires under the guise of preventing outsiders from accessing the exchange. In the 1853-4 reconstruction of the London Stock Exchange, it was resolved that there should be "no entrance," from the street directly into the wing of the building that housed the Telegraph Office, Reading Room, and Checking Room (Figure 8). The only access points to the Telegraph Office were from within the Stock Exchange

[21] Ibid. 211-213.
[22] London Stock Exchange, Trustees and Managers Minutes, 1868-1872, 303, MS/19297/006 GL.
[23] Ibid. 203.
[24] London Stock Exchange, Trustees and Managers Minutes, 1874-1878, 311-312, MS/19297/008 GL.
[25] London Stock Exchange, Trustees and Managers Minutes, 1852-1860, 40, MS/19297/004 GL.

itself.[26] Limiting physical access to telegraphic offices and infrastructure became a key practice of stock exchange design.

When the GPO introduced telegraph offices to stock exchanges in the provinces, the Birmingham, Manchester, Dublin, and Liverpool stock exchanges all prevented any members of the public or outsiders from using their telegraphic facilities despite the fact that they were ostensibly public wires. Only Glasgow and Edinburgh had GPO telegraphic facilities that could be used by stockbrokers and members of the public alike.[27] Stock exchanges fought intensely to keep these offices private. For instance, when the Liverpool Stock Exchange underwent renovations in the 1870s, the GPO pushed for a telegraphic office that would be open to both brokers and the public. The Treasury backed them up, calling into question the "propriety and justice of putting the public to expense for the special accommodation of such societies." But the Liverpool Stock Exchange threatened the GPO with the severe "loss of confidence" if brokers were forced to "transact their business at an outside office."[28] Since over 100,000 messages a year were sent from the Liverpool Stock Exchange, even a small proportional dip in business could adversely affect the GPO's revenues. In the end, the Liverpool Stock Exchange did not give the GPO or the Treasury much of a choice. The only rooms they offered to rent to the GPO were on the second and third stories of the Stock Exchange, a specific design so that "the office (would be) used exclusively by members of the Stock Exchange and not (be) accessible to the general public."[29] The Manchester Stock Exchange followed suit, placing its telegraphic office on the second floor (See Figure 9). Between threatening decreases in telegraph busines and through restrictive office design, stock exchanges had begun bending the development of public telegraphic infrastructure to the needs of the financial system.

[26] Ibid. 81.

[27] For Birmingham and Dublin, see Telegraphic Facilities for the Birmingham Stock Exchange, Letter from the GPO to the Birmingham Stock Exchange, June 29, 1898, File I Post/30/816B BT; for Liverpool, Glasgow, Edinburgh, see Rental of Liverpool Stock Exchange Telegraph Office, Letter to Secretary of the GPO, July 8, 1878, File I, Post/30/857 BT.

[28] Rental of Liverpool Stock Exchange Telegraph Office, Letter from GPO to Liverpool Stock Exchange, September 3, 1878, File II, Post/30/857 BT.

[29] Rental of Liverpool Stock Exchange Telegraph Office, Letter from GPO to Liverpool Stock Exchange, January 27, 1919, File V, Post/30/857 BT.

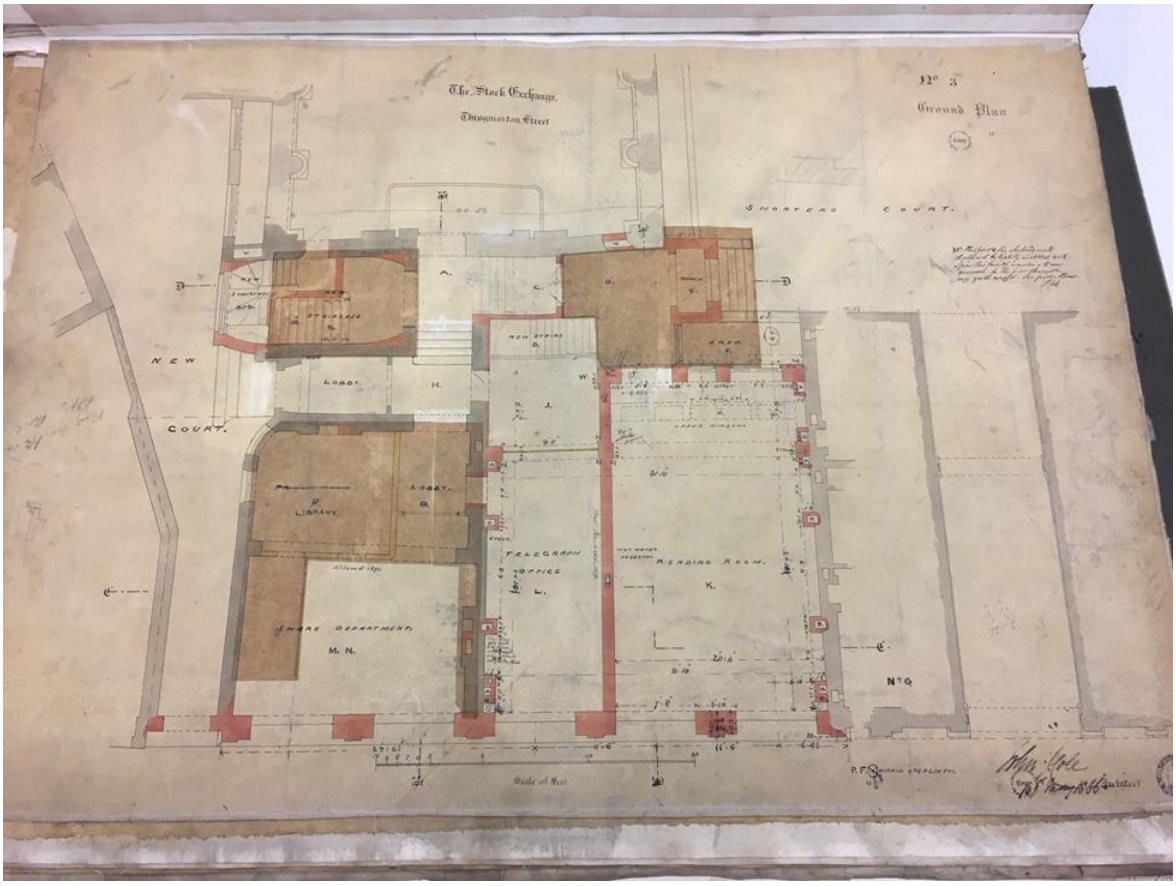

Figure 8: London Stock Exchange Telegraph Office Plans, 1870. (MS/29321 GL)

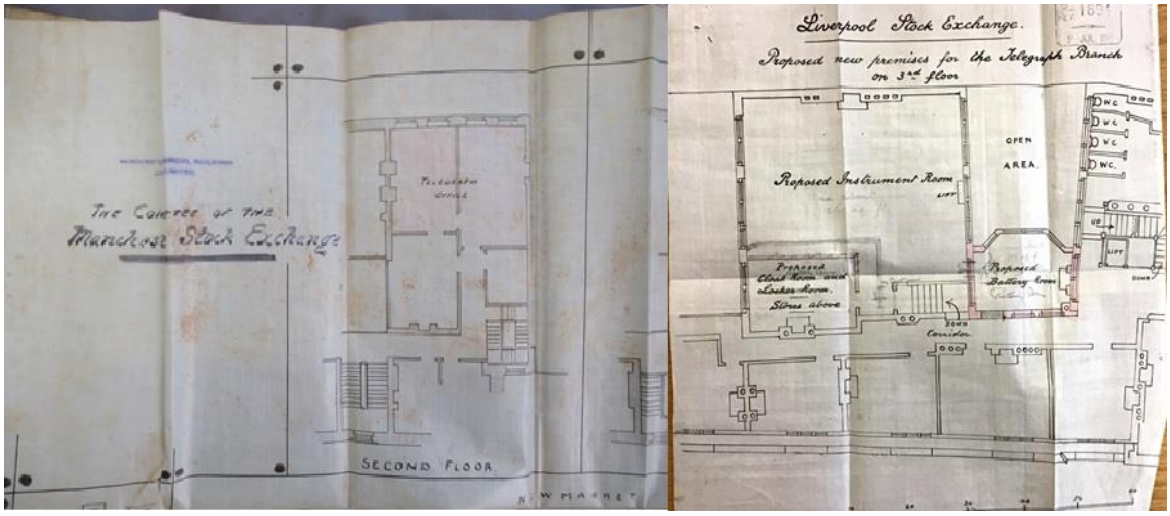

Figure 9: Manchester and Liverpool Stock Exchange Telegraph Offices Circa 1880. (B18/6/71 MRO and Post/30/857 BT respectively)

The GPO did not simply let stock exchanges dictate the terms on which they were serviced. By the end of the 19th century, the GPO made its telegraphic services to stock exchanges conditional on the ability for the public to use stock exchange wires as well. Stock exchanges, however, still found ways to exclude the public from telegraphic facilities through the physical design of offices. In the Birmingham Stock Exchange, brokers and members of the public were forced to use "independent entrances at the counter."[30] The broker's counter was only accessible from inside the stock exchange while public's counter was only accessible from the street. Not only did this prevent those who didn't belong from gaining access to the trading floor, but it also separated the messages into different circuits and wires so that the financial messages would not be unduly slowed down by public messages. When the London Stock Exchange was redesigned in the 1870s, the GPO's initial telegraph office was moved from its enclosed position to a location off of Threadneedle Street on the Stock Exchange's South side. However, the stock exchange managers almost expelled the GPO entirely unless they included "the compensating advantage of a passage way," that led from the back of the GPO's telegraphic facilities into the Stock Exchange for the exclusive use of stockbrokers.[31] Even ostensibly "public" telegraph offices attached to stock exchanges included special infrastructural privileges for financiers.

Not only were members of the public excluded from ostensibly public infrastructure, but the physical design and layout of telegraphic facilities also privileged particular markets and types of business over others. In the mid-1870s when the GPO moved to its new office on Threadneedle St, it forced the Submarine Telegraph Company—the company principally responsible for telegraphic business with the European continent—to move its offices in turn. Both political and material concerns shaped the Submarine Co's response. The Submarine Co. could have chosen offices of a similar size to their previous one, but they would have been far away from the "Foreign Market" in the Stock Exchange, whose members were the company's main clients. Pneumatic tubes connecting the market with the telegraphic facilities were declared an "impossibility" because of structural concerns with the stock exchange. Limited by the material constraints of the stock exchange itself, the Submarine Co chose to move to a much smaller office that was just off the trading floor of the Foreign Market. The managers of the London Stock Exchange had pushed for this decision and didn't hide their delight when the Submarine Co chose its offices. "The general convenience of the members (of the exchange) will be greatly promoted by bringing, as far as may be, those who principally send and receive Inland and Submarine telegraphs respectively into close contact with the office they use," the managers proclaimed. [32]

In the early 1880s the London Stock Exchange underwent yet another massive reconstruction. The "New House" as it was dubbed, fully enclosed the city block upon which the stock exchange sat, from the corner of Throgmorton and Old Broad Streets, to the corner of Threadneedle Street and Bartholomew Lane. The stock exchange assumed a castle-like, enclosed structure that prompted one observer to claim that it looked like "some monument of the Middle

[30] Telegraphic Facilities for the Birmingham Stock Exchange, Letter from the GPO to the Birmingham Stock Exchange, June 29, 1898, File I Post/30/816B BT
[31] London Stock Exchange, Trustees and Managers Minutes, 1868-1872, 234, see also 216, MS/19297/006 GL.
[32] London Stock Exchange, Appendix to Trustees and Managers Minutes, 1875-1881, May 7, 1880, MS/19514/003 GL.

Ages" in the center of the City.[33] Previously, sections of the stock exchange were spread across different buildings in a fairly disjointed manner, but the new stock exchange had a contiguous trading floor that stretched 18,000 square feet. While in the 1860s and 1870s the placement of telegraph offices was largely beholden to where specific markets were on the trading floor, this dynamic was reversed in the New House. When the New House opened in 1885, markets were re-organized around where specific telegraph and telephone offices were located on the perimeter of building. The Foreign Market, which had previously been located in the stock exchange's Northwest corner near Capel Court and Shorter's Court, was moved under the "New Dome," near the entrance on the stock exchange's east side near the intersection of Throgmorton and Old Broad Street. This was explicitly done to bring it closer to the "proposed new office of the Submarine Telegraph Company," in the recently created "Foreign Telegraph Office." The British Railways market was grouped around the "existing inland Telegraph Office," (the Threadneedle Street post office) on the south side of the house. Other markets were staggered behind the British Railways market in logical turn. First was the Caledonian Market (the market for the Caledonian Railway in Scotland), then the colonial market, and finally the English Consol market, which had a "certain affinity" with the colonial market it was placed next to.[34] Markets that used the foreign telegraph service extensively, like the Foreign and American markets, gained prime position, while markets that had previously been at the center of the exchange, like the English consol market, were shunted to the perimeter (See Figure 10).



Figure 10: Map of Markets within the London Stock Exchange circa 1900.

The re-arrangement of markets should not just be seen as a rationalization of market structure around the telegraphic system. Instead, we should view the re-organization of markets that occurred in the mid-1880s as the culmination of social conflicts within financial institutions for control of telegraphic infrastructure. Many markets were not "rationalized" at all by the new

[33] Charles Duguid, *The Story of the Stock Exchange: Its History and Position,* (London: Grant Richards, 1901) 309.
[34] London Stock Exchange, Committee for General Purposes Minutes, 1883-1884, 390-391, MS/14600/050 GL.

arrangement but were shunted into tight corners of the exchange and stripped of any infrastructural privileges they had. Jobbers in the English consol market were especially angry at what they saw as the new, permanent, disadvantage the re-organization of markets placed them at. Their position resulted in a "much impeded" ingress and egress through the rest of the market and limited access to the clerks of the house stationed on the trading floor.[35] A petition of brokers and jobbers operating in the English consol market reminded the managers that they were "the original market of the stock exchange," and that:

> the large increase in the number of members for transactions is not a valued reason for depriving us of facilities to which we have been accustomed for periods long antecedent to the existence of those securities. We urge that the present arrangements are not prejudicial to anyone else and that the alterations will give no additional space where it can be at all available. We point out to you *that telegraph offices have been attached to the building principally for the convenience of other markets* and therefore that our national debt market is equally entitled to the consideration of the special wants of its daily business.[36]

The telegraph had not revolutionized how financial information was transmitted, it merely sped up the existing operations of markets and exacerbated their social conflicts. Not everyone benefited from the increased efficiency the telegraph promised. Public infrastructures were co-opted by financial institutions and specific types of business and markets were given significant advantages over others. The nodal system of telegraphic communication had been captured by certain institutions and firms that accrued the lion's share of the benefits.

Ticker Tape

The adoption of the ticker tape beginning in the late 1860s and early 1870s promised a revolution in the transmission of financial information that the telegraph had never delivered. Instead of the nodal and knotty centers of telegraphic service, the ticker tape companies collected prices centrally on the stock exchange floor itself and then sent those prices simultaneously to the ticker tape machines located within the offices of individual stockbrokers. The ticker tape still relied on the telegraph to be fully functional, as neither brokers nor their clients could actually transact business on the ticker tape system since it was a one-way, information delivery scheme.

Numerous scholars have noted just how profound the change inaugurated by the ticker tape was. Alex Preda has argued that the ticker tape created a "market" that was "abstract and visible in several forms to everybody at once…(a) new visual experience of the market (that) was radically different from that of the eighteenth-century marketplace."[37] Peter Knight has similarly focused on the experience of *reading* the ticker tape. In the late 19th century, he argues,

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[35] London Stock Exchange, Sub-committee of the Trustees and Managers and a Sub-Committee of the Committee for General Purposes Appointed to Confer on the Arrangements of the Markets, 4, MS/19302 GL.

[36] London Stock Exchange, Appendix to Trustees and Managers Minutes, 1875-1881, 1875-1881, (undated) MS/19514/003 GL.

[37] Preda, *Framing Finance: The Boundaries of Markets and Modern Capitalism,* (Chicago: University of Chicago Press, 2009) 142. Much of the problem within Preda's account derives from the fact that he focuses exclusively on the ticker tape within the New York Stock Exchange, and relies entirely on published stockbroker memoirs, using no sources from within stock exchanges themselves nor yet the various ticker tape companies.

"reading the market came to mean reading the ticker tape." The new forms of ticker tape reading "imbued (the market) with a humanlike agency that was decidedly irrational, uncanny and supernatural," rather than necessitating technical or economic knowledge.[38] For both accounts, the ticker tape was a key technology that made financial markets seem abstract and simultaneous for the first time. Yet, this approach ignores how the ticker tape actually changed and impacted the behavior of markets. As one recent study has argued, the ticker tape made markets *less efficient* as more low-information investors were able to chase market trends.[39] Beyond asset pricing, the ticker tape also embedded particular forms of normative market behavior, power imbalances, and inequalities, into the material forms and technical operation of its system. This section asks: what were the *politics* of the ticker tape? Instead of focusing on how people read the ticker tape, this section examines how ticker tape companies and stock exchanges produced and transmitted the numbers that were read.

Unlike the telegraph, the ticker tape's main advantage was the way it centralized control over the information it distributed. This centralization resulted not in the fantasy of an abstract, simultaneous market that many people could experience at the same time, but rather a strict form of control over what prices were sent out and to whom: not all ticker tapes were created equal. Not all stock exchanges had access to the same types of ticker tape services, nor did all subscribers to the ticker tapes receive the same information via the ticker service. Through control over the physical infrastructure that underpinned ticker tapes—from the instruments themselves, to batteries, to cables, to electrical circuits—certain stock exchanges and companies were able to exert massive control over what information was actually circulated and who was able to receive it. Though stock exchanges and ticker tape companies had faith that they could effectively control access to the market through the nature of ticker tape infrastructure, the unique, asymmetrical nature of the ticker tape unleashed an unintended set of social dynamics that overwhelmed the restrictive politics stock exchanges had attempted to implement through the ticker tape system itself.

The Origins of the Ticker Tape

The ticker tape was invented in America by Edward Calahan in 1867 in response to a very particular social problem. One afternoon near the New York Stock Exchange, Calahan was thrown into the street by messenger boys "pushing (and) yelling out the prices…and rushing back again." The "noise and confusion" of the stock exchange had ruined his day. Calahan thought he could fix this problem by furnishing stock prices "through some system of telegraphy."[40] Calahan's invention was introduced to the floor of the New York Stock Exchange later that same year.[41]

The ticker tape worked like this: company employees known as reporters would wander around the different markets of the stock exchange recording prices of particular securities and

[38] Knight, *Reading the Market: Genres of Financial Capitalism in Gilded Age America*, (Baltimore: Johns Hopkins University Press, 2016) 60. Knight's work proceeds analogously to Preda's. His work is based on brokers and investors reactions to the ticker tape, not the ticker tape system itself.
[39] Barbara A. Bliss, Mitch Warachka, and Marc D. Weidenmier, "What Makes Uninformed Traders Tick?" (April 2020) *SSRN*: https://ssrn.com/abstract=2728540.
[40] Edward Calahan, "The Evolution of the Stock Ticker," *The Electrical World and Engineer*, vol. 37 no. (February 9, 1901) 236.
[41] Preda, *Framing Finance*, 115; Ranald Michie, *The London and New York Stock Exchanges* (New York: Routledge, 2011) 174.

passing them to telegraph operators stationed on the stock exchange floor. The operator would telegraph the price to a central office (in the case of New York, the top floor of the stock exchange itself, in London, a building a few blocks away). From the central office, the price would be simultaneously transmitted out over a host of different circuits to all the connected ticker tapes. Ticker tape machines themselves were typically stationed in stockbrokers' offices where brokers, clerks and investors would wait to watch the price fluctuations of the market. The early ticker tape included a wheel of paper that was fed under two electrically charged printing wheels, one which had numbers and one which had letters. As the paper was fed through the wheels, the electrical signal from the central office animated the printing wheels and the name of the stock and the recorded price were printed out. Some ticker tapes were merely placed on office desks or tables while others were installed on columns, under which the electric wiring was protected, and covered with glass cases to prevent dust and other intrusions from hurting the machinery (Figure 11).

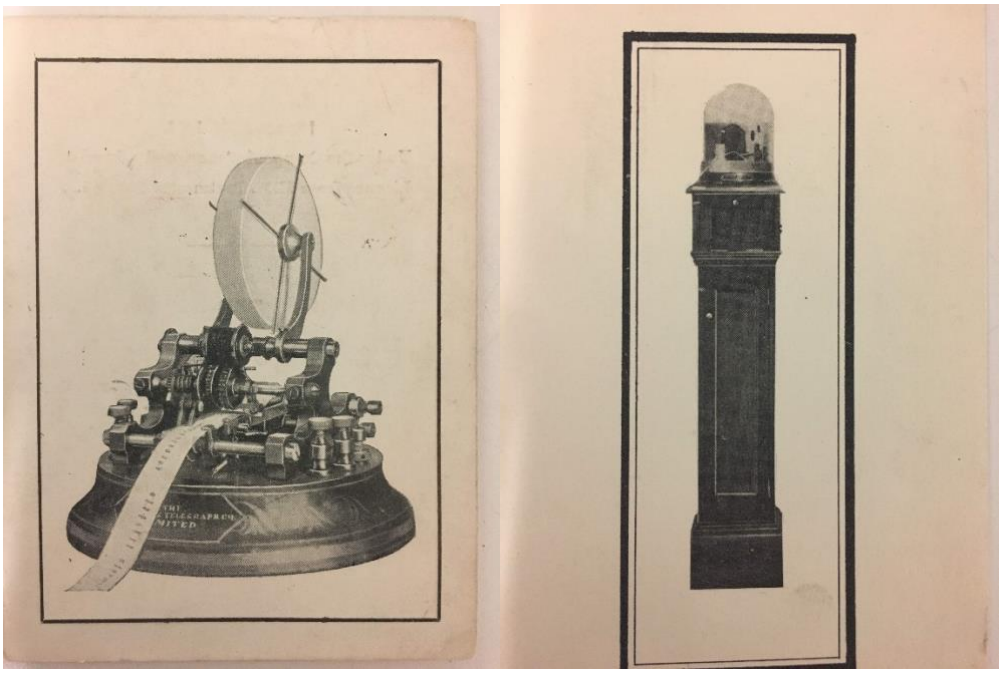

Figure 11: Exchange Telegraph Company Ticker Tapes (MS/23110 LMA)

Various attempts were made to introduce the ticker to London before 1872 but they were all rebuffed. From the start, control over the information transmitted by the ticker tape was the exchange's key concern. The managers of the exchange worried that it was "not desirable to admit any person in the house for (ticker tape services) as they had no guarantee but that prices might be wired to other places than the offices of brokers and might tend to the formation of markets elsewhere."[42] In 1872 ,the Exchange Telegraph Company, colloquially known as Extel, was formed with the goal of introducing ticker tape services to English financial markets.[43] Like

[42] London Stock Exchange, Trustees and Managers Minutes, 1868-1872, 43, MS/19297/006 GL.
[43] The only history of Extel to date is James Maurice Scott, *Extel 100: The Centenary History of the Exchange Telegraph Company*, (London: Benn, 1972). This primarily relies on interviews with employees and includes almost no archival sources.

their American counterparts, Extel's first request for entry to the London Stock Exchange in May of 1872 was declined. It was only in November of 1872, alongside a petition with the names of 655 members of the exchange, that the managers of the London Stock Exchange finally relented, and allowed Extel to "fix their apparatus in the settling room for one month as an experiment." The London Stock Exchange imposed one other set of conditions. Extel was granted a virtual monopoly over the collection and distribution of prices but only if those prices were sent to "members of the house exclusively."[44] Over time, this would come to be one of the most controversial and impactful regulations on the operation of the ticker tape.

Extel faced other regulatory problems in establishing its services, particularly from the GPO. The GPO closely guarded its monopoly over telegraph services and worried that Extel's ticker tape service could erode the local telegraph business. It thus imposed two additional conditions for granting Extel a license to operate. The first was that prices could only be circulated within a 900 yard radius of the Stock Exchange "because it was thought that no postal telegrams would be sent over so short a distance and that therefore the (telegraph) department would lose nothing."[45] Secondly, the GPO stipulated that "no subscribers office shall be used for the reception of telegrams by or on behalf of the company," to prevent the unfair distribution of prices to some subscribers before others.[46]

The skepticism of the GPO and the London Stock Exchange against the ticker tape system went beyond basic concerns of profit and loss. What was at stake was who would have access to the market itself. Where the telegraph was introduced to financial markets with abandon because of the limited nature of its access points, access to the ticker tape was closely guarded and ridden with social anxiety. If the ticker tape promised to make the market "abstract and visible in several forms to everybody at once," as Preda has claimed, how could this power be restricted to only qualified, socially acceptable people (as stock exchanges themselves had attempted to do over the course of the century)? Moreover, how could the information sent out over the ticker be deemed as reliable and its fair and equal distribution be ensured? Both the London Stock Exchange, the GPO, and Extel turned to technological solutions to many of these problems, but in doing so inadvertently created a new set of social dynamics that would reshape financial markets.

Collecting and Reporting Prices

A central contradiction lay at the heart of Extel's ticker tape service. On the one hand, Extel's principal clients were brokers who monitored changing prices from their offices and informed their waiting investors about market movements. On the other hand, Extel relied almost entirely on jobbers for the prices they sent out over the ticker, since jobbers stood in the market and made prices all day. Almost no jobbers subscribed to the ticker services. "Jobbers," Extel reported, "have no other use for (ticker tape) instruments," while they stood on the floor of the stock exchange and made prices.[47] While this was no different than the state of affairs that had long existed in the London Stock Exchange —jobbers were market makers while brokers were

[44] London Stock Exchange, Trustees and Managers Minutes, 1872-1874, 76, see also 43, MS/19297/007 GL. Mary Poovey mistakenly claims that the ticker was introduced to the London Stock Exchange in 1867. It was not. See ed. Poovey, *The Financial System in Nineteenth-Century Britain*, (New York: Oxford University Press, 2003) xv.
[45] Exchange Telegraph Company License, GPO Memorandum, October 29, 1874, File XIV, Post/30/371A, BT.
[46] Exchange Telegraph Company License, GPO Memorandum, June 24, 1872, File V, Post/30/371A, BT.
[47] Exchange Telegraph Company, Annual General Meetings, 1886, MS/22964/1 LMA.

market takers— it stripped many of the social dynamics of price negotiation away from market transactions. Brokers and jobbers knew the reputations of the men and firms they dealt with. Brokers tended to prefer jobbing firms with larger capital reserves who they believed were of a "more responsible character." Jobbers, on the other hand, were always wary about making prices for any transaction that they suspected was "speculative" in nature.[48] Jobbers could compete against one another to make a better price for a broker trying to place an order.[49] Brokers and jobbers also used the price negotiations of the market to "control what firms (they) wanted to trade with." Bad prices could be made for untrustworthy firms, while firms that were trusted and respected could be given certain advantages.[50] The ticker tape flattened prices from a dynamic social interaction into what appeared to be an objective and neutral price, though in practice, this was far from the case.

Rather than ever reporting "objective" prices, the price transmitted by the ticker tape were produced by both delicate webs of social trust and through social conflicts over information. Trust in Extel's numbers was hard to come by and was frequently called into question. Many were suspicious that Extel's low level clerks and operators could be bribed to "send out a fake price."[51] Still others believed that the ticker tape service was "worked in the interest of certain outside operators," and that the way it was "mismanaged (was) nothing short of a disgrace."[52] The problem of trusting the prices reported over the ticker was exacerbated by the speed of the system. "There is a shout," of a price at which a deal was done and "it is telegraphed all over the country immediately," one stockbroker described.[53] To the frustration of many, the ticker service was often littered with errors in prices or stock notation.[54] William Davies, the managing director of Extel, attempted to explain away these errors. Extel never sent out "marked" prices over the ticker tape but rather reported the "price bid or offered," which meant that his reporters sent out prices as "they overhear (them)."[55] This meant that a deal had not necessarily occurred at the prices reported. Transmitting pricing information with speed actively worked against reporting accurate or objective market prices at which deals had been transacted.

Attempting to reconcile speed with accuracy forced Extel to increasingly rely on certain trusted jobbers for information about prices within particular markets. Skeptics saw the weakness in this approach. In front of the Royal Commission that investigated the Stock Exchange in 1878, Davies was asked if his reporters and operators were "liable to be imposed upon" by jobbers within the Stock Exchange. Davies responded unequivocally that it had "never…happened," though he admitted that the most common method for collecting prices was simply "ask(ing) the dealer(s)" in the market.[56] Rather than the low-level clerks or outside dealers and bucket shops, it

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[48] *Royal Commission on Origin, Objects, and Constitution of the London Stock Exchange,* 1878, 44-45.
[49] Ibid. 98.
[50] Bernard Attard, "The Jobbing System of the London Stock Exchange: An Oral History. Interview No. 6: Anthony Jenkins." London: Institute of Historical Research, (1990).
[51] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Queries by Sir James Anderson, MS/23028 LMA.
[52] "Tape Prices," *Financial Times,* November 14, 1888, 2.
[53] *Royal Commission on Origin, Objects, and Constitution of the London Stock Exchange,* 1878, 340.
[54] See for example "The Tape and Mining Prices," *Financial Times,* May 2, 1895, 3; London Stock Exchange, Managers Minutes of Subcommittees relating to Exchange Telegraph Co, 54-55, 72, MS/14608/03 GL.
[55] *Royal Commission on Origin, Objects, and Constitution of the London Stock Exchange,* 1878, 351.
[56] Ibid.

was an alliance of convenience forged between Extel and the jobbers of the London Stock Exchange that produced the prices reported over the ticker tape.

It was difficult to institute reforms and discipline on the price reporting system that did not disrupt either speed at which prices were transmitted or the delicate webs of social trust that Extel reporters relied upon to collect prices. But that did not prevent certain groups within the London Stock Exchange from trying. In 1900, Norman Herbert, the head of Extel's operations on the floor of the Stock Exchange argued that a new system should be installed to report more accurate prices. He proposed that every price slip "handed in by jobbers (be) countersigned" by at least one other member corroborating the price. Herbert was opposed not only by stock jobbers but also by his bosses at Extel. The alliance between jobbers and Extel was mutually reinforcing. The jobbers almost unanimously opposed the reform since it implied "a doubt of their reliability," and the managing director of Extel was "very reluctant to put it in force," since it was "only by the courtesy of the jobbers that (Extel) are enabled to obtain prices."[57] Reforms meant to regulate and routinize the reporting of pricing information risked destroying the informal trust between jobbers and Extel reporters. The managers of the stock exchange, on the other hand, jumped at the opportunity to have more safeguards and regulations around the distribution of prices via the tape, regulations which expanded their own power over how prices were distributed. They instructed Herbert to inform the directors of Extel that "all prices tendered to (Extel) for quotations by members should be verified by the signatures of 2 members or firms."[58] Implicit in the new arrangement was that one of the two firms signing the slip would be a brokerage firm, as every deal in the stock exchange was ostensibly done between a broker on the one hand and a jobber on the other. It was a blow to the power of jobbers on the London Stock Exchange but helped both brokerage firms and the managers exert more power over what prices were reported.

Before stock prices were ever sent out over Extel's ticker tape wires, they were subject to power struggles between particular social forces within the London Stock Exchange itself. While Extel's low level employees were viewed as potential sites for the corruption of the market, it was the brokers, jobbers, stock exchange managers, who did the most to report prices that accurately represented *their* version of the "market." For all of its abstractive power, the technology of the ticker tape was beholden to the social forces in the market it was often claimed to have superseded.

The Politics of Transmission

Politics and the struggle for social power over the market did not end when prices were transmitted over the electrical wires. The mundane technical details of transmission—and the material infrastructures that carried the electronic signals of prices to subscribers—became crucial sites of power struggles in the shaping of 19th century financial markets. Through the implementation of its ticker tape infrastructure, Extel was able to centralize a massive amount of power over financial markets, stockbrokers, and investors alike by controlling the information that passed through it system and who had access to it. Instead of an abstract and simultaneous market that was available to all who had a ticker tape, the physical infrastructure of the ticker system imposed new inequalities and hierarchies on the financial system. At the same time,

[57] London Stock Exchange, Managers Minutes of Subcommittees relating to Exchange Telegraph Co, 54-55, MS/14608/03 GL.
[58] Ibid.

however, Extel's quest for control over infrastructure inadvertently led to a new set of social dynamics that fundamentally altered the nature of 19th century financial markets.

Extel's initial infrastructure of transmission was tightly circumscribed by the physical constraints of the London Stock Exchange and the electrical constraints of transmission. From its entry to the stock exchange in November of 1872 until its expulsion in 1882, Extel was forced to work from a small vestibule in a hallway outside of the stock exchange's main trading floor.[59] While Extel had had the opportunity to take larger offices in the Stock Exchange, they were further away from the trading floor and would have impeded the speed at which Extel reported prices.[60] Yet the smaller offices presented Extel with a stark fact: there was not nearly enough space to house the amount of batteries and circuitry needed to work the entire ticker tape system from the London Stock Exchange itself.[61] Unlike the New York Stock Exchange, where ticker tape companies placed equipment in upper floors, spatial constraints forced Extel to develop a different system to house its equipment and transmit its prices.

The keystone to Extel's system was a relay within the Bartholomew House, a building on the Northwest corner of the stock exchange at the intersection of Throgmorton Street and Bartholomew Lane. Prices were sent from the telegraphist in the stock exchange vestibule through the relay in Bartholomew House back to Extel's headquarters at 17 & 18 Cornhill. From the Cornhill headquarters, using a roomful of battery power, the stock prices could simultaneously be sent to every ticker tape on each of the different circuits that Extel serviced. Bartholomew House was not only a key waypoint for sending prices from the Stock Exchange back to Extel headquarters but also provided two other important affordances. Overhead wires could be run directly across the roof of the Royal Exchange from Extel's headquarters on Cornhill Street to Bartholomew House; and shorter wires could then be run directly from the Bartholomew House relay to stockbrokers' offices in Angel Court, Copthall Court, and Austin Friars (see Figure 12). Because of the length of the wire required, and the challenge of finding wayleaves, running reliable overhead wires directly from Cornhill into those locations would have been enormously difficult otherwise.

[59] See London Stock Exchange, Trustees and Managers Minutes, 1868-1872, 211-213MS/19297/006; Trustees and Managers Minutes, 1872-1874, 260, 264, MS/19297/007 GL.
[60] London Stock Exchange, London Stock Exchange, Appendix to Trustees and Managers Minutes, 1875-1881, 1875-1881, January 10, 1878, MS/19514/003 GL.
[61] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Diary of William Davies, April 16, 1886, MS/23028, LMA.

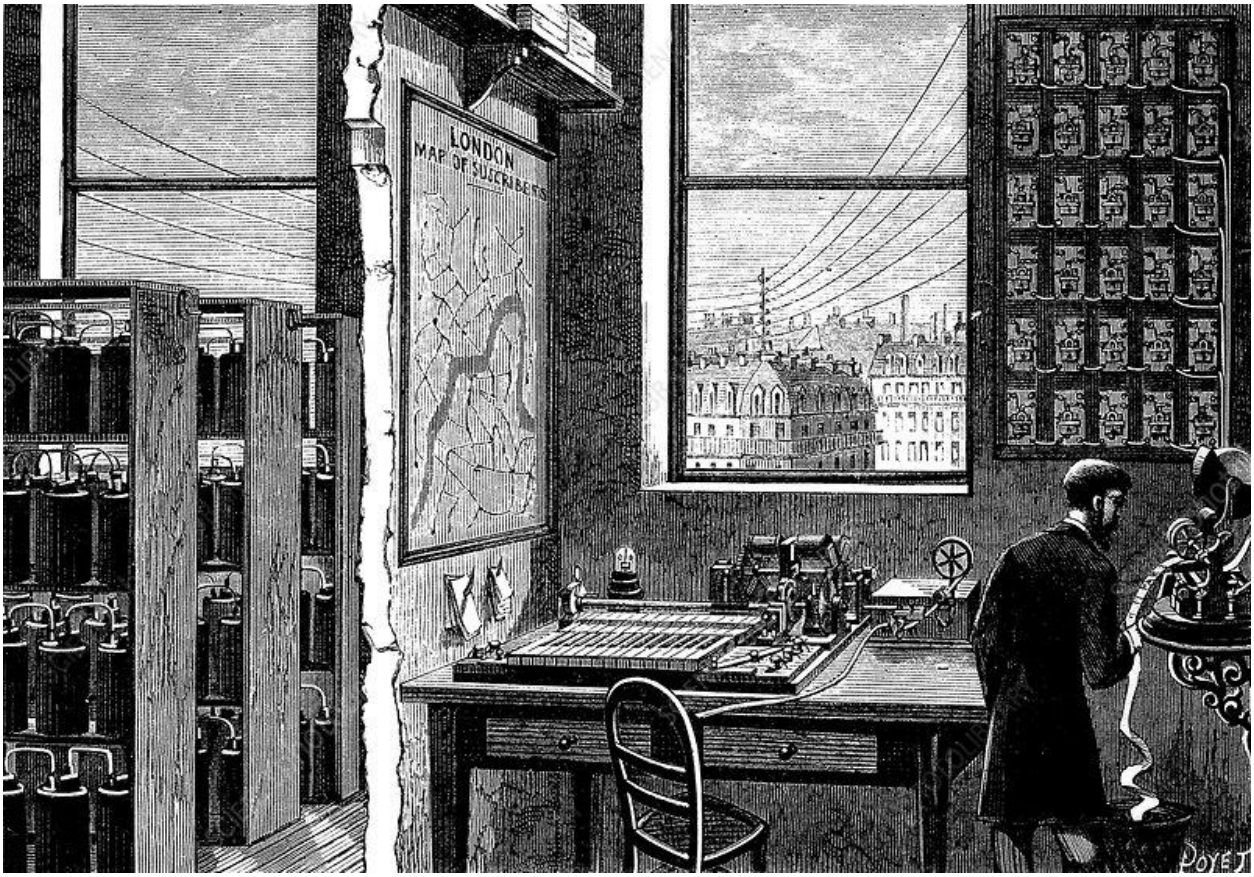

Figure 12: The view from Extel's Headquarters in 1882

Yet the question of where, *specifically*, Extel ran its cables and wires was always more than a simply technical problem. Bartholomew House was home to the offices of numerous stockbrokers. The large firms that could afford the expensive offices directly connected to the stock exchange itself were also the first firms that could afford to try the ticker tape. Initially Extel did not actually have an office in Bartholomew House and instead relied on its first customer, the stockbroking firm of Borthwick and Wark, for space. A seven-wire cable was run from Cornhill, above the Royal Exchange, and into the offices of Borthwick and Wark, where it then ended and six "single wires radiate(d) from it to the offices of other subscribers," the last wire was saved for transmitting prices from the stock exchange back to Cornhill.[62] The technical needs of Extel immediately threw Borthwick and Wark under suspicion that they were gaining extra benefits from the placement of these wires within their offices. The GPO sent an inspector to Borthwick and Wark's to ascertain whether "messages intended for other subscribers (were) received (first) by Messrs. Borthwick & Co. from the company at their office and thence by them transmitted to the subscribers." Moreover, the GPO asked if "any instruments for transmitting telegrams (have) been set up in Messrs. Borthwick's office and connected with the wires passing through it?"[63] Put more simply, were Borthwick and Wark using their critical position within

[62] Exchange Telegraph Company License, GPO Memorandum, July 19, 1872, File V, Post/30/371A, BT.
[63] Exchange Telegraph Company License, Letter from Solicitor to the GPO, September 3, 1872, File V, Post/30/371A, BT.

Extel's infrastructure for their own gain? The answer was ultimately "no," as a GPO inspector determined that Borthwick and Wark's office was simply used as a wayleave for Extel's system which "shortened the journey of the messages from the Stock Exchange," and no "practical mischief results from such infringement."[64] Though the GPO ultimately ruled in favor of Extel, the anxiety and effort that went into ascertaining the truth pointed to how deeply politicized the simple act of laying wires could be.

Within a year the ticker tape service proved so popular that Extel struggled to stay within the remit of the imposed on it by the GPO and London Stock Exchange. By May of 1873, at the urging of "19 influential firms" the London Stock Exchange repealed its resolution that Extel could only send its prices to members of the stock exchange.[65] The managers primarily intended for other financial institutions to have access to the ticker, most notably banks and insurance companies. Yet stockbrokers and Extel saw other opportunities. By extending the ticker tape services to clubs and the homes of their clients, they could stimulate more business for themselves. Extel had even broader plans in mind, namely, the extension of services to three new locations: newspaper offices on Fleet Street, the clubs of London's West End, and the provincial stock exchanges. Each one of these additions would have substantially exceeded the GPO's requirement that they circulate prices only within 900 yards of the Stock Exchange. After wrangling with the GPO's solicitor's, both sides found a more flexible interpretation of the initial license. If Extel set up a second office in the West End, near Charing Cross, prices could then be distributed to "the offices, residences, clubs, or hotels…(of) other persons having business with or upon the Stock Exchange in the City of London," as long as these locations were within a 900 yard radius of the new office.[66]

Even for the new offices in Charing Cross, the 900 yard radius quickly proved too limiting a constraint. Extel and its customers constantly pressured the GPO for the extension of wires and regulatory licensing to include private clubs and newspapers that fell beyond this radius. According to Extel, the further away clubs and newspapers were from both Extel's offices and the stock exchange itself, the more in need they were of ticker tape services. The Temple Club was one example. Located off Arundel Street in the Temple near the present site of King's College, the club had numerous "members who are on the Stock Exchange."[67] During the day, club members periodically received "a list of prices from brokers in the City," yet, because of the distance from the Temple to the City, the prices "arrive(d) by hand, too late for any practical use."[68] Club members urged both their brokerage firms and Extel to pressure the GPO to allow an extension of ticker tape services to the club's location. The GPO remained skeptical of exceeding the license and renting a wire to Extel and for the transmission of prices to the Temple Club. If they supplied one club with a wire beyond the licensing limit, what was to stop a slew of other applications?

The GPO eventually had to confront the transformations Extel's financial technology was ushering into late Victorian Britain, especially the ticker tape's unique asymmetry. In a lengthy internal memo, one GPO official noted the peculiar "system of the Exchange Telegraph Co,"

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[64] Exchange Telegraph Company License, Letter to the Engineer in Chief of the GPO, September 19, 1872, File V, Post/30/371A, BT.
[65] London Stock Exchange, Trustees and Managers Minutes, 1872-1874, 129-130, MS/19297/007 GL.
[66] Exchange Telegraph Company License, Letter from Solicitor to the GPO, October 7, 1874, File XIV, Post/30/371A BT.
[67] Exchange Telegraph Company License, Report from Alan E. Chambre, October 29, 1874, File XIV, Post/30/371A, BT.
[68] Exchange Telegraph Company License, Letter from Extel to GPO, October 27, 1874, File XIV, Post/30/371A BT.

where an office could "be placed on (only) one wire without detriment to the proper working of their system…as the wire is for use in one direction only and for a purpose quite foreign to that which an ordinary private wire is devoted."[69] Since Extel only transmitted prices *outward*, rather than eroding the GPO's business, it in fact drove more customers to send messages over GPO telegraph wires to place orders on stock prices they obtained from the tape. Between 1872 and 1874 alone, metropolitan telegraph messages had increased from 4000 a week to *13,000* a week. The memo expressed the GPO's fear that failing to extend the remit of Extel's license would "stop any further increase of such messages."[70] Instead of diverting business away from the GPO, Extel's service was increasingly central to the revenues and expansion of the GPO's metropolitan telegraph service.

Not only had Extel's infrastructure ushered in a technological transformation of how finance operated, but it also ushered in a social transformation of who was connected to financial markets. In a memo the GPO was forced to admit that because of these transformations the restriction of the distribution of prices to "other persons having business with or upon any such stock or commercial exchange," in Extel's original license were close to meaningless.[71] If the definition of "other persons" was to be adhered to "nearly everyone in the Kingdom might come within this category, inasmuch as all persons have had during their lives some business with or upon the Stock Exchange."[72] By 1876 the GPO's stance had changed. It was now "impolitic for the Post Office to stand in the way of public convenience in matters which it cannot itself undertake."[73] The GPO formally altered Extel's license later that year. Extel had to pay an increased the royalty to the GPO for renting wires but otherwise was given free rein. Most importantly, all qualifications for new subscribers were eliminated and the service radius from any Extel office was extended to 1 mile.[74] The dramatic social expansion of those with access to ticker tapes had fundamentally reshaped the GPO's ability to police and regulate Extel's new financial communication system. A new investing public, the GPO believed, could no longer be reasonably denied access to financial information and infrastructure based on outdated norms of communications law.

Expanding the Ticker Tape

Between the GPO's extension of Extel's operating license and the London Stock Exchange allowing non-members to subscribe to the ticker tape, the mid-1870s to early-1880s were a time of rapid expansion for Extel. In 1886, Extel's chairman proclaimed to the shareholders that "the financial business…has touched the highest remunerative point in the history of the company, and this is due in a very great measure to the increased facilities afforded to members of the stock exchange."[75] By 1887, Extel had opened offices in Liverpool, Manchester, Leeds, Glasgow, Edinburgh, and Brighton, in addition to those they already had in

[69] Exchange Telegraph Company License, Report from Alan E. Chambre, October 29, 1874, File XIV, Post/30/371A BT.
[70] Exchange Telegraph Company License, GPO Memorandum, November 3, 1874, File XIV, Post/30/371A, BT.
[71] Ibid.
[72] Ibid.
[73] Exchange Telegraph Company License, Letter from the GPO to HMS Treasury, August 14, 1876, File XVII, Post/30/371A, BT.
[74] Exchange Telegraph Company License, Letter from Alan E. Chambre to the Secretary of the GPO, March 14, 1876, File XVI, Post/30/371A BT.
[75] Exchange Telegraph Company, Annual General Meetings, 1886, MS/22964/1 LMA.

London. These offices serviced a total of 903 ticker tape instruments throughout the country by 1893.While the geographic distribution of subscribers was more varied than in the past, the ticker tape business was still highly skewed to London. 537 of the financial service ticker tapes were located in London, while only 15 were in Manchester, 12 in Liverpool, and 3 in Brighton.[76] Importantly, these ticker tapes were not a local system unto themselves. Ticker tapes in Manchester did not simply transmit Manchester stock exchange prices to Manchester brokers. Extel's services in the provinces circulated London prices to provincial brokers and reported the prices of select local securities back to London subscribers. Thus, the ticker tape service in the country was mostly for brokers engaging in arbitrage trading with London. Extel utilized the same structure to report prices from foreign stock exchanges as well. While Extel did not conduct services internationally, it had a network of reporters that sent in stock prices and news from New York, Paris, Berlin, and Frankfort, but it did not operate local services in these cities.[77] Because the prices Extel's ticker tape circulated were of such importance to financiers in London, the same information was also, by necessity, of importance to financiers in the provincial financial centers and throughout the rest of the world. .Extel's ticker tape service tautologically reinforced London's role central role in global finance.

The expansion in the amount of people who had access to Extel's ticker tape services necessitated an expansion of the material infrastructure that provided financial information. But expansion had both technical and political challenges. One of the principal problems Extel faced was simply how to engineer a system that could simultaneously broadcast rapid price quotations to hundreds of different ticker tape instruments at the same time. The asymmetrical, unidirectional transmission of information required a massive amount of electrical power and current. Extel's service relied on 2000 battery cells which produced close to 200 volts of electricity, which in turn, created an average electrical current on transmitting wires of 35 amperes.[78] In contrast, a closed-circuit telegraph that delivered messages between two nodes typically used 120 volt charges and a maximum of 20 amperes of electrical current per wire.[79] The simultaneity of transmission demanded by the ticker tape, as well as the constant updates of stock prices fluctuations Extel sent out, caused far more electrical traffic on wires than mere telegraphing.

Providing a physical infrastructure of wires that could handle Extel's unique and difficult business was a challenge. In 1876, GPO officials warned against renting wires to Extel. Any wires the GPO rented to Extel risked becoming "injured" and "their use must be carefully watched," given the "strong currents" that "harmed" many wires. The official urged caution, indicating that the GPO should include clauses forcing Extel to pay for all wire repairs in any new license.[80] The GPO's hesitance to rent Extel any local wires was met by enthusiasm from

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[76] The other 336 ticker tapes were operated for non-financial services. Exchange Telegraph Company, Annual General Meetings, 1893, MS/22964/05 LMA.

[77] It is important to note that many foreign stock exchanges, like Paris, did not even have a local ticker tape service at all. See Preda, *Framing Finance*, 113-127. See Exchange Telegraph Company, Expenditure and Revenue Accounts of the Offices in Liverpool, Manchester, Glasgow, Edinburgh, and Brighton, MS/22981; Annual General Meetings, 1893, MS/22964/05, LMA.

[78] See Exchange Telegraph Company, Engineer's Report Book, 236-238, MS/23075, LMA. One should think of the amount of voltage as the electrical "road" over which messages travelled, while the amperage measures the actual "traffic." My thanks to electrical engineer Adam Mackenzie for this analogy.

[79] Anonymous, *Technical Pamphlets for Workmen: Elementary Principles of Telegraphy and Systems up to Morse Duplex*, (London: His Majesty's Stationery Office, 1919) 26-28.

[80] Exchange Telegraph Company License, Letter from Alan E. Chambre to the Secretary of the GPO, July 10, 1876, File XVI, Post/30/371A, BT.

Extel's team of engineers. Frederick Higgins, Extel's chief engineer, urged the replacement of rental lines "owing to the superior conductibility of *our* wires over those of the Post Office."[81] Extel embarked on extensive construction projects and by the end of the 19th century had erected nearly 200 miles of private wires, primarily within London.[82] Though many competing telecommunications companies, local political authorities, and the GPO opposed Extel's infrastructural expansion, by the early 1900s, the company could claim to have triumphed over all the obstacles in their way.[83] Extel's private infrastructure of wires took pride of place in the company's early 20th century advertising material. The reason why Extel provided "the most perfect" service, the company boasted, was because "the wires belong to the company," and were thus of a higher quality and received more immediate maintenance than any other telecommunications infrastructure in Britain.[84] The technical challenges of creating a material infrastructure capable of transmitting Extel's information had been turned into a key advantage for the company over its competitors.

A larger infrastructure of offices, wires, and ticker tapes allowed Extel to expand its business beyond just financial news and stock prices. The company quickly realized that it could leverage its numerous contacts throughout Britain and Europe as well as its massive transmission system to broadcast all manner of information to its subscribers. Thanks to the "insatiable…demand for news and intelligence of all kinds," by the 1880s, Extel had developed a host of new services including general news, parliamentary news, sporting news, and commercial news.[85]The new services Extel introduced in turn drove an even further expansion and specialization of material infrastructure.

Unlike the financial service that sent out only updates to changing stock prices, other news services needed to rapidly transmit far larger pieces of information, like news stories or parliamentary speeches. The necessity of communicating different and larger amounts of information forced Extel to develop new technologies and infrastructures beyond the ticker tape. The key innovation that helped Extel expand into different types of news was the cumbersomely named "telegraphic type-printing transmitter," a machine that combined the continual updates of the ticker tape with the capabilities of a modern day fax machine.[86] A reporter would transmit a news story or a speech from parliament and the printing transmitter would print out the story in real time at a length of up to "ten thousand words for each sitting."[87] However, the machine

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[81] Exchange Telegraph Company, Engineer's Report Book, 207, MS/23075 LMA.
[82] Exchange Telegraph Company, Annual General Meetings, 1893, MS/22964/05 LMA.
[83] There are numerous examples of the legal and political fights that Extel became embroiled in during the 1880s and 1890s. The most salient was an extended legal dispute between Extel and the United Telephone Co regarding wire space over the roof of the Royal Exchange into the Stock Exchange. Extel also faced stiff opposition from various London metropolitan authorities, especially the Sewage Commissioners who opposed Extel's attempts to move their wiring underground. Telecommunications companies, the sewage commissioners argued, "had already interfered with the streets to an objectionable extent." See Exchange Telegraph Company, Engineer's Report Book, 135, MS/23075; See also, Papers Concerning Telephone and Telegraph Equipment, including affidavit by Frederick Higgins in a High Court case against the United Telephone Co Concerning Rooftop Telegraph Wires, MS/23081 LMA
[84] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Advertising Announcement of New Telephone Services, MS/23028 LMA.
[85] Exchange Telegraph Company, Annual General Meetings, 1888, MS/22964 LMA.
[86] For the earliest record of the machine, see Exchange Telegraph Company, Instructions for the use of ETC Telegraphic Instruments, MS/23080 LMA.
[87] Exchange Telegraph Company, Copy of the 'Times' with a full page advertisement by ETC entitled 'How the Newspapers Get Their News,' MS/23123 LMA.

required even more "powerful" working electrical currents than a ticker tape. In fact, the printing transmitter required so much extra electrical current that it caused "breakdowns," on circuits with "other descriptions of instruments," like ticker tapes. Extel's chief engineer admitted that "not more than three of these instruments (would) work on one circuit" even with no other instruments attached.[88] Not only could the printing transmitter not be on the same electrical circuits as financial ticker tapes, but the placement of ticker tapes themselves had to be carefully monitored. Newer and faster financial ticker tapes could not work from the same central transmitter as slower, older ones and had to be kept on entirely different electrical circuits. [89] When Extel did upgrade ticker tapes, they had to upgrade all of the ticker tapes on a circuit at the same time and could not simply swap new machines in piecemeal. Circuits also had a limit: only about twenty normal ticker tape instruments could be placed on a circuit at the same time.[90] A technical solution was needed to accommodate the needs of Extel's non-financial news services.

Technical necessity forced Extel to segregate its electrical circuits into specialized networks during the 1880s. In order to manage the different instruments needed for each type of news service, and the different electrical currents (and thus wires, transmitters, etc.) that each instrument required, Extel intentionally specialized the electrical circuits that it used. Figure 13 shows the rough plan of circuits that Extel utilized within London and how circuits were separated. The "C" in the center of the map stands for Extel's central Cornhill headquarters from which all prices and information were transmitted. The four complete loops to the right were the financial wires which ran from Cornhill to the Stock Exchange, to broker's offices north of the stock exchange near Austin Friars, Angel Court, and Copthall Court, and south of Cornhill to the banks on Lombard St. The three lines to the left were the wires that ran from Cornhill to Parliament in Westminster, the clubs and outside brokers of the West End, and the newspapers on Fleet St. Some regions were busier than others. The Fleet St. circuit had ten miles of wiring but only eleven working instruments, while the City had over 25 miles of wiring that serviced fifteen different circuits, each of which had twenty ticker tapes apiece. [91]

But technical details were always more than just technical details. Extel's entirely private infrastructure of offices, wires, ticker tapes, and the form that that material infrastructure was forced to take because of technical limitations and affordances, directly shaped how the flow of financial information was controlled and who had access to it. The centralized and private nature of the ticker tape service gave Extel the power to send different information across different circuits: a ticker tape located in the City on the financial service would provide different information (and different prices) than a ticker located in the West End on the "commercial" or "general news" service. The decision over what information was sent and to whom had been powerfully centralized by Extel through the material infrastructure of the ticker tape.

[88] Exchange Telegraph Company, Papers Concerning Telephone and Telegraph Equipment, MS/23080 LMA.
[89] Exchange Telegraph Company, Annual General Meetings, 1892, MS/22964/04 LMA.
[90] Exchange Telegraph Company, Engineer's Report Book, 230, MS/23075 LMA.
[91] Ibid. 271.

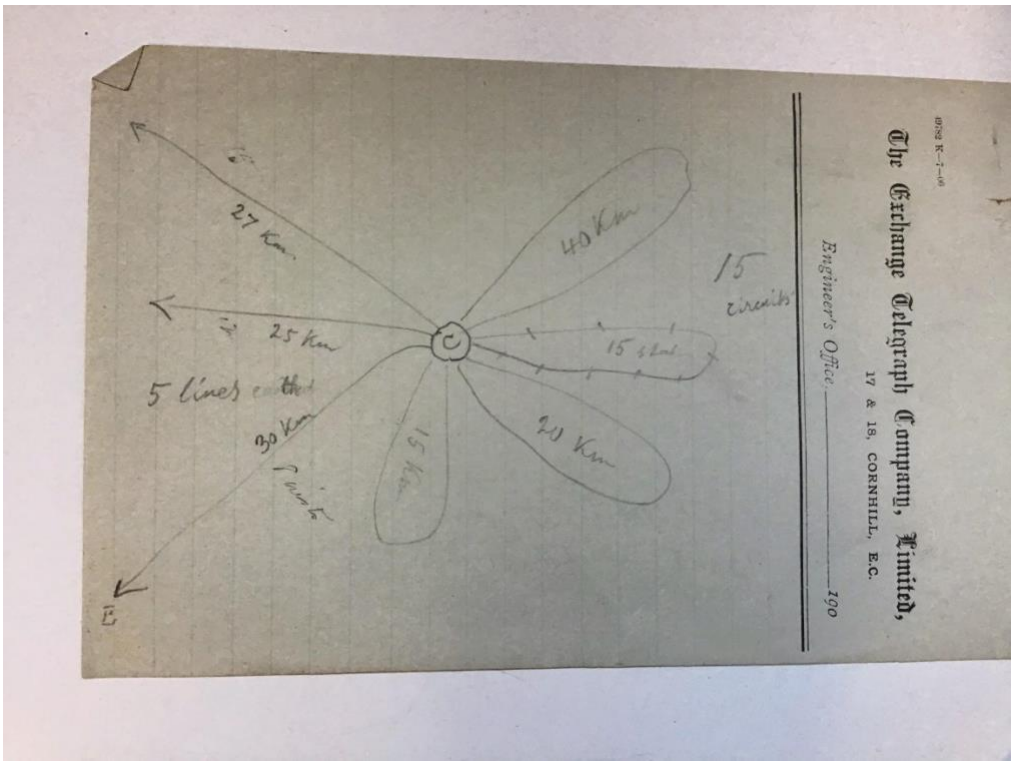

Figure 13: Sketch of Extel's operating circuits circa 1887. (Exchange Telegraph Company MS/23083 LMA).

The Social Consequences of the Ticker Tape

The political and social problem of managing who had access to the market became suddenly and deeply entangled with the technical problem of operating the ticker tape in 1885 when the London Stock Exchange expelled Extel from the premises. Ticker tape service continued unabated from the Bartholomew House relay but the quotations that appeared on the tape could no longer be called "official" or even exclusive, as the formal connection with the stock exchange had been broken. Stockbrokers believed that Extel's supply of price quotations to outside stockbrokers and bucket-shops was draining business away from the London Stock Exchange. Throughout 1884, private letters circulated within the Stock Exchange condemning the "present unprecedented stagnation of business," as the fault of "outsiders having the prices furnished (to) them direct from the house by means of the exchange telegraph company's machine." Many members of the London Stock Exchange believed that outside brokers were, thanks to the ticker tape, "rendered independent of the stock exchange itself but…subsist and thrive upon the information derived therefrom."[92]

The problem of outside brokers attempting to do deals had been a thorny one for stock exchanges throughout Britain. In London, outside brokers had a number of advantages. They could advertise in newspapers and periodicals to increase their clientele; a practice stock

[92] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Letter from C.A. Streeten For Circulation Amongst Members of the Stock Exchange, December 19, 1884, MS/23028 LMA.

exchange brokers were explicitly barred from. Additionally, outside brokers were not subjected to the same capital requirements or legal strictures that bound members of the London Stock Exchange. Thanks to the ticker tape, continuous, up-to-date pricing information was no longer sheltered within the London Stock Exchange itself, and outside brokers could much more easily do deals at or around the market price and have the information to *prove* that the prices they quoted were accurate.

In 1886, the managers of the London Stock Exchange re-admitted Extel but under a new contract that established the managers in a "much more authoritative position." On the one hand, Extel was allowed to expand its operations. Two Morse operators were permitted, one at each end of the house and new services like the "challenge system," whereby subscribers could telegraph or telephone the head office and ask for quotes of particular shares, were introduced. In order to give stockbrokers easier facilities to use the new challenge system, Extel was also allowed to introduce its own telephone system to the stock exchange. On the other hand, Extel was forced to "decline any further applications from outside brokers," and agreed to "do their best (to) gradually eliminate all outside dealers and brokers…as subscribers to the tape." Furthermore, the Committee for General Purposes now had the final say over every quotation sent out over the tape and over every new subscriber Extel wished to add.[93] In order to secure a monopoly over the distribution of official stock exchange ticker tape prices, Extel had forfeited its power to select its own clients and discriminate which prices it sent out over the tape.

The new arrangement was a harrowing test of financial and political fortitude for Extel. Entirely new infrastructural systems had to be constructed not just for business expansion, but for the *exclusion* of outside brokers. "In carrying out these new arrangements," Davies wrote, "we had to run entirely new circuits for members so as to cut out outsiders from the telephone and challenge system, thus incurring additional permanent charges (and) attending a duplicate staff and maintenance."[94] Infrastructure was expensive. Extel reported spending £1,856 on the erection of new circuits and an additional £13,337 on maintenance. In a desperate attempt to make up the revenue it was losing from the lapsing contracts of outside brokers, Extel lowered prices for members of the stock exchange, hoping to gain new clients. They didn't. In total, Davies estimated the London Stock Exchange's new regulations had cost Extel £32,144. [95]

Part of the problem were the contracts Extel had signed with outside brokers before 1886. Legally, Extel could not simply shut off ticker tape services to these customers. However, Extel's infrastructure provided what seemed like a simple technical solution to the problem. Davies informed the managers of the London Stock Exchange that since "the instruments used by outsiders are on entirely different circuits to those used by members…the information supplied can always be regulated as may be found necessary." [96] Not long afterwards, Extel began shifting the service it provided outside brokers from the "financial" service to the new, amorphously named "commercial" service. Prices were continually relayed as usual, but instead of the two prices normally used in the exchange—a buying and a selling price—the commercial service only sent out the *middle* price, effectively precluding outside brokers from knowing what

[93] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange Agreement between London Stock Exchange and Exchange Telegraph Co. June 22, 1886, MS/23028 LMA.
[94] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, William Davies Internal Extel Memorandum, November 29, 1893, MS/23028 LMA.
[95] Ibid.
[96] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Letter from William Davies to the London Stock Exchange, May 13, 1886, MS/23028 LMA.

the actual buying and selling price of stocks were.[97] The managers of the London Stock Exchange also worried that their own members would take bribes from outside brokers to jerry-rig their tapes onto the circuits used by members. But once again, the material technicalities of Extel's system proved a benefit. Ticker tapes illegally added onto circuits would "not be attached to the company's (central) batteries" preventing them from functioning.[98] The material limits of the ticker tape and its circuits had, in fact, provided a technical solution to one of the largest social problems the London Stock Exchange faced in the 19th century.

Extel also assiduously policed the physical placement of its ticker tapes to prevent their use by members of the public and outside brokers alike. The years after 1886 saw Extel engage in the ruthless removal of ticker tapes from restaurants, hotels and clubs where the "publicity of the tape (was) objected to."[99] Some affluent clubs protested but Extel removed their machines all the same, since "all members of the high-class clubs, if wanting to deal on the stock exchange, can have no difficulty in dealing through a broker."[100] Some restaurants and hotels attempted to construct separate ticker tape rooms "to which no one but subscribers were admitted," yet they were not spared either.[101] Extel even sent inspectors to root out more nefarious placements of ticker tapes. One London stock exchange member named A. Moreton Mandeville had his offices next to bucket-shop deceptively named the "London and Paris Exchange." However, upon inspection, there was a door inside Mandeville's ticker tape room that led "into another office," next door, presumably the bucket-shop's, and Mandeville's ticker tape was promptly removed.[102]

Yet for all of the control over material infrastructure that Extel exercised, there were no easy technical solution to the social problem of who should have access to the market. The mass adoption of the ticker tape by outside brokers before 1886 had unleashed new social dynamics within financial markets that were nearly impossible to stop. While some outside brokers, particularly bucket-shops, merely had clients bet on the movement of prices on the tape itself (without actually ever purchasing the underlying security) they were the minority. Many outside brokers did legitimate business by aggregating small, often speculative, orders from clients and then processing them with official brokers on the London Stock Exchange. The average outside broker simply funneled business to the London Stock Exchange "employing one or more members as necessary to transact their business thereon and…sharing the commission." Davies strenuously attempted to demonstrate the importance of outside brokers to the managers of the London Stock Exchange. According to informal Extel estimates, outside brokers were responsible for "53 and a quarter million" pounds worth of business on the Stock Exchange each year.[103] Outside brokers had become a huge source of revenue for members of the London Stock

[97] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Diary of William Davies, June 20, 1894, MS/23028 LMA.
[98] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Diary of William Davies, April 16, 1886, MS/23028, LMA.
[99] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Notice of Discontinuance to Outsiders Objected to by Committee of the Stock Exchange, June 23, 1894, MS/23028 LMA.
[100] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Letter from C.A. Streeten For Circulation Amongst Members of the Stock Exchange, December 19, 1884, MS/23028 LMA.
[101] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Letter from the Bristol Hotel and Palmerston Co. to Extel, June 27, 1894, MS/23028 LMA.
[102] Exchange Telegraph Company, Correspondence with the Committee for General Purposes of the London Stock Exchange, June 28, 1897, MS/23030/001 LMA.
[103] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, William Davies Internal Extel Memorandum, November 29, 1893, MS/23028 LMA.

Exchange and had had to create close working relationship with many of the stock exchange brokers for their own outside business to function smoothly.

In an effort to convince the London Stock Exchange that "the removal of instruments from outsiders will do little harm to anyone but the Exchange Telegraph Company," Extel sent a survey to the 58 largest outside brokers they serviced.[104] The survey asked the amount of business done on the stock exchange by the outside firm, how many members of the stock exchange were used to execute that business, and "if the instrument is removed, will it stop your business?"[105] The 58 firms were unanimous: the removal of the ticker tape would make no difference because they already had working relations with London Stock Exchange brokers who would continue to supply them with prices and place orders. One firm claimed that they found "the instrument useful, but in no way necessary." Another firm noted that they could "always obtain prices from members of the house, who gladly give prices and execute orders," while yet another said that "there would not be the slightest difficulty in getting the prices from our brokers directly."[106] Thanks to the ticker tape, outside brokers and inside brokers had forged mutually beneficial relationships funneling business from smaller speculators into the formal London Stock Exchange. Extel's survey also revealed that these social ties were here to stay, in large part facilitated by a new technology: the telephone. By 1893 it was clear to the directors of Extel that "with the advantages of private telephones…the tape is but an auxiliary."[107] Though the ticker tape was used well into the 20th century, by the end of the 19th, it was no longer a technology that could effectively determine the boundaries of the stock market.

Where the telegraph system was centered on key nodes and was effectively controlled through stock exchange architecture by small groups of markets and traders, the ticker tape changed these dynamics dramatically. Faith in the ticker tape's asymmetric and centralized control over infrastructure and information led to its mass adoption both by those within the London Stock Exchange and many outside of it. And while the ticker tape made financial pricing information simultaneously and immediately available to a much wider swath of brokers and investors, it was still always subject to the social forces of the stock exchange floor. The prices the ticker reported were by no means objective or accurate, nor yet were they delivered equally to everyone with a ticker tape. Moreover, the infrastructure of the ticker was immediately politicized, at first primarily by the GPO who viewed Extel as a threat. But the social expansion of the "market" the ticker engendered eventually forced the GPO to retreat from many of its protests and allowed Extel to expand ticker services even more widely, with the belief that they could effectively control the market through their physical infrastructure. Once the ticker tape was more widespread, however, it ushered in a new configuration of social relations within financial markets that technical solutions and material politics—from controlling the placement of ticker tapes to the information that was transmitted over them—could no longer control.

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[104] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Questionnaires Completed by Subscribers as to the Possible Effects on Their Business of the Removal of Extel Instruments, 1893, MS/23028 LMA.
[105] Ibid.
[106] Ibid.
[107] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, William Davies Internal Extel Memorandum, November 29, 1893, MS/23028 LMA.

Telephone

The historical relationship between the telephone and financial markets is the most difficult relationship to track of the technologies that have been covered in this chapter. Unlike the telegraph system that made stock exchanges key transmission nodes or the centralized system of the ticker tape, the telephone was a largely de-centralized network. As a postal official noted in 1881, instead of prices or information being collected and distributed at central nodes, "any one person who avails himself of (the telephone) should be able to communicate with every other."[108] Because of the decentralized nature of telephonic communication, many stockbrokers began using telephones within their private offices years before the telephone was formally introduced to the London Stock Exchange. Having telephones on the stock exchange floor was not necessary to the functioning of the telephonic system writ large. This distinction has confused multiple historians who have conflated the use of telephones by stockbrokers with the use of telephones on the floor of the stock exchange and has allowed the actual operations of the telephone to be largely ignored.[109]

This section has two arguments. The first is that the use and adoption of the telephone by financiers and financial institutions was an outgrowth of the social relations initially forged by the ticker tape. Because of the widespread use of the telephone by outside brokers and investors, stock exchanges were eventually forced to allow telephones within their walls or risk losing business and power. The second argument is that, once telephones were allowed within stock exchanges, they were once again socially captured by the managers of the exchanges, certain high-powered trading firms, and select telephone companies themselves.

Infrastructure Arms Race

Outside brokers were the first class of financier to use the telephone *en masse* and many of them were connected by as early as 1882. Outside brokers adopted the telephone both out of competitive necessity and out of dreams for commercial expansion. The nature of outside brokerage business—processing a high volume of low quantity, speculative orders—necessitated rapid communication with official brokers in the stock exchange. Without the telephone, messages were primarily delivered either by telegram or messenger boy, both of which came with high costs and various delays. Additionally, investors realized that outside brokerage firms with telephone lines would have more efficient service than outside brokerage firms without telephonic connection. Expanding and advertising one's telephonic connection was a way outside brokerage firms attracted new clients.

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[108] Exchange Telegraph Company Bartholomew House Exchange, Letter from GPO to Extel, December 23, 1881, File I, Post/30/1774 BT.

[109] Mary Poovey bewilderingly asserts that "telephones were first used on the London Stock Exchange in 1878." There is zero evidence to substantiate this claim. ed. Poovey, *The Financial System in Nineteenth-Century Britain*, xv. Ranald Michie claims that a "telephone room was in use within the stock exchange" by 1883, yet he cites no evidence for this either. Michie, *The London Stock Exchange*, (New York: Oxford University Press, 1999) 81. Michie most likely conflates the fact that Extel began introducing a telephonic system in 1882-1883 with the establishment of a formal call room within the stock exchange. While *members* of the London Stock Exchange were no doubt using the telephone by 1882-1883, a formal call room was not opened until January of 1889. See Exchange Telegraph Company Bartholomew House Exchange, News Clipping, File IX, Post/30/1774 BT. See also *The Electrician*, January 4, 1889, 243. The only other historian who correctly identifies when the telephone appeared on the floor of the London Stock Exchange is Jeremy Leon Stein, "Ideology and the Telephone: The Social Reception of a Technology, London 1876-1920," (Ph.D. diss, University College London, 1996) 82-83.

In the competition between outside brokers to attract clients and orders, the telephone was a tool that was wielded for different purposes. One outside broker named Alfred Cooke prominently advertised that his offices were "connected by telephone with the subscribers to the United Telephone Company, whereby instantaneous communication can be established in all parts of London." Cooke's telephonic service was aimed at ensuring him a large client base (anyone connected to the United Telephone service), rather than necessarily having the fastest placement of orders. Especially because there was no formal telephonic communication within the stock exchange yet, many outside brokers had to undertake a hybrid service. Clients could place orders with Cooke via the telephone, but Cooke in turn placed those orders via "direct *telegraphic* communication…with the stock exchange."[110] The telephone did not give Cooke a technological edge in placing orders faster than other brokers but was rather a means to expand his potential client base.

Other outside brokers used the telephone differently. Cochrane and Sons, one of the most successful outside brokerage firms in London, had two offices: one in the West End at Waterloo Place and another near Extel's headquarters in Cornhill. Understanding the differences between Cooke's business and Cochrane's illustrates a broader distinction that usually goes unmentioned: how private telephone lines functioned differently than lines connected to a broader network. By being connected to the entire United Telephone service network, Cooke was attempting to aggregate the small business of many clients who placed orders at his City office over the telephone. Cochrane and Sons, however, operated with only a private telephone connection between their West End and City office and was not connected to a broader network. Cochrane and Sons' West End office was "sumptuously fitted up" with "telegraphic and telephonic communication on an ample scale…so as to avoid the disagreeable journey to the City."[111] This was because their business was focused on "only four or five clients" who did a high volume of transactions. [112] Cochrane and Sons essentially replicated a club experience with luxurious rooms in the West End for high end clients. The telephone was a useful, and distinctly private, means of connecting clients from their comfortable locale in the West End to Cochrane and Son's brokers in the City who then relayed orders to members of the London Stock Exchange.

Of all the outside brokerage firms, John Shaw was the largest and most successful (and one of the most reviled within the London Stock Exchange itself). At the peak of Shaw's success, before the London Stock Exchange forced Extel to cut off ticker tape service to outside brokers, Shaw ran a network of offices throughout Britain, spanning London, Manchester, Liverpool, Dublin, and Brighton, using 34 ticker tapes.[113] Not only did Shaw's clients have wide access to ticker tape pricing information, but they also had "free access to rooms, telephones, financial journals, record books, and…(could) ask advice without doing business throughout the year." Shaw bragged, probably in truth, that his offices provided "unquestionably more facilities for transacting stock exchange business than any other office in London."[114] The telephone was just one part of Shaw's infrastructural apparatus, an apparatus that centered around his ticker tapes and the social relations Shaw had with 13 different London Stock Exchange brokers who

[110] *Times*, November 5, 1882.
[111] *Times*, July 12, 1885.
[112] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Outside Brokers and Institutions Who are Banned from Using the Instrument, MS/23028 LMA.
[113] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Diary of William Davies, October 31, 1893, MS/23028 LMA. See also London Stock Exchange, Managers Minutes of Subcommittees relating to Exchange Telegraph Co, 70, MS/14608/01 GL.
[114] *Times*, March 11, 1888.

executed his orders.[115] While the telephone was used differently by each firm, and each firm required a slightly different configuration of infrastructure (telegraph, ticker tape, and telephones), the core affordance of the telephone was not increased speed or efficiency but rather how it concretized the social relations that were initially forged by the ticker tape

The second dynamic that drove the increased adoption of the telephone was the London Stock Exchange's assaults on the permissiveness of the ticker tape system between the mid-1880s and early-1890s. As outside brokerage firms, including both Cochrane and Sons and John Shaw's, were forced to give up their ticker tapes, they increasingly relied on the telephone to receive pricing information from brokers inside the stock exchange and subsequently to place orders with these same members. "The various outside brokers have already prepared for the worst by making such arrangements that they will be enabled by telephone and blackboard to supply prices as before," the *Financial Times* reported.[116] As outside brokerage firms shifted toward the telephone members of the London Stock Exchange were forced to do the same in turn. When surveyed by Extel, many outside brokers claimed that if their ticker tape was shut off, they could simply "get prices telephoned from members of the stock exchange."[117] One member of the London Stock Exchange had at least 10 telephones in his office, each of which was connected to "outside stock exchange men."[118] As telephones proliferated among the stock exchange brokers who dealt with outsiders, other brokerage firms were also forced to begin using the telephone. Large brokerage firms that specialized in dealing with prominent, wealthy clients were especially under pressure to provide telephonic connections specifically for their key investors. By the end of the 19th century, for instance, the stockbroking firm of de Zoete and Gorton had two dozen private telephone lines to clients in their office, including three devoted to the British merchant banker Sir Ernest Cassel alone.[119] The telephone was increasingly essential to the operation of the stock exchange by the end of the 19th century, but the telephones that were used were largely private ones that connected brokers to each other or to particular high-powered clients.

In short, the social dynamics inaugurated by the ticker tape drove the increased use of the telephone. One member of the London Stock Exchange put it succinctly in 1907: the infrastructural development among financiers was the result of "the competition of outside houses," and the race for a "monopoly of private telephones," amongst members.[120] Whether it was because stockbrokers within the London Stock Exchange were working alongside outside brokerage firms, or because of competition either with other members of the stock exchange or outside brokers, the telephone became a staple financial technology for stockbrokers *off* the floor of the exchange. It was these social relations and business pressures that eventually forced the London Stock Exchange itself to allow the first telephones onto its trading floor in 1889.

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[115] Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Questionnaires Completed by Subscribers as to the Possible Effects on Their Business of the Removal of Extel Instruments, 1893, MS/23028 LMA.
[116] *Financial Times*, February 17, 1894.
[117] At least four different firms explicitly name the telephone as the solution to shutting of the ticker tape. See Exchange Telegraph Company, Correspondence, Reports, etc. Relating to the London Stock Exchange, Questionnaires Completed by Subscribers as to the Possible Effects on Their Business of the Removal of Extel Instruments, 1893, MS/23028 LMA.
[118] London Stock Exchange, Managers Minutes of Subcommittees relating to Exchange Telegraph Co, 87, MS/14608/01 GL.
[119] Hurford Janes, *de Zoete & Gorton: A History* (London: Harley Publishing Co., 1963) 54, 48.
[120] London Stock Exchange, Committee for General Purposes Minutes,1907-8, 419, MS/14600/081 GL.

Institutionalizing the Telephone

The decision for the London Stock Exchange to allow Extel to fix the first telephones onto its floor was born from a mix of competition and necessity. As early as 1887, petitions with nearly 500 signatures were submitted to the managers of the stock exchange, urging the introduction of telephones "to enable subscribers to communicate between the (stock exchange) and their office and with each other."[121] When the managers relented in 1888, their decision was partly a recognition of the fact that Extel had willingly cut off "objectionable" outside brokerage firms from the ticker tape service and was simultaneously an acknowledgement of the effects the discontinuation of ticker tape service would have, namely, increased telephonic business. "If (the committee) threw obstruction in the way of business or rather if they did not increase the facilities and show the public that business could be done cheaper and better on the Stock Exchange than elsewhere, it would flow into other channels," the managers announced. Indeed, it was sure that "the telephone would be very useful to members and would make the stock exchange popular."[122] The elimination of ticker tape services to many outside brokers necessitated the creation of telephonic facilities within the stock exchange itself.

The telephonic service Extel introduced did not actually connect the London Stock Exchange to broader networks within London or the rest of the country. Nor yet were the telephones on the floor of the exchange simply private lines available for brokers who paid the most to use them. This was a feature, not a bug. In 1886, when negotiations were first beginning between Extel and the London Stock Exchange, Extel assured the managers of the exchange that "that by our system…it would not be possible for outsiders to be put in communication with the house but only for members who could be subscribers to our system."[123] The telephonic system Extel eventually introduced was simply an expansion of the "challenge" system they had been operating since 1886, where stockbrokers could call Extel's office and ask for specific securities to be quoted on the ticker tape. Initially, access to Extel's telephonic system was also "limited to the subscribers to the (ticker) tape distribution," but with more functionality.[124] The expanded telephonic system, called the "Bartholomew House Exchange," (for the location of Extel's main switchboard) was an entirely private telephonic network that connected the call room on the stock exchange floor to stockbrokers' offices nearby and stockbrokers' offices to each other. Neither the phones on the trading floor nor the phones in stockbrokers' offices could make or receive calls anywhere outside of the "Bartholomew House Exchange" network.[125] The privacy ensured by the Bartholomew House Exchange's material infrastructure was one of the principal reasons telephones were allowed to be introduced to the London Stock Exchange at all.

Extel's new network hardly meant telephones for all. One commentator noted how Extel's network disproportionally favored the stockbroking firms that already had extensive telephonic and ticker tape services. "It seems…very unfair that this facility should…be limited to

[121] London Stock Exchange, Managers Minutes of Subcommittees relating to Exchange Telegraph Co, 38, MS/14608/01 GL.
[122] London Stock Exchange, Trustees and Managers Minutes, 1888-1891, 60-61, MS/19297/012 GL.
[123] London Stock Exchange, Managers Minutes of Subcommittees relating to Exchange Telegraph Co, 33, MS/14608/01 GL.
[124] Exchange Telegraph Company, Bartholomew House Exchange, Letter from Ogilvie to King, November 25, 1909, File XVII, Post/30/1774 BT.
[125] See Exchange Telegraph Company Bartholomew House Exchange, Letter October 11, 1909, File XV, Post/30/1774 BT.

the small number of members of the house who pay the heavy subscription for the tape and tape telephone."[126] Unlike the telegraph offices which were free to use (as long as you paid the fee for sending a telegram), use of the call offices on the stock exchange floor required a hefty subscription fee of £50 per year. Larger stockbroking firms with more partners and more capital resources had overwhelmingly higher percentages of subscription to Extel's services. In 1908-9, 75% of brokerage firms on the London Stock Exchange with 6 or more partners subscribed to Extel services, 64% of firms with 5 partners were subscribers, and firms with 3 or 4 partners had a subscription rate of 58%. However, only 37% of firms with one partner were subscribers.[127] What was more, the firms that could afford Extel's services were not content to have the simple advantage of the new private telephone network. The GPO warned Extel that the private nature of the Bartholomew House Exchange did not mean much in the face of unscrupulous firms with plenty of resources. Apparently, the GPO had fielded numerous requests from stockbrokers to attach their Bartholomew House Exchange lines "to the same switchboard in their office as private lines to certain important clients in order that these clients might speak direct to the Stock Exchange (trading floor)."[128] In every instance the GPO declined to assist the stockbroking firms but noted that such practices were bound to force the question of the "connection of the Exchange with the public telephone system of London."[129]

Rather than attempting to limit the inequalities of their telephonic system the managers of the London Stock Exchange and Extel responded by accelerating them. In October of 1909, Extel introduced a tiered service. Class "A" subscribers received access to both ticker tapes and the telephones for £50 per year, Class "B" subscribers received access to only the telephones for £25, and Class "C" only had access to the call rooms on the stock exchange floor but were not given an Extel telephone in their own office for £12 10s.[130] The Class A service was essentially unchanged for most firms who already subscribed to the ticker and the telephone. The two innovations were the Class B and C services. Class B was an entirely new service and was the first time Extel had offered the telephone service independent of the ticker tape. Class C service had been available to stockbrokers since 1889, but the price for access to the call room was previously £5. The increase in price for access to the call room was done at the request of the managers of the stock exchange and intended to "restrict the use of the call room to the more important members of the exchange."[131] The tiered call room system quickly created the inequality it was supposed to. Three firms were using the call room so much and their calls were "so numerous that the other call room traffic was greatly delayed." Extel came to a special arrangement with these firms, allowing them to pay £100 a year each for "exclusive use of a call box," on the stock exchange floor.[132] Extel's system was wildly successful. Only one year after the call room was open, Extel's chairman boasted of the "enormous increase in the telephone

[126] Exchange Telegraph Company, Bartholomew House Exchange, News Clipping "Truth," November 29, 1888, File XI, Post/30/1774 BT.
[127] Exchange Telegraph Company, Stock Exchange Telephones ,1908, MS/23031 LMA.
[128] Exchange Telegraph Company, Bartholomew House Exchange, Letter from Ogilvie to King, November 25, 1909, File XVII Post/30/1774 BT.
[129] Ibid.
[130] Exchange Telegraph Company, Stock Exchange Telephones, Agreement Between the Stock Exchange and Exchange Telegraph Company, September 23, 1909, MS/23031 LMA.
[131] Exchange Telegraph Company, Bartholomew House Exchange, Internal GPO Memo, November 12, 1909, File XVII, Post/30/1774 BT.
[132] Exchange Telegraph Company, Bartholomew House Exchange, GPO Report February 25, 1910, File XVI, Post/30/1774 BT.

service which…involves higher rents and royalties. This telephone business of ours has now attained wonderful perfection."[133] By 1891 the system was processing over 15,000 calls per month.[134] Inscribing inequality into the creation of the London Stock Exchange's telephone network was good business.

The success of Extel's intra-stock exchange telephone service prompted both telephone companies and the Stock Exchange to look into further expansion. In particular, the stock exchange and its members wanted a telephone service that linked outward to business partners in other cities.[135] In March of 1889, three months after Extel had opened its first call room, the United Telephone Company was allowed to open a similar call room for stock exchange members. However, the service United Telephone introduced did not connect the London Stock Exchange to the wider telephone network the company operated in London or the rest of the country. Instead, it was a series of private telephone cables from the London Stock Exchange to the Manchester, Liverpool, and Birmingham stock exchanges intended "to be used only within the said stock exchange." The private infrastructure was especially attractive to the members of the London Stock Exchange because "there would be no delay, as the messages would not go through a telephone exchange but a member would ring up a friend direct as if he were using a private wire."[136] Members of the London Stock Exchange justified their seeming monopoly on private telephonic connections between major cities and financial institutions by arguing that "the private telephones were not a monopoly and tended to keep the public lines more free."[137] In the thinking of financial institutions, private telephonic infrastructure purely for the transaction of financial business was a public service insofar as it kept commercial communications from clogging up civilian telephone lines.

Even when the GPO began introducing "public" telephones to its London Stock Exchange offices in 1890-1891, the infrastructure was specifically designed to benefit particular members of the London Stock Exchange. When the first London-Paris telephone line was being built in 1890, the GPO asked the managers of the stock exchange if there was "suitable accommodation at the Stock Exchange," that would be "convenient for the large financial firms who might be expected to make use of the system?"[138] The GPO was not merely compliant in giving special facilities to the London Stock Exchange, but eagerly willing, so much so that the managers of the stock exchange even became suspicious. "My board find some difficulty in believing that (the GPO) proposes to lay down special wires solely out of love to the Stock Exchange," W.F. Perowne, the secretary of the stock exchange wrote to his counterpart at GPO.[139] The London-Paris telephone line was a marked shift in relations between the GPO and the London Stock Exchange. Not only was a line specifically laid for the exchange but for specific firms *within* the exchange. And it was a concession given willingly in hopes that there would eventually be a "large increase of business and therefore profit…from the

[133] Exchange Telegraph Company, Annual General Meetings, 1890, MS/22965/02 LMA.
[134] Exchange Telegraph Company, Annual General Meetings, 1891, MS/22965/03 LMA.
[135] For the social pressure on the managers see *Financial Times*, October 18, 1888.
[136] London Stock Exchange, Trustees and Managers Minutes, 1888-1891, 96, MS/19297/012 GL.
[137] London Stock Exchange, Committee for General Purposes Minutes,1907-8, 405, MS/14600/081 GL.
[138] Introduction of the London to Paris Telephone Service, Part 2, Letter from GPO to the Stock Exchange, July 31, 1890, File XXII, Post/30/581 BT.
[139] Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, Letter from London Stock Exchange to GPO, July 31, 1889, File I, Post/30/1362 BT.

improvement."[140] The financial good of a public institution like the GPO depended in no small part on catering to the specific needs of the most elite stockbroking firms in London.

For various technical reasons, the London-Paris phone was placed in the GPO branch in Threadneedle St. on the South side of the stock exchange near the domestic markets and was thus a hassle for the brokers doing business with the continent to use, since the foreign market was on the opposite side of the exchange. Additionally, having both foreign and domestic telephone lines located in the same office resulted in massive "overcrowding." By 1903 the London Stock Exchange and the GPO began exploring the expansion of the GPO branch on Throgmorton St. to alleviate the overcrowding at the Threadneedle St. branch and to meet the "desirability of having the Foreign Telephone as near the Foreign market as possible."[141] During construction, the stock exchange managers asked the GPO if "it would be possible to arrange for a special trunk wire or wires so as to put the members generally using this room on an equality with certain private members who have…special trunk lines reserved for them." The GPO's answer was telling. They argued that "after a number of long private wires had been provided" to stockbrokers, there was a "want of space on telegraphic routes between the chief towns," that "made it impossible to provide additional private wires (to the stock exchange as an institution) without interfering with the requirements of the public service."[142] So many private wires had been laid between the largest firms of the London Stock Exchange and other key financial centers that the GPO was physically incapable of increasing the exchange's telephonic capacity.

The solution to the overcrowding of both wires and call rooms came, once again, at the expense of the public. Only this time the GPO was a willing collaborator with the financiers of the London Stock Exchange. "The proposed new telephone room," one postal official wrote, would "be for the use of the members of the stock exchange only and such arrangements will be made as will effectually prevent the public having access to it."[143] Though the GPO had limits in the extent that it could devote public infrastructure for the use of the stock exchange, it could still find creative ways to exclude the public from infrastructure that they otherwise should have had access to.

Conclusion: The Material Politics of Finance

Over the course of the 19th century, as stock exchanges were constructed *en masse* and linked together through complex telecommunications networks, finance was made distinctly material for the first time in modern history. Of course, financial markets have always had some material component. But the seven stock exchanges of the 18th century, some of which met informally in coffee-shops or alleyways, were a far cry from the 89 stock exchanges that existed throughout the globe at the end of the 19th century. These modern stock exchanges were purpose-built, unique buildings that were all, by some type of connection, linked via telecommunications. The material conditions and boundaries of modern finance had been born.

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[140] Ibid.

[141] Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, Letter from London Stock Exchange to GPO, December 31, 1903, File XII, Post/30/1362 BT.

[142] Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, Internal GPO Memo, January 6, 1904, File XII, Post/30/1362 BT.

[143] Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, Letter from GPO to Comptroller, January 11, 1904, File XII, Post/30/1362 BT.

As stock exchanges and the telecommunications systems that linked them were constructed a host of possible alternative material orderings were discussed, explored, attempted, and foreclosed. This process was highly path dependent: telegraph companies' early reliance on the financial sector for business slowly transformed stock exchanges themselves into key hubs of telegraphic transmission which then gave stock exchanges greater control over the telecommunications system. Even when the GPO nationalized the domestic telegraph business in 1870 it was still forced, whether through the economics of the telegraph business or the material design of stock exchanges, to devote substantial public resources to an elite set of institutions and firms at the expense of the public. Path dependent outcomes were not always this straightforward or obvious. The introduction of the ticker tape precipitated a massive expansion of people who had some form of access to the closely guarded pricing information of the London Stock Exchange. While Extel and the London Stock Exchange aggressively tried to rein the expansiveness of the ticker tape system in, the social relations the ticker depended on to function outlasted the usefulness of the technology itself and drove the increased adoption of the telephone. Material infrastructures encoded particular forms of politics and economic activity that outlasted the actors who designed and built them.

The material politics of finance as they first emerged in the 19th century cemented a set of hierarchical and exclusionary practices within finance capitalism. Beyond the exclusion of the public from public telecommunications infrastructure (let alone the diversion of public resources to cater toward the needs of financiers), other hierarchies emerged as well. Through the extension of ticker tape infrastructure, the London Stock Exchange cemented its position as the most important financial market in the world. Within the London Stock Exchange, the advantages provided by the telegraph and telephone were captured by particular markets and even particular firms within those markets. Technology did not make financial markets more interconnected and efficient. It made the particular markets and particular firms who were able to exert the most power over the construction of financial telecommunications networks more efficient and profitable than their competitors.

Finally, the language of the material politics of finance was precisely an outgrowth of the developments that constituted it. In other words, as finance became more material—whether through purpose-built stock exchanges, the construction of ticker tape networks, etc.—technical and material questions of how to build financial telecommunications systems became social and economic questions about who financial systems should serve.

Chapter 4:
Arbitrage: The Politics of Market Efficiency

Introduction

Arbitrage trading is the central mechanism of most modern economic theories of markets.[1] When inefficiencies or discrepancies in the price of the same asset occur in two different markets, arbitrage trading exploits the price discrepancy for a profit while at the same time resolving the inefficiency. For instance, if the price of Union Pacific stock was $99 on the New York Stock Exchange but was $101 on the London Stock Exchange, arbitrageurs would purchase shares of Union Pacific in New York while selling them in London until the price reached an equilibrium in both markets at $100. Arbitrageurs would, in theory, make risk-free profit, and markets as a whole would benefit because the stock would be priced fairly. According to economic theory, arbitrageurs are the "impact" force that keep markets in equilibrium and adjust prices when there are event shocks, new information, or general inefficiencies.[2]

During the late 19th century, roughly from the implementation of the first transatlantic telegraph cable in 1866 until WWI, arbitrage became a global phenomenon that integrated markets throughout the world.[3] The ability to send orders in a matter seconds or minutes via telecommunications was a stark difference from the inconsistent and risky arbitrage undertaken at the speed of sailing ships during the eighteenth and early 19th century.[4] Price differentials between key financial centers fell in statistically significant quantities.[5] Within the new, globally integrating system of financial markets, the London Stock Exchange had pride of place. Britain's role as the imperial hegemon gave London the most extensive set of telegraphic connections in the world.[6] Telegraphic connectivity only enhanced the London Stock Exchange's already

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[1] Donald Mackenzie, *An Engine Not a Camera: How Financial Models Shape Markets,* (Cambridge: MIT Press, 2006) 211; Donald Mackenzie, Daniel Beunza & Iain Hardie "The Material Sociology of Arbitrage," in Mackenzie, *Material Markets: How Economic Agents are Constructed,* (New York: Oxford University Press, 2009) 87; Suleyman Basak & Benjamin Croitoru, "On the Role of Arbitrageurs in Rational Markets," *Journal of Financial Economy*, 81 (2006) 143-173; Yong Chen, Zhi Da, Dayong Huang, "Arbitrage Trading: The Long and Short of It," *Review of Financial Studies* 32 no. 4 (April 2019) 1608-1646.

[2] Basak & Croitoru, "On the Role of Arbitrageurs in Rational Markets," 144, 159.

[3] A good summary of how financial markets relied on the rapidly expanding global telecommunications system is Simone Müller and Heidi Tworek "'The Telegraph and the Bank': On the Interdependence of Global Communications and Capitalism, 1866–1914." *Journal of Global History* vol. 10 no. 2 (2015) 259–283.

[4] See Peter Koudijis, "The Boats That Did Not Sail: Asset Price Volatility and Market Efficiency in a Natural Experiment," *Journal of Finance* vol. 71 no.3 (June 2016) 1185-1226.

[5] See for instance, Kenneth Garbade & William Silber, "Technology, Communication and the Performance of Financial Markets: 1840-1975," *The Journal of Finance* 33 no.3 (June 1978) 819-832; Christopher Hoag, "The Atlantic Telegraph Cable and Capital Market Information Flows." *The Journal of Economic History* 66, no. 2 (2006) 342–353; Peter J. Ferderer "Advances in Communication Technology and Growth of the American Over-the Counter Markets, 1876–1929." *The Journal of Economic History* 68, no. 2 (2008) 501–534; Ranald Michie, *The London and New York Stock Exchanges* (New York: Routledge, 2011) 45-48.

[6] For the classic account of the concurrent rise of British imperial power and telecommunications infrastructure see Daniel Headrick, *The Tools of Empire: Technology and European Imperialism in the Nineteenth Century*, (New York: Oxford University Press, 1981); idem, *The Invisible Weapon: Telecommunication and International Politics*

dominant financial position as the market with the most listings, the largest amount of listed capital, and the most daily turnover. As one commentator noted, the infrastructural and economic advantages of London fed on each other and made the London Stock Exchange the "centre to which the bulk of investment and speculative business naturally flows."[7]

While this account of the emergence of arbitrage trading and market integration may be correct in the abstract (markets *were* more integrated by the turn of the 20th century) it is also deeply reductive. The evidence scholars use to illustrate the connection between technology, arbitrage trading, and market integration is telling. Rather than trying to uncover who was actually moving market prices and how, the vast majority of work simply juxtaposes the volume of telegraph messages between two financial centers against the price signals of certain securities.[8] The picture of arbitrage trading that lurches into view via this approach is both economically simplistic and technologically deterministic. Markets are presumed to be unified wholes (as opposed to aggregation of the actions of individual participants) who, with the help of technology, become seamlessly and naturally more integrated.

This chapter argues that arbitrage trading first systematically emerged in the late 19th century not out of sheer economic rationality or technological determinism but as the product of a new system of financial infrastructure that had been assembled over the course of the century. Firms needed access to the material infrastructures of global telecommunications networks and the proper technology to utilize those networks. They needed skilled labor forces of messengers, clerks, and brokers capable of executing complex calculations and trades. They needed access to continuous and reliable knowledge of pricing information that was distributed across large distances in different, unstandardized forms. Infrastructure enabled arbitrage.

But financial infrastructure was never neutral. Infrastructural systems did not simply service an overarching economic rationality. Rather, financial infrastructures were shaped by politics and power. Different actors within the financial system—from exchanges, firms, and the state—all competed with each other to shape the design of infrastructural systems for their own advantage. The system of financial infrastructure that was built by these struggles and the arbitrage trading it enabled was marked by power relations, hierarchies, and inequality. Put simply: arbitrageurs were not created equal.[9] Formal arbitrage trading was only made possible because of the massive changes in the infrastructures underpinning the financial system that had occurred over the 19th century but in turn, the practice of arbitrage and the profits gained by it, exposed the underlying political assumptions and power relations that had forged global financial infrastructures in the first place.

1851-1945, (New York: Oxford University Press, 1991). Empirical data supporting London's centrality to the system is helpfully marshaled in Roland Wenzlhuemer, *Connecting the Nineteenth-Century World: The Telegraph and Globalization*, (New York: Cambridge University Press, 2013) 135-162.

[7] F. E. Armstrong, *The Book of the Stock Exchange: A Comprehensive Guide to the Theory and Practice of Stock and Share Transactions and to the Business of Members of the London and Provincial Stock Exchanges*, 3rd edition (London: Isaac Pitman & Sons, 1939) 141.

[8] See David Kynaston, *The City of London: A World of its Own, 1815-1890*, vol I. (London: Chatto & Windus, 1994) 258; Michie, *The London and New York Stock Exchange* 45-48; Hoag, "The Atlantic Telegraph Cable and Capital Market Information Flows."

[9] Recent economic literature has also made this argument in a variety of ways. See Denis Gromb & Dimitri Vayanos "The Limits of Arbitrage: The State of the Theory," *Annual Review of Financial Economics*, 2 (2010) 251-275; and Mukarram Attari & Antonio Mello, "Financially Constrained Arbitrage in Illiquid Markets," *Journal of Economic Dynamics and Control* vol. 30 no. 12 (December 2006) 2793-2822.

The Technology of Arbitrage

Perhaps the most obvious way that arbitrage trading was unequally distributed in the financial system was through communication technology. As already noted, Britain's imperial hegemony had allowed it to construct a global telecommunications system that provided unique advantages to metropolitan London and its attendant financial institutions. But even within particular cities and markets, arbitrage opportunities were circumscribed by the technological devices used to conduct trading. In short, it is impossible to write a history of arbitrage trading without understanding the particular affordances and limitations of the telecommunications infrastructure that linked markets at the turn of the twentieth century

The London Stock Exchange actively worked to gain even greater advantages within Britain's global telecommunications network and continually pressured both the British General Post Office (GPO) and other financial markets to give them an edge. In 1889-1890 when the Submarine Telegraph Company, which handled most European telegraphs, was nationalized by the GPO, the London Stock Exchange agreed to lease the Submarine Telegraph Co.'s office to the GPO for free, instead of for the usual £500 in yearly rent on the condition that the GPO begin to connect "the stock exchange office with Paris, Amsterdam, Berlin, and Frankfort by means of private wires to be used only for Stock Exchange messages in the same manner as Liverpool, Manchester and other English town's (exchanges) are now connected." [10] Until then, telegraphic connection between the London Stock Exchange and the continent had only been achieved by going through the national telegraphic networks of Britain and different European countries: there were no private wires between exchanges.

Linking the London Stock Exchange to its European counterparts via private wires was a difficult technical and political challenge. For instance, the GPO noted that the telegraph office at the Paris Bourse dealt not just with financial transmissions but also with a "considerable amount of ordinary commercial traffic and is a large delivery and transmitting office for Paris generally."[11] It would be enormously difficult to disaggregate stock exchange messages from public messages on the Paris side. What was more, the Paris system of delivering telegraphs was (according to British officials anyways) far more inefficient than that used in Britain. Any telegraphs that arrived before the opening of the Paris Bourse at 1pm were not immediately delivered but were "retained until that hour." Finally, GPO officials warned the London Stock Exchange managers that the technical limitations of creating a system of private wires with European Bourses could actually result in a *worse* service, not a better one. In 1890, the stock exchange business was spread over the GPO's eleven wires that ran to Paris, but if five wires were diverted for exclusive stock exchange business "a pressure of stock exchange business could only be met by the use of those five wires and the remaining six would not be available although some…might be comparatively idle." [12] A private wire system was not necessarily more efficient than the public system already in operation. While the London Stock Exchange

[10] Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, Report for the Secretary of the GPO, September 29, 1889, File I, Post/30/1362 BT.
[11] Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, Letter from Fischer to the Secretary of the GPO, October 5, 1889, File I, Post/30/1362 BT.
[12] Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, Letter November 19, 1889, File III, Post/30/1362 BT.

and the GPO both wielded tremendous amounts of influence over the global telecommunications network, they were still beholden to the infrastructural and political constraints of telegraphy in other countries.

The London Stock Exchange did not give up on its dreams of direct, private connections with other stock exchanges. In 1911, as the GPO was preparing to nationalize the National Telephone Company, the London Stock Exchange once again tried to leverage their control over the telephone company's offices in the stock exchange for more concessions from the GPO.[13] One of the key differences between 1890 and 1911-1912 was the widespread adoption of multiplex telegraphy.[14] Telegraphs had long faced a fundamental technological problem. The original telegraph was a simplex system: a transmitter on one end sent an electrical signal over a wire to a receiver at the other end. The electrical signal took up the entire wire and so messages could only be sent one at a time, in one direction. Inventions by David Hughes and Émile Baudot during the 1860s and 1870s pioneered a new type of telegraphic system that could send two messages in different directions at the same time (duplex telegraphy) and eventually four messages in different directions at the same time (quadruplex).[15] Not only could the new telegraphic systems send a higher volume of messages back and forth, but they were also faster than simplex More or Wheatstone telegraphs. The average words per minute telegraphed increased from 12-15 on Morse machines, to 31 on Hughes machines, to 35-40 on Baudot machines.[16]

The efficiency that multiplex telegraphy promised was challenging to enact in practice. For one, both Hughes' duplex telegraph and Baudot's quadruplex telegraph were larger machines than a simple Morse (See Figure 14). They were more expensive, required more space within the cramped stock exchange telegraph office, and required more skilled operators. While the GPO agreed to run a new system of private, direct telegraphic wires from their office in the stock exchange they struggled to come up with a bureaucratic and material organization of the office that would ensure maximum telegraphic capacity for the exchange's stockbrokers. Two plans for the office were proposed. The first had 17 telegraphic channels open to European stock exchanges, while the second had 26 (See Figures 15 and 16). Even though it had substantially less telegraphic capability, the GPO adopted the first plan. As long as the stock exchange office only dealt with bourse to bouse communication and there was no "diversion of (foreign) traffic" from the GPO's central telegraphic office through the stock exchange wires, the GPO believed that 17 channels would be enough.[17]

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[13] London Stock Exchange, Trustees and Managers Minutes 1910-1913, 79 MS19297/021 GL.
[14] Ibid. 168-169.
[15] A good summary is H.G. Sellars, "Overseas Communications—Its Origin and Development," *The Telegraph and Telephone Journal* (January 1927) 66, 95-97.
[16] See Andrew Butrica, "From Inspecteur to Ingénieur: Telegraphy and the Genesis of Electrical Engineering in France, 1845-1881," (Ph.D.diss, Iowa State University, 1986) especially 78-83; 97-108. See also *Technical Pamphlets for Workmen: Baudot Multiplex Type-Printing System,* (London: His Majesty's Stationery Office, 1919); *Technical Pamphlets for Workmen: Hughes Type-Printing Telegraph,* (London: His Majesty's Stationery Office, 1919). These instructional pamphlets have been helpfully digitized at http://www.samhallas.co.uk/telecomms.htm.
[17] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Letter March 12, 1913, File I, Post/30/1988B BT.



Figure 14: A station for quadruplex working of Baudot telegraphs

The new telegraphic channels that were opened constrained arbitrageurs as much as they enabled them. The final plan the GPO adopted included 6 telegraphic channels to the Paris Bourse, 5 to Berlin, 2 to Hamburg and Amsterdam, and 1 each to Frankfort and Brussels. Not only did the larger bourses receive more open telegraphic channels but they also received better equipment. The two quadruplex Baudot apparatuses the GPO assigned to stock exchange work were assigned to Paris and Berlin respectively, alongside additional Hughes simplex machines. Other European exchanges received far less in terms of transmission capacity. The Hamburg connection was facilitated by a Hughes duplex machine, making it the third best telegraphic service behind Paris and Berlin. Brussels, Frankfort, and Amsterdam, however, were all worked through simplex systems. Amsterdam was granted two Hughes simplex machines, so in theory one machine could send messages outward while the other could receive messages from the continent. Brussels and Frankfort were worked with only one Hughes simplex apiece, making them far more liable to telegraphic traffic jams and unequal flows of information from London to the continent and vice versa. Even with bourse-to-bourse service, arbitrageurs remained at the mercy of telegraphic efficiency that was unequally distributed.

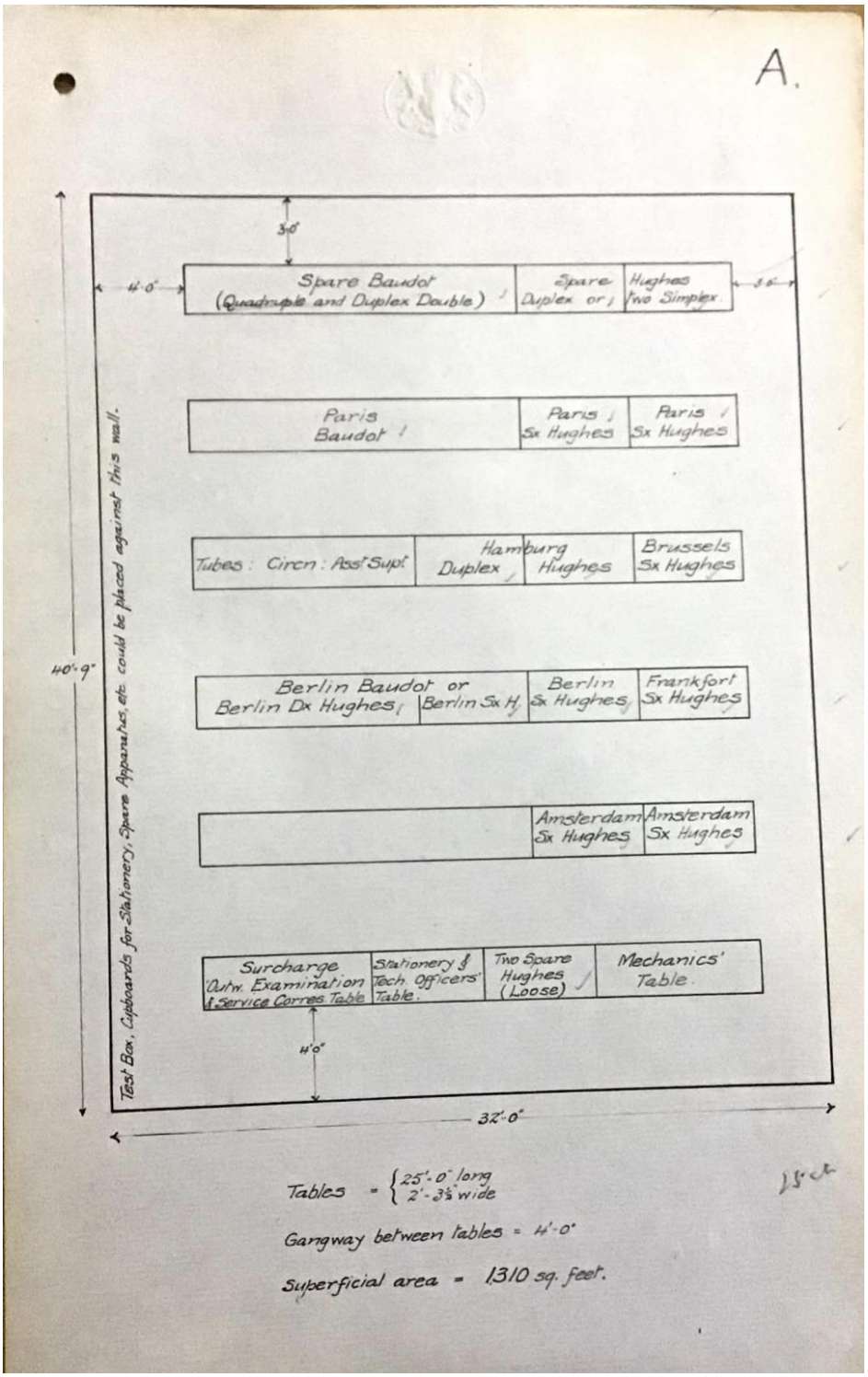

Figure 15: Plan 1 for bourse-to-bourse communication that was selected by the GPO (Post/30/1988B BT)

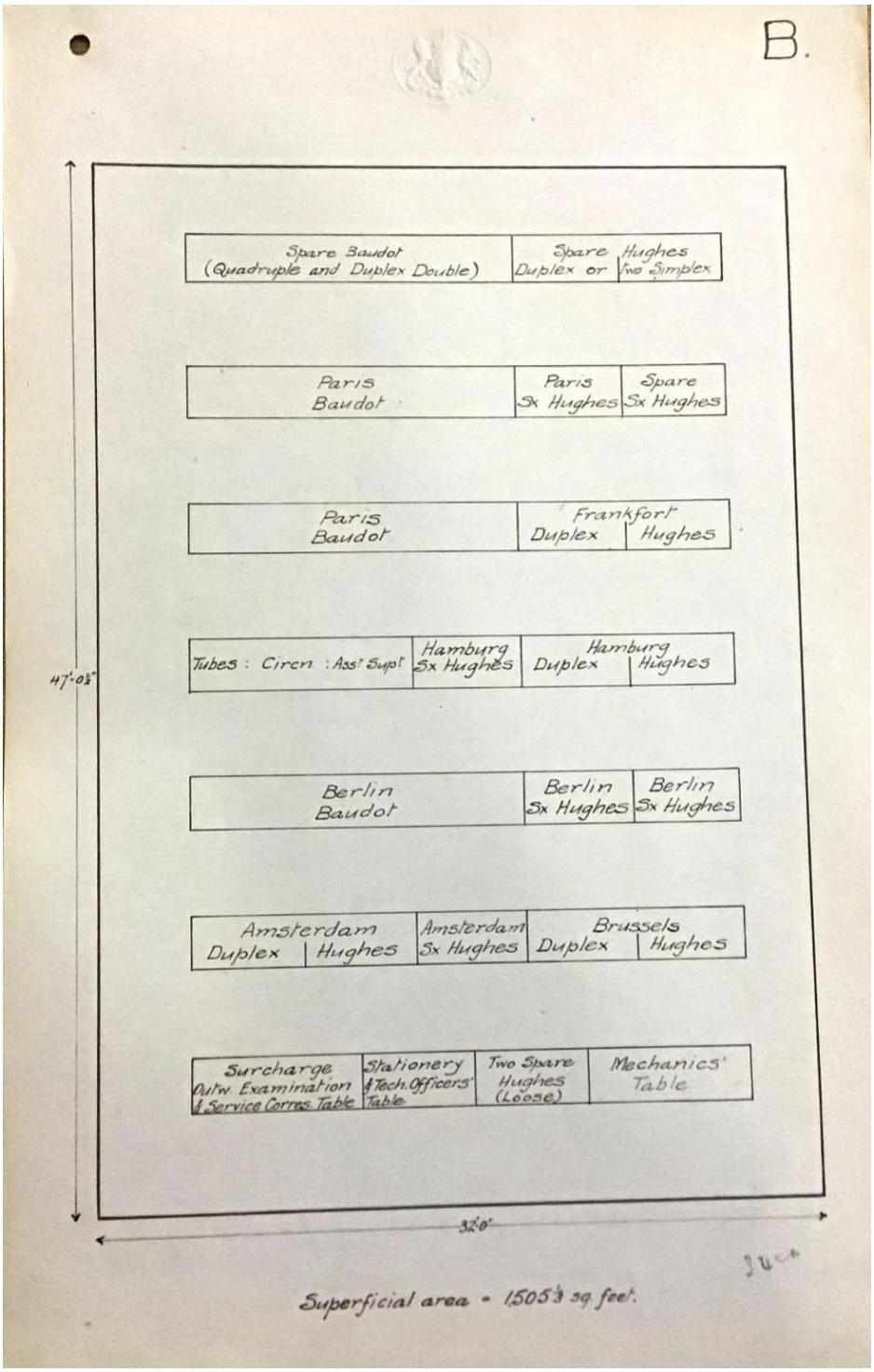

Figure 16: Plan 2 that was not selected by the GPO (Post/30/1988B BT)

London's technological advances meant nothing if they were not adopted in broader network of financial markets that they were attempting to connect to. For instance, the telegraphic service at the Amsterdam Bourse obstinately refused to shift to multiplex telegraphy. The GPO went so far as to loan Hughes duplex telegraphs to Amsterdam, hoping it would encourage them to shift service but it did not. The London Stock Exchange was forced to use Hughes simplex telegraphs for its communication with the Amsterdam Bourse and fielded repeated complaints from arbitrageurs because of it.[18] Even when the same apparatus and system of working was set up, a host of technical problems still plagued early twentieth century telegraphic technology. As one French commentator wrote, "the increasingly general use of rapid instruments with sensitive parts, of simultaneous transmission, and of multiple systems has led electricians to attach a great importance to certain properties of telegraph lines that they did not have to take into account as long as Morse or other equally simple apparatuses were the only ones in use."[19] Because the Hughes and Baudot were printing telegraphs, they needed to be in complete synchrony. If the electrical impulses were even slightly mismatched between the sending and receiving machine, the wrong letter or number on the printing wheel would be engaged and the resulting message would be gibberish.[20]

The problem of maintaining synchrony between sending and receiving machines also created much larger infrastructural problems. The cables that ran under the Atlantic and under the English Channel carried seven wires each but the wires within each cable could not be easily switched from simplex to duplex to quadruplex working because the differences in current of one wire could easily disrupt all the other wires in the same cable. Engineers frequently complained about the difficulty in managing the "inductive disturbance between wire and wire of (a) submarine cable section." The more "efficient" modes of telegraphic working, like a Baudot quadruplex system, created so much interference with other types of wires working on different systems that it was nearly impossible to "establish…more than two (quadruplex) wires in the same cable."[21] Long-distance cables that were laid with one kind of telegraphic system in mind could not easily be transitioned into use by newer telegraphic systems and any attempt to switch one wire without switching them all could cause problems throughout the entire telegraphic system. What "efficiency" actually meant in this context was quite unclear. What is more certain is that telegraphic efficiency was always constrained by a variety of technical and administrative differences in national telegraph services.

The push for bourse-to-bourse service in the London Stock Exchange also created a more explicitly political backlash within the rest of the financial system. Provincial stock exchanges in Britain felt that they were being excluded from business with European financial markets. Liverpool, Britain's second largest stock exchange, was especially concerned at the disadvantage they found themselves at. While Liverpool had the second most international telegraphic wires behind London, including direct wires to North America, le Havre in France, and Hamburg and Bremen in Germany, any advantage the Liverpool Stock Exchange gained from these direct lines was eliminated because the GPO "direct(ed) the whole of the North of England traffic over the

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[18] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, GPO Report September 21, 1921, File II, Post/30/1988B BT.
[19] "Notice Sur Les Essais Électrique: Des Lignes Télégraphique," *Annales Télégraphique* (1881) 216.
[20] *Technical Pamphlets for Workmen: Baudot Multiplex Type-Printing System,* (London: His Majesty's Stationery Office, 1919) 18.
[21] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Proposals for Extension of Baudot Working, August 1912, File VII, Post/30/1988B BT.

Liverpool wires."[22] Even more egregious for any Liverpool broker attempting to do business with European exchanges was that these direct wires were set up for simplex working. When price discrepancies occurred in Germany or Liverpool, simplex wires "put it in the power of German houses telegraphing to Liverpool to block the wires for Liverpool houses who wished to telegraph to Germany," since simplex telegraphy only allowed for one message on a wire at a time.[23] Brokers from Germany wishing to prevent arbitrage in their markets could simply clog up Liverpool's international telegraphic wires with nonsense messages. Technical problems, like one-way transmission of messages in simplex working, or managing flows of telegraphic traffic, had consequential importance for the power of different stock exchanges.

In the face of political pressure and complaints from the Liverpool financial community, the GPO needed an answer. Though the GPO wanted to switch some Liverpool working to multiplex telegraphy, it was too expensive, slow, and technologically difficult to make any immediate impact. Two different solutions were developed. The first solution was planned. Liverpool telegraphs were diverted from the overcrowded direct wires to the GPO's central telegraph office in London. The beginning of bourse to bourse working from the London Stock Exchange would, in theory, take traffic away from the GPO's other channels, allowing the them in turn to relieve traffic on Liverpool's wires. The second solution was unplanned. Frustrated Liverpool stockbrokers began sending messages to New York to be transferred to the European continent. Thanks to the time difference, New York wires were essentially empty during peak business hours in Europe and so sending a message from Liverpool to le Havre or Bremen via New York took "half (the) time occupied by a direct wire."[24] Despite these work arounds, the brokers in the Liverpool Stock Exchange still had substantially fewer opportunities to conduct arbitrage trading with European stock exchanges, and when they did, often faced daunting infrastructural hurdles in sending messages and executing orders that brokers in London simply did not face.

But even the best laid plans, and telegraph wires, sometimes go awry. In August of 1914 WWI broke out. Stock exchanges closed, international communication between warring nations was severed, and arbitrage trading became "practically impossible."[25] The GPO and London Stock Exchange abruptly abandoned all of their plans for new telegraphic facilities. It would take another seven years before bourse to bourse telegraphic from the London Stock Exchange was established in 1921. Even then it was in a much more limited fashion than initially planned. The Paris, Brussels, and Amsterdam Bourses were afforded direct telegraphic channels to and from the London Stock Exchange though notably no German exchanges were included. The GPO also limited the time certain wires were available for bourse-to-bourse communication to the busiest hours of the business day.[26] Moreover, some governments still remained reluctant to join the

[22] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Liverpool Delegation Meeting with Postmaster General, May 9,1911, File VI, Post/30/1988B BT.
[23] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Extract from Liverpool Daily Post, May 10, 1911, File VI, Post/30/1988B BT.
[24] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Liverpool Delegation Meeting with Postmaster General, May 9,1911, File VI, Post/30/1988B BT. Shrewd arbitrage firms in London and Paris also utilized the same technique when wires were jammed.
[25] *Times*, July 31, 1914, 17.
[26] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Letter, January 14, 1922, File II, Post/30/1988B BT.

London Stock Exchange and GPO's scheme for bourse-to-bourse telegraphy. The Amsterdam Bourse's telegraph continued refusing to switch to duplex working and London-Amsterdam arbitrageurs vigorously complained, while brokers whose orders travelled via the Baudot quadruplex channel between London and the Paris Bourse "greatly appreciated" the service and expressed as much to the GPO.[27]

For all of the careful planning of the GPO and political pressure exerted by the London Stock Exchange, the telegraphic system and international arbitrage capabilities that flowed from it, were difficult to change. Complex infrastructures that cut across different international jurisdictions constantly threw technical and political challenges in the way of creating efficient telegraphic systems for global arbitrage trading. Stock exchanges jockeyed with one another over access to infrastructure and telegraphic technologies while arbitrageurs operating in different markets were subject to different technical affordances and limitations. Rather than simply facilitating global financial integration, material infrastructure helped lock in a hierarchical and unequal system of arbitrage trading.

The Work of Arbitrage

More than any other kind of financial activity in the 19th century, arbitrage trading depended on a large and skilled labor force for its execution. Because of the technical nature of arbitrage trading, stockbrokers, clerks, even messenger boys had to be highly trained. Brokers and clerks had to be able to speak multiple languages, calculate price differentials in different currencies on the fly, keep complex account books, and constantly monitor price changes in different markets throughout the globe. Messenger boys, despite being relatively menial labor, were also key links within the system of arbitrage trading. They had to be physically fast and efficient, but also had to learn the intricate and detailed routines of arbitrage trading in order to best tailor their services to the needs of the financiers they worked for. These skilled laborers produced the conditions of possibility for global arbitrage trading.

The lowest link in the chain of arbitrage labor was also its most visible: messenger boys. Messenger boys were the crucial "human infrastructure" that connected telecommunication hubs to waiting clients and vice versa.[28] Contemporary depictions and historical reminiscences of financial life in the 19th century prominently feature the constant scrum of messenger boys that ran through financial districts the world over.[29] One writer from the *Statist* captured the cacophony of the "cable race" that took place in the City every afternoon as London brokers began arbitraging with the New York Stock Exchange.

> Visitors to the City who are not familiar with its ways must observe a good many scenes which puzzle them. If they chance to be loitering about Bartholomew-lane or Throgmorton street between three and four o'clock in the afternoon they may see telegraph boys racing along at a breakneck pace. It is not a kind of racing that boys would indulge in without reason…Day after day they may be seen about the

[27] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Letter from London Stock Exchange to GPO, July 6, 1921, File IV, Post/30/1988B BT.
[28] Katie Hindmarch-Watson, "Male Prostitution and the London GPO: Telegraph Boys' 'Immorality' from Nationalization to the Cleveland Street Scandal" *Journal of British Studies* 51 3 (July 2012) 596.
[29] For a few examples see London Stock Exchange, Trustees and Managers Minutes, 110, 1860-1868, MS/19297/005; Committee for General Purposes Minutes,1908, 42, 424, MS/14600/082 GL; Edward Calahan, "The Evolution of the Stock Ticker," *The Electrical World and Engineer,* vol.37 no.6 (February 9, 1901) 236.

> same time going through a similar performance. They dash across streets, shoot round corners like greased lightning—often into the unexpectant stomachs of elderly and unstable citizens—dodge past hansoms, and rush up stairs into demure looking offices in the most unceremonious fashion. As soon as they reach the door they shout 'cable!' But these fleet footed youngsters may make as much noise as they please and nobody objects…They are indeed privileged youths; and besides being specially paid by their employers they no doubt have many a good tip from the receivers of these urgent messages.[30]

Though the messenger boys employed by the GPO may have "radiated state order over communications," the telegraph boys that worked for stockbrokers and banks radiated the chaos of the financial market.[31] In one moralistic story about finance published in 1883, a stockbroker recommended a series of investments to a client. As each investment went wrong, the stockbroker recommended a new stock to make up the difference. While this resulted in the predictable bankruptcy of the investor and enrichment of the broker, what is interesting about the story is how the market and financial action were represented. The stockbroker repeatedly told the client that he "never gives advice," but merely served as the neutral mouthpiece of the market. The "market" in this story was the changing prices on the ticker tape and the transmission of those prices to the stockbroker by a messenger boy named Mike. The only action the stockbroker ever actually performs is to read aloud the messages Mike delivers. (Figure 17) At the climax of the story, when the hapless investor is trying to place one last order to cover his losses, the outcome rests entirely on Mike. "You'll just have time, I think, before the market closes," the broker told the client, "Hurry, Mike, and fill these orders. Lively now! Look sharp!"[32] The labor of messenger boys like the fictional Mike became culturally representative of the financial market itself.

[30] *Statist: A Journal of Practical Finance and Trade*, August 14, 1886, 179.
[31] Hindmarch-Watson, "Male Prostitution and the London GPO" 616. Idem, *Serving a Wired World: London's Telecommunications Workers and the Making of an Information Capital*, (Berkeley: University of California Press, 2020). See also Patrick Joyce, *The State of Freedom: A Social History of the British State Since 1800*, (New York: Cambridge University Press, 2013) 98-99.
[32] Robert Grant, *The Lambs: A Tragedy*, (Boston: James Osgood & Co, 1883) 22, 26, 51.



Figure 17: Mike delivers a telegram to the broker

Messenger boys' operational importance went beyond their cultural connection to financial markets. Their work was both physically and socially demanding and was especially critical for facilitating the connections necessary for arbitrage trading. In physical terms, messenger boys were important simply for their ability to run more quickly than older stockbrokers or clerks. As one stockbroker told a messenger boy in his firm, "in the City, as young man you never walk, but always run."[33] The physical speed of British messenger boys was important to arbitrageurs especially when contrasted to the slower messengers in other countries. "In England (telegrams) are delivered by sharp boys, in other countries the delivery (of telegrams) is entrusted to army pensioners and other middle aged or old men, sometimes women, who are naturally slower than boys," one concerned arbitrageur complained to the GPO.[34]
In order to facilitate speedy connections, messenger boys also needed social knowledge of the financial world. Messenger boys needed to learn the networks of investors, brokers, and bankers that their firms frequently dealt with and learn which clients and which orders to prioritize in their routes. Many professional stockbrokers began their careers as messenger boys to learn the ins and outs of City life.[35] The social aspect of messenger boys' work was most apparent when it went wrong. Stockbrokers frequently complained about the "trouble" it took to "get and teach a new boy every year," as a new boy that did not understand the social networks of the City could

[33] Quoted in Hurford Janes, *de Zoete & Gorton: A History* (London: Harley Publishing Co., 1963) 47.
[34] Direct Working of the Anglo-Continental Telegraph Services Between London Stock Exchange and Bourses in European Capital, Part 2, Liverpool Delegation Meeting with Postmaster General, May 9,1911, File VI, Post/30/1988B BT.
[35] See for instance, Philips and Drew, Records Relating to the History of the Firm: Notes from interview with David Phin, June 4, 1984, MS/4606/H/01/001 LMA; Janes, *de Zoete & Gorton*, 47; Kynaston, *The City of London: A World of its Own*, 300.

be costly for business.[36] For instance, one financial order in 1865 went missing for three weeks when a "new boy" delivered a message to a waiter at the London Stock Exchange instead of the office of the intended broker.[37] Messenger boys, with both physical aptitude and social knowledge, were the critical connective tissue of the global arbitrage business.

While messenger boys made the physical and social connections necessary for arbitrage trading, clerks provided the operational expertise.[38] When the London Stock Exchange debated prohibiting forms of arbitrage trading in 1907-1908 (covered later in this chapter), one of the primary objections of arbitrageurs was that such a rule would end London's global role as the center of financial talent. "An adverse decision," the firm Heseltine and Powell wrote, would lead to the "dispersal of highly trained and specialized clerks and the loss occasioned on both sides of the Atlantic in the abandonment of expensive administrative machinery which has taken many years to perfect."[39] Even in the imagination of 19th century finance, clerks stood out for their proximity to the actual operations of trading. One angry article in the *Financial Times* complained that "on Continental Exchanges one daily meets with the elite of the financial world," but the London Stock Exchange was populated only by "junior partner(s) or clerk(s)."[40] Others had a more positive view and marveled at the "arbitrage clerks…lucky strokes at the telephone!" It was the clerks who waited by the telephone or telegraph when momentous news events created pricing shocks in markets. It was clerks, not the elites of finance, who became known as the "daring operators" of the arbitrage business.[41]

Arbitrage trading required clerks with a much higher level of skills than the usual bookkeepers that populated the City's workforce. The first qualification many arbitrage firms looked for was clerks who could speak foreign languages and could thus handle global trading operations. "There is a confusion of tongues, French and German may be heard almost as often as English," the *Financial Times* reported of the London Stock Exchange.[42] As early as the 1860s, firms were explicitly recruiting foreign clerks for arbitrage work. In 1869, one firm advertised for a "German clerk," who could "speak and write English correctly, have an accurate knowledge of accounts and arbitrage transactions, and write a good hand, both in English and German." [43] The need for clerks who spoke a foreign language resulted in the immigration of a multitude of well-trained clerks to London in search of work. Clerks looking for work were quick to advertise their language abilities and nationalities. Ads such as "A German Gentleman age 22 with two years' experience in a City banking house and four abroad well acquainted with French, English, bookkeeping, and arbitrage desires a re-engagement," were frequent.[44] The brokerage firm of Nathan and Rosselli encapsulated many of these trends. Founded in the late

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[36] London Stock Exchange, Appendix to Committee for General Purposes, Statement of the Case between Thomas Francis, Stock and Share Broker, and Henry Lloyd his Clerk, MS/19515/001 GL.
[37] London Stock Exchange, Trustees and Managers Minutes, 257, 1860-1868, MS19297/005 GL.
[38] This argument has been made about the importance of clerks to modern capitalism writ large. See Michael Zakim, *Accounting for Capitalism: The World the Clerk Made*, (Chicago: University of Chicago Press, 2018) especially 9-82.
[39] Heseltine Powell and Company, Copy Letters to the London Stock Exchange General Purposes Committee, January 15, 1908, MS/23263 LMA.
[40] "Stock Exchange Reform," *Financial Times*, August 18, 1888, 1.
[41] Cleveland Moffett, "The Paris Bourse," *The Century Illustrated Monthly Magazine* LXVII no.5 (March 1904) 651.
[42] *Financial Times*, July 20, 1890.
[43] *Times*, February 17, 1869, 3.
[44] *Times*, July 23, 1875, 3. There are of course too many examples to cite but for representative samples see *Times*, September 25, 1878; *Times*, August 1, 1905, 16; *Times*, Jan 16, 1908, 14.

19th century by two immigrants, Moses Nathan of Germany and Joseph Rosselli of Italy, the firm was almost exclusively committed to arbitrage trading with Europe, and as such, recruited an international team of clerks. By 1914, the firm employed eight foreign clerks: five from Switzerland, two from the Netherlands, and one from Germany.[45] Immigration of foreign clerks to Britain in general and London in particular was so great by the end of the 19th century that it led to "status panic," among the English commercial class: a pervasive fear that English clerks were lagging behind their continental counterparts in technical proficiency.[46]

The second key qualification for arbitrage clerks was an understanding of mathematics. Firms were explicit in requiring clerks skilled in financial calculations: "Exchange clerk required, thoroughly experienced and accustomed to arbitrage operations in foreign exchange," one ad read.[47] Calculating whether or not an arbitrage trade would be profitable required processing a number of different variables in a short period of time. Clerks had to calculate the foreign exchange rate of currencies, the cost of telegraphing an order, and they had to understand the rules of different markets—in particular what the commission rates and taxes on transactions were in a variety of different stock exchanges. But arbitrage clerks needed more than a good head for figures. The speed and complexity of arbitrage trading, especially within firms that conducted arbitrage operations in more than one market, required clerks that were personally poised as well. One ad required clerks with the "natural ability (to take) charge of office management in emergencies."[48] When Nathan and Rosselli checked the references of a clerk who had applied to their arbitrage department they wrote to ask if the applicant not only had a "trained mind" but more importantly wanted to be sure that the applicant was "not pedantically wedded to figures (and) is capable of looking all round any figures or problems which come before him."[49]

The rewards for the clerks that did manage to secure positions in arbitrage trading were great. Clerks in the financial industry, from banking to insurance to stockbroking, were already considered the "aristocracy of the clerical profession."[50] As David Lockwood has shown, by the early twentieth century about 45% of financial clerks earned over £160 a year compared to the civil service where the number was 37% and railways where the number was just 10%.[51] Typically clerks were recruited as "juniors" or apprentices and did relatively menial bookkeeping work until they were promoted up through the ranks. Junior clerks were often recruited at salaries anywhere between £20 and £90 per year.[52] Skilled arbitrage clerks frequently surpassed this process and jumped directly into more highly paid positions because they were directly recruited from accounting or actuarial positions. Ads for arbitrage clerks promised starting

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[45] One unfortunate Swiss clerk left London for a holiday back home on July 30, 1914. He will "doubtless have had to join his regiment," the firm's records note. See Nathan and Rosselli, Note Book Relating to Foreign Clients, 1911-15, List of Foreign Clerks, August 6, 1914, MS/15113 LMA.

[46] Gregory Anderson, *Victorian Clerks*, (Manchester: Manchester University Press, 1976) 60-65.

[47] *Times*, August 29, 1904, 14.

[48] *Times*, December 24, 1883, 15.

[49] Nathan and Rosselli, Correspondence and Agreements Relating Generally to Salaries, Commission, Terms of Employment and Spheres of Activity, November 18, 1927, MS/15110 LMA.

[50] Anderson, *Victorian Clerks*, 16.

[51] Lockwood, *The Blackcoated Worker: A Study in Class Consciousness*, (Oxford: Oxford University Press, 1969) 42.

[52] See Anderson, *Victorian Clerks*, 20-27. Anderson's data also aligns with what I have found in the records of select stockbroking firms. At Heseltine Powell & Co during 1876, junior clerks were paid between £25 and £80 per year. See Heseltine Powell and Company, Salary and Bonus Payments Lists Giving Names of Staff and Lengths of Service, MS/23260 LMA.

salaries ranging from £150 to £300 per year.[53] Other payment structures existed too. One common method was to underpay clerks but offer them commission on any new business they introduced to the firm. Nathan and Rosselli offered young clerks with less demonstrated arbitrage ability £100 per year and 50% of the commission received through the business of any new arbitrage partners they were able to bring in.[54]

The high pay and international competition for jobs, coupled with the complex nature of arbitrage trading, created a need for instructional material for would-be arbitrage clerks.[55] One manual, directed at the "financial and commercial public as a practical work on stock exchange arbitrage," attempted to show the "most easy and simple modes of calculating the relative values of the principal stocks and shares dealt in on the London and Continental Bourses." The manual covered a host of important calculative practices arbitrageurs needed to master, including how to convert fractional prices to decimals and how to incorporate the interest on stocks into an overall valuation of a stock's price (for instance, how to price 5% Indian Railway shares).[56] Other manuals were more geared toward high level practitioners, like one written by Henri Deutsch in 1904. Deutsch's manual provided a deep dive into the different rules and practices of each major stock exchange in Europe and provided both exhaustive lists of the major securities that were arbitraged between different markets, and sample calculations of how to assess the arbitrage possibilities of each security in a different market.[57]

Arbitrage instructional manuals were only helpful because of a broader shift towards the quantification and standardization of financial knowledge during the 19th century. In order for arbitrageurs to even begin to make their calculations about whether or not a trade was profitable, different stock exchanges had to have relatively standardized and quantified price lists and telecommunications companies and firms had to have standardized notations for how to demarcate a price. Most arbitrage instructional material was geared towards helping arbitrageurs understand complex foreign price lists. Manuals explained how different exchanges notated key pieces of financial information differently, for instance, if interest on a share was not explicitly stated in the official list of the Brussels Bourse than the "shares in question are negotiated without (interest)."[58] Tips on reading a price list could span from simple observations, like which

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[53] Many arbitrage clerks were recruited from outside of the stockbroking business. Accountants and insurance clerks were especially prized for their superior calculative abilities. See *Times*, February 17, 1869, 3; *Times*, December 24, 1883, 15; *Times*, August 29, 1904, 14; Nathan and Rosselli, Correspondence and Agreements Relating Generally to Salaries, Commission, Terms of Employment and Spheres of Activity, November 24, 1927, MS/15110 LMA.

[54] Nathan and Rosselli, Correspondence and Agreements Relating Generally to Salaries, Commission, Terms of Employment and Spheres of Activity, January 1924, MS/15110 LMA.

[55] Once again, this is a subset of a larger trend in the "self-making" of clerks in the nineteenth century. See Zakim, *Accounting for Capitalism*, 24-46, 70-82.

[56] Maurice Cohn, *The London Stock Exchange in Relation with the Foreign Bourses: The Stock Exchange Arbitrageur*, (London: Effingham Wilson, 1874) 3. For other examples in this genre see Ottomar Haupt, *Arbitrages et Parites: Traite Pratiqe des Operations D'Arbitrages sur lettres de change, fonds publics, et matieres d'or et d'argent Avec Les Principales Places de L'Etranger,* (Paris: Libraire Moderne, 1880); Charles Castelli, *The Theory of Options in Stock and Shares* (London: Frederic Mathieson, 1877) 74-77.

[57] Henri Deutsch, *Arbitrage in Bullion, Coins, Bills, Stocks, Shares, and Options Containing a Summary of the Relations between the London Money Market and the Other Markets of the World*, (London: Effingham Wilson, 1904). It is difficult to assess how popular or influential Deutch's book was. A year after its publication, Deutch was posting personal ads in the financial press looking for work. In his own words he was the "author of standard works on arbitrage, indefatigable worker, good organizer, university graduate, fluent French and German," who has "made practical arbitrage business his specialty." So, while Deutch's academic work never sold enough for him to live off its profits, it at least forced Deutch to actually put his arbitrage theories into practice. *Times*, August 1, 1905, 16.

[58] Cohn, *The London Stock Exchange in Relation with the Foreign Bourses*, 12.

German words notated the seller's price, buyer's price, and actual prices made at the Berlin Bourse, to far more complex operations, like how to calculate "put" options on a stock in the price list of the Paris Bourse, where only "call" options were officially listed.[59]

In addition to quantified price lists, international arbitrage also required standardized share certificates. Though most arbitrageurs operated "on account," which is to say, they closed their books every night and rarely took delivery of actual stock certificates, arbitrage trading generated business in foreign securities that resulted in the increasing traffic of share certificates across borders. Thus, a share certificate from a company based in one country had to meet the legal requirements imposed by another. International companies that gained advantages from raising capital on multiple stock exchanges were key drivers of share certificate standardization alongside the brokers, investors, and arbitrageurs who trafficked in their shares. In 1888 for instance, a new facility was set up in the London Stock Exchange's Share and Loan department for the registration and standardization of the shares of American railway companies in Britain. "Most if not all of the leading companies would be willing to grant special facilities to a department established under the control of the committee of the Stock Exchange in London," Henry Burdett, the secretary of the Share and Loan department, proclaimed. The new facility would also "obviate much of the delay and difficulty now caused to brokers and shareholders."[60]

The standardization and quantification of financial information was uneven. Many companies, often smaller ones, could not or did not provide the requisite information to exchanges in order to be included in the official list, thus preventing the formation of any sustained market that would have allowed for arbitrage trading.[61] Even when companies did list themselves on different exchanges and complete the legal requirements for registering shares the globalization of financial trading threw up new obstacles. In May of 1875, one delivery of Anglo-American Telegraph shares that initially been registered in France, was refused by a London investor because he was "not able to read French."[62] When market liquidity was determined by the deliverability of paper share certificates, the form of those share certificates was consequential. Standardizing share certificates and meeting the requirements for getting listed in different markets was simply unfeasible for some companies while it was a necessity for others. Exchanges and companies that successfully standardized share certificates were key pre-requisites to the development of arbitrage trading between different markets.

Global arbitrage trading was produced by, and in turn helped produce, new forms of financial labor and information. Messenger boys, clerks, quantified price lists, and standardized share certificates all predated arbitrage trading. At the same time, the profits and imperatives of arbitrage trading also heightened the need for faster and more knowledgeable messenger boys, polyglot and mathematical clerks, and paper technologies for share transfer and price calculation. Arbitrage trading *depended* on the existence of a host of different financial infrastructures while at the same time, it also began to shape those infrastructures in new ways.

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[59] Cohn, *The London Stock Exchange in Relation with the Foreign Bourses*, 8; Deutsch, *Arbitrage in Bullion, Coins, Bills, Stocks, Shares, and Options*, 170.

[60] London Stock Exchange, Subcommittee on American Railway Shares, MS/14605 GL.

[61] See for instance London Stock Exchange, Committee for General Purposes Minutes, 1875, 5, MS/14600/40; Committee for General Purposes Minutes,1889, 288-289, MS/14600/56 GL.

[62] London Stock Exchange, Committee for General Purposes Minutes,1874-1875, 341, MS/14600/39 GL.

Arbitrage as Market Practice

How did firms in the late 19th and early 20th century actually conduct arbitrage trading? One of the main reasons so much economic history has relied on juxtaposing the price signals of certain securities against the volume of telegraphs is because it is difficult to reconstruct the daily trading activities of specific market actors, let alone the rationality and operational practices behind their trading decisions. This section principally focuses on the little-known records of the arbitrage firm Nathan and Rosselli to examine how arbitrage worked in practice and to show that far from any overriding economic rationality, arbitrage trading was at the mercy of the infrastructures that underpinned it.[63]

The first and often most difficult aspect of 19th century arbitrage trading was finding a trading partner. Unlike modern traders who can place orders in different markets around the world from a single computer in their office, 19th century arbitrageurs needed a physical partner to execute orders in the distant markets that they were arbitraging with. Despite the processes of financial and economic globalization that were taking place in the late 19th century, finding a stranger to do business with in a far-flung city was far from easy. Most firms simply took to advertising. The financial press in London was replete with arbitrageurs who ran the financial equivalent of personal ads. "Advertiser in touch with the various American Arbitrage Houses would like to meet with a gentleman having spare capital at his command with a view to acting upon valuable information on mutual lines," one ad read.[64] Others were vaguer still: "Arbitrage with Egypt offers today most favourable opportunities," one Egyptian firm cryptically advertised in the London press.[65] Especially when a firm was established in the global arbitrage business, like Nathan and Rosselli, they often received unwarranted correspondence from unknown people offering to become business partners.[66]

Firms were quick to exploit any chance at a rare in-person meeting with potential partners abroad. When the firm Edmund and Charles Randolph of New York went into an arbitrage partnership with Nathan and Rosselli in 1911, the head of Randolph's arbitrage department, Paul Stamm, insisted on an in-person meeting. "Randolph is not very anxious to have us go," Stamm wrote to his counterpart Louis Sanders, the head of arbitrage at Nathan & Rosselli, "but I would not undertake the thing without having seen you personally, gather your views, (and) talked over all the details."[67] The ethos of establishing business via an in-person meeting seemed to have carried over to Nathan and Rosselli. After WWI, Nathan & Rosselli urged one of their clerks, who was an injured veteran visiting the spas of Wiesbaden, to make good use of his vacation. "If you should be able during your enforced residence in Wiesbaden to bring about the transmission

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[63] The only historian to my knowledge who has used these records is Ranald Michie. Unfortunately, his treatment of them is rough to say the least. He cites two letters in the firm's records via block quotes and provides essentially no analysis other than that they illustrate the "complexity of arbitrage trading." See Michie *The London and New York Stock Exchanges*, 71-73. There are two reasons for the lack of attention to Nathan and Rosselli's quite detailed and helpful records. The first is that the firm was acquired by a larger stockbroking company, James Capel & Co, in 1965. The second is that, when Guildhall Library's archives were taken over by the London Metropolitan Archive, Nathan and Rosselli's papers ceased to have their own separate collection and were merged with the papers of James Capel & Co. Thus, their records have been relatively hidden by the organization of the archive.

[64] *Times*, February 18, 1895, 16.

[65] *Financial Times*, August 25, 1905.

[66] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Suspicious Letters File, MS/15123 LMA.

[67] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, June 8, 1911, MS/15123 LMA.

of any business to us by some of the leading banks in Germany, we should be quite pleased," they wrote.[68]

Finding an arbitrage partner was one thing, keeping them was another. Trust between trading partners was fragile and easily broken through botched or duplicitous transactions. Often, firms with questionable creditability in their local market did substantial arbitrage business with partners abroad who had little understanding of the firm's local standing. One example is Blondel and Carnier, a Paris firm that "by no means enjoyed first class credit on the (Paris) Bourse," but nevertheless did "a very large business…of offering abroad all sorts of options and even firm stock through its remissiers (arbitrage partners)." When the firm failed in June of 1892, it sent shocks through the Vienna, Constantinople, and London stock exchanges where they did most of their arbitrage business. Blondel and Carnier's two London trading partners conspicuously "bolted" from the stock exchange when news of the failure reached Britain.[69] Even an experienced arbitrage firm like Nathan and Rosselli sometimes failed to fully vet their trading partners. In 1928 Nathan and Rosselli discovered that their new New York partner, Ashley Dodd, had been "dealing with several firms of brokers in addition to ourselves," and even raised suspicions about whether or not Dodd had played competing orders from different foreign brokers off against one another.[70] Nathan and Rosselli promptly broke off their connection with Dodd and began searching for another New York arbitrage partner.

Personal connections between arbitrage partners had to be facilitated by material infrastructures. Control over these infrastructures thus mattered immensely. By 1911, European telegraph companies had been forced out of the transatlantic business by Western Union, who controlled the majority of the undersea cables alongside their American competitor the Commercial Cable Company.[71] But even under unified management, transatlantic telegraph cables were notoriously fragile. In 1908, fishing trawlers off the coast of Ireland interrupted service between the New York and London stock exchanges a total of 29 times causing "serious inconvenience" to members of the stock exchange. The London Stock Exchange was so concerned that it petitioned to the British government to station protective gunboats at key points along the cable's oceanic route.[72] Even when the technology worked, long-distance submarine telegraphy suffered from limitations that inland telegraphs did not face. For instance, duplex telegraphy was invented in the 1860s but was not adapted for submarine cables until the 1890s.[73] For most of the 19th century, the "feebleness of the (electrical) current over thousands of miles of cable under the sea," forced telegraph companies to use simplex, Morse telegraphy for transatlantic transmission.[74] As late as 1935, only 3 out of the 13 transatlantic cables utilized multiplex telegraphy.[75] Because of the expense of transatlantic telegraphy and the technical challenges of transmission, most arbitrageurs relied on code books to send complicated messages

[68] Nathan and Rosselli, Correspondence and agreements relating to salaries, commission and terms of employment, Letter to Gustave Wolfsohn, November 8, 1926, MS/15111 LMA.
[69] *Financial Times*, June 7, 1892.
[70] Nathan and Rosselli, Correspondence and agreements relating to salaries, commission and terms of employment, Letters to E. Ashley Dodd, October 24-25, 1928, MS/15111 LMA.
[71] Simone Müller, *Wiring the World: The Social and Cultural Creation of Global Telegraph Networks,* (New York: Columbia University Press, 2016) 132-138.
[72] London Stock Exchange, Committee for General Purposes Minutes,1908, 266-267, MS/14600/082 GL.
[73] Müller, *Wiring the World*, 168.
[74] "The Spectator," *The Outlook* vol. 60 (October 15, 1898) 421.
[75] *First Annual Report of the Federal Communications Commission to the Congress of the United States,* (Washington, 1936) 44.

in as few words as possible.[76] The codes that financial firms utilized became so byzantine that the GPO chastised the members of London Stock Exchange for employing words of "doubtful pronounceability" like "bujksrocty" or "bywrgrocbx," which, they argued, ultimately impeded the speed at which a telegraph operator could send a message.[77]

Far from being meaningless technical details, the reliance on code words, the technicalities of transmission, and the shift from British to American companies in managing transatlantic telegraphy, had far reaching effects on how financial markets were organized. The growing importance of American telegraph companies posed a particular problem for the London Stock Exchange and its arbitrageurs. Unlike the GPO and British telegraph companies, Western Union did not have an office within the stock exchange itself. Up until WWI, Western's Union's primary offices for stock exchange business were located in No.1 Old Broad St, which was across the street from the south eastern side of the London Stock Exchange.[78] This was a problem for two reasons. First, the American market was located in the North-Western corner of the stock exchange, in and around Shorter's Court. Messengers had to sprint around the entire length of the exchange to deliver communications. Second, those communications were largely in code and there was no space either within Western Union's offices or the trading floor of the American market, for arbitrageurs to decode the messages they received. The lack of a space to decode messages created caused chaos in the market. The "rushing in and out of telegraph boys and clerks," caused so much commotion so as to make executing business even more difficult than usual.[79] One commentator described the American market as "a howling multitude half in and half out of Shorter's Court," where "an operator of sufficient physical energy to fight his way rapidly from one (end) to the other might have carried on a species of arbitrage business between the two."[80]

Beginning around 1907, the London Stock Exchange opened special decoding rooms just off the entrance to Shorter's Court. Officials from the American telegraph companies were allowed into the room as were clerks from arbitrage firms. The London Stock Exchange policed the decoding room like the critical infrastructure that it was. Firms had to specially apply to secure space in the room for their clerks. Space in the decoding room was limited to two clerks per firm, and only one of the two clerks could ever be working in the decoding room at a time.[81] Because of the difficult and high-pressured nature of arbitrage business and telegraph decoding, most firms developed "special staff for the decoding of cables," that was separate from the clerks they used to settle accounts or check bargains.[82] When firms broke the London Stock Exchange's rules surrounding arbitrage, punishment was typically enforced by suspending that firm's clerks

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[76] See for instance E.B. Broomhall, *The Arbitrage Code: Containing over Twenty Millions of Combinations* (London: Walbrook, undated); E. B. Broomhall, *The Imperial Combination Code for Mining, Company Promotion, Financial and Stock Exchange Purposes, Rubber Edition*, (London: Walbrook, 1913).

[77] London Stock Exchange, Committee for General Purposes Minutes,1908, 271-272, MS/14600/082 GL.

[78] For the location of the Western Union office, along with evidence of the gradual shift away from Anglo-American Telegraph Co to Western Union, see Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Undated Telegram from E.C. Randolph to Nathan and Rosselli, MS/15123 LMA. See also *Post Office London Directory: Commercial and Professional Directory* (London: Kelly's, 1915) 1316.

[79] London Stock Exchange, Committee for General Purposes Minutes,1908, 43, MS/14600/082 GL.

[80] *Times*, November 11, 1885, 11.

[81] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letters from Edward Satterthwaite to Nathan and Rosselli, July 23, 1913; November 25, 1913, MS/15123 LMA.

[82] London Stock Exchange, Committee for General Purposes Minutes,1908, 37, MS/14600/082 GL.

from entry into the decoding room.[83] The telegraphic form that international arbitrage orders were forced to take because of infrastructural constraints led to the development of a special labor force of decoding clerks alongside new facilities and new market regulations within the London Stock Exchange.

The infrastructures of transatlantic telegraphy also had a direct bearing on the strategies adopted by arbitrage firms. In 1911, Nathan and Rosselli began an arbitrage business between the New York and London Stock Exchanges with the firm of Edmund and Charles Randolph as their New York partners. The very first order of business between the new partners was to plan out the management of telegraphic communication. Between 3pm and 4pm London time—the only hour the London and New York Stock Exchanges were formally open simultaneously—Nathan and Rosselli agreed to send the initial price "changes in the market" from London to New York via the Commercial Cable company after which it was Randolph's responsibility to "suggest dealings" based on the opening New York prices. At the end of the New York trading day, it was Randolph's turn to cable "any news of importance," and alert Nathan and Rosselli of any "important changes (or) indications" in the New York market that had occurred overnight and could affect the opening prices in London. The final stipulation was that that every cable with an order, whether to New York or London, had to be "answered by cable, giving either the execution or quoting the market." No execution of an order could simply be left hanging. An order to execute a deal required either confirmation of execution or a new quotation of the price, indicating that the market had moved beyond the position where it would be a profitable arbitrage trade. The two firms even built redundancies into their telegraphic strategies. "On very busy days" where the Commercial Cable Co's wires were overloaded, the firms arranged to send "duplicate cables by Western Union," because that company's telegraphic channels were not usually "overworked."[84]

The second order of business was to determine whether arbitrage trading was done on a joint-account basis or a nostro/vostro basis. In a joint-account partnership, the risk and reward was split evenly between both parties. The profits from a deal first executed in London that was sent to New York to be undone were deposited in a jointly shared account. Likewise, if the price of a stock moved too quickly and the trade was no longer profitable, losses were booked equally between the New York and London firms. Arbitrage done on a nostro/vostro basis kept the profits for the firm that initiated the trade while reducing the risk for the counterparty who had to undo the business in a different market. When a London firm sent an order to New York to be undone, the New York firm simply acted as an agent, executing the deal and taking a small commission while the whole profit or loss on the transaction went to the London firm. The same arrangement applied for any business originated in New York and sent to London. While a nostro/vostro system lowered risk, it also increased costs in certain ways. Most firms operating on a nostro/vostro basis required each other to have margin—capital from one firm that was at the disposal of the other in case prices moved unexpectedly and the position had to be held or sold off at a loss.[85] Arbitrage between new partners was typically done on a nostro/vostro basis

[83] London Stock Exchange, Committee for General Purposes Minutes,1908, 377, MS/14600/081 GL.
[84] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Nathan and Rosselli to E.C. Randolph, undated, MS/15123 LMA.
[85] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from E & C Randolph to Nathan & Rosselli August 1, 1911, /MS/15123 LMA.

until enough trust was built up between the two firms to switch to a joint account. Nathan & Rosselli and E & C Randolph were no exception and utilized a nostro/vostro system.[86]

The accounting system that arbitrage partners chose also directly affected how they conducted their telegraphic operations. In order to "avoid confusion in the cabling with reference to Nostro and Vostro orders," Nathan and Rosselli and E & C Randolph used different telegraphic codes.[87] All deals done for Nathan and Rosselli's account were done using their telegraphic code of choice: *Hartfield's Wall St. Code*. Whereas any business done for Randolph's account was done using the firm's in-house telegraphic code. The use of particular telegraphic codes, especially Nathan and Rosselli's deployment of *Hartfield's*, was also related to the securities the two firms planned to deal in, which were primarily American. While there was a long list of securities the two firms monitored for arbitrage opportunities, their "specialty" was in the stock of the Pennsylvania and Reading railroads, the Anaconda and Amalgamated Mining companies, and a few smaller railroads like the Missouri-Pacific and Utah.[88] While the dual code system employed by Nathan and Rosselli and Randolph was complicated and resulted in a heavier workload for the decoding clerks, it was a system that was specifically designed to operate effectively while arbitraging American securities on a nostro/vostro basis.

But even armed with a clear telegraphic strategy, expert clerks, and a specific arbitrage strategy, pulling off transatlantic arbitrage was a difficult task. The partnership between Nathan & Rosselli and E & C Randolph was shaky from the start. The transactions from April 26, 1911 are indicative. The day netted approximately £2700 in profit from arbitraging price differences in Union Pacific and Amalgamated Copper shares, but the two firms disagreed with the strategy the other pursued.[89] In short, Nathan & Rosselli believed that E & C Randolph had been to hesitant to buy and sell shares when they received prices from London. E & C Randolph believed that Nathan & Rosselli were merely chasing momentum in price movements, not suggestions trades that were precise, low-risk arbitrage.[90]

By August of 1911, the partnership had reached a breaking point. Stamm, of E & C Randolph, was particularly upset by the trading that took place on August 22. At New York's opening, Nathan & Rosselli had sent an order to buy Canadian Pacific Railways at £234. Canadian Pacific was trading in the low £240s on the London Stock Exchange. Theoretically, E & C Randolph should have bought shares in New York, causing the price to rise, while Nathan and Rosselli should have immediately sold shares in London, causing the price to drop, and eventually reach an equilibrium. But by the time their order reached Stamm, the New York price had begun dropping, falling to £233$^{7/8}$ and then £233 ½ on news of major sales from Berlin. Stamm furiously telegraphed London, warning them that a sell-off was headed their way and was

[86] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Nathan and Rosselli to E.C. Randolph, undated; E & C Randolph to Nathan & Rosselli August 24, 1911, MS/15123 LMA.
[87] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from E & C Randolph to Nathan & Rosselli, April 25, 1911, MS/15123 LMA.
[88] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Nathan and Rosselli to E.C. Randolph, undated, MS/15123 LMA.
[89] To reconstruct the trading undertaken by the two firms see *Financial Times*, April 26, 1911, 1; Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Cables Received from Nathan & Rosselli and Cables Sent to Nathan & Rosselli, April 25, 1911, MS/15123 LMA.
[90] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, June 7, 1911, MS/15123 LMA.

able to cable the lower price "ahead of anybody else."[91] But this time it was Nathan & Rosselli who hesitated, waiting for the London price to fall to 238 before they sold. Shortly thereafter the price rallied to close at $238^{3/4}$.[92] "Do you call this arbitrage?" Stamm angrily wrote to Sanders at Nathan and Rosselli.[93]

The firms faced two problems. The first was their telegraphic operations. In New York, arbitrage operations were split between Stamm, a partner in the firm, and his clerk, "Mr. Haussman," a Frenchman who had previously handled the firm's business with Credit Lyonnais and was considered an "able arbitrageur."[94] In the New York Stock Exchange, arbitrage was typically a two-man job. One man, usually the senior partner, was on the trading floor and signaled the price to his "clerk outside the rail who writes the cable message (and) passes it to the telegraph office within the Exchange."[95] But within a few months of the partnership between Nathan & Rosselli and E & C Randolph, Stamm realized that Haussman was "too slow," and that other firms were winning the cable race to London. Stamm found himself having to both "watch the market" and "do most of the quoting," himself.[96] "As far as our cabling is concerned," Stamm wrote, "we are trying our best," but it was "impossible to compete" against the other firms armed with teams of speedy clerks.[97] The problem was compounded by Nathan and Rosselli's unresponsiveness in London. On August 14th of 1911 the two firms missed "an elegant opportunity" in arbitraging a large price gap in Union Pacific shares, but Stamm received "no reply" from Nathan and Rosselli and the opportunity passed.[98] "It cannot go on forever," Stamm concluded.[99]

The second problem the firms faced was one of trust. "What I miss in our relation is the mutual feeling and understanding, which I had with former friends, where I could have been sure…of getting a lot of stock sold," Stamm wrote to Sanders. It was no use if he "quoted his head off" as long as there was no implicit understanding on the other side of the Atlantic of how to interpret the prices he quoted. "Formerly I could tell myself 'such and such a thing was sure to be done in London' and could act accordingly, often without awaiting advices from the other side. It is this mutual understand we (have) got to learn more than anything else."[100] For all of its reliance on calculation and speed, arbitrage was still an operation that depended heavily on instinct. Trust could not be easily transmitted over a telegraph cable.

In late September and early October of 1911, the two firms gradually ceased doing business together. A series of hectoring letters from Stamm added insult to injury. In one letter, Stamm accused Nathan and Rosselli of operating "against all principles of arbitrage," and

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[91] Nathan and Rosselli , Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, August 24, 1911, MS/15123 LMA.
[92] *Financial Times*, August 23 1911, 1.
[93] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, August 24, 1911, MS/15123 LMA.
[94] Nathan and Rosselli , Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, June 8, 1911, MS/15123 LMA.
[95] Francis Eames, *New York Stock Exchange*, (New York: Thomas Hall, 1894) 90.
[96] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, August 24, 1911, MS/15123 LMA.
[97] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, August 15, 1911, MS/15123 LMA.
[98] Ibid.
[99] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, August 24, 1911, MS/15123 LMA.
[100] Ibid.

invoiced them for overdue cable charges. [101] In a later letter, Stamm condescendingly suggested that Nathan and Rosselli should send "some member" of their firm to New York to "study with us…and then carefully and fully formulate a policy for the conduct of the account." There was, after all, "good money in properly conducted arbitraging."[102] Nathan and Rosselli declined to send any member to New York, as well as to pay the cable charges. The correspondence between the two firms ended in July of 1912 when E & C Randolph accused Nathan & Rosselli of going "out of your way to act to the detriment of your own interests and with unfairness to us."[103] It is unclear if the cable charges were ever paid.

The history of Nathan & Rosselli's abortive attempt at arbitrage trading with E & C Randolph demonstrated that arbitrage was never simply an activity driven by economic rationality. For one, whatever constituted "economic rationality" differed greatly between the two trading partners. Nathan & Rosselli pursued an aggressive, speculative form of arbitrage business while E & C Randolph faced substantial operational difficulties applying the theoretical principles of low risk, precise arbitrage in practice. Most importantly, however, the experience of Nathan & Rosselli shows that infrastructure not only created the conditions of possibility for arbitrage trading, but actively shaped its everyday practice. Technical details mattered. Arbitrageurs needed strategies for sending telegraphs via different companies and wires. Particular telegraph codes were developed to trade in specific markets and were linked to specific forms of accounting. A slow clerk, burdened by having to master multiple telegraph codes, created a roadblock in the entire system. Distance was not overcome via technology but rather exacerbated the difference between the arbitrage instincts of the partners on either side of the Atlantic. Over the course of the 19th century a variety of infrastructures had been built up enabling global arbitrage trading by the beginning of the twentieth century. Those infrastructures, more so than any law of economics, shaped the everyday practice of global arbitrage trading.

The Politics of Arbitrage

On December 18, 1907, the small jobbing firm of Wrightson & Mursell lodged a complaint with the London Stock Exchange's Committee of General Purposes. Wrightson & Mursell alleged that a firm of stockbrokers, Marshall & Co. had broken "Rule 75"—the rule that stipulated the division between brokers and jobbers. Marshall & Co. the complaint argued, were not operating simply as brokers but were functioning in a "double capacity" by "bidding for, and offering shares, and making prices," in the mining market, just like a jobber would.[104] Rather than denying the charge, Marshall & Co. admitted to it. Though they were a brokerage firm, their principal client was in Glasgow and their principal business was arbitrage between the two markets. In order to successfully execute their arbitrage trades it was "necessary to make prices to suit." Executing arbitrage profitably meant that brokerage firms unavoidably had to take on some of the market-making responsibilities of jobbers. Marshall & Co. admitted that this

[101] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, September 6, 1911, MS/15123 LMA.
[102] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, September 28, 1911, MS/15123 LMA.
[103] Nathan and Rosselli, Correspondence and Papers, Mainly Concerning Securities for Loans and the Underwriting of Shares, Letter from Paul Stamm to Louis Saunders, July 19, 1912, MS/15123 LMA.
[104] London Stock Exchange, Committee for General Purposes Minutes,1907-1908, 284-285, MS/14600/081 GL.

technically broke Rule 75, but argued that their firm "only did what some of the biggest brokers in the house were doing all day long."[105]

It was a minor complaint; the kind that populated the minutes of the London Stock Exchange and usually resulted in merely a slap on the wrist or a short-term suspension from the exchange's premises. But this time, the Committee of General Purposes responded drastically. In January of 1908, the committee proposed an amendment to Rule 75 that, "brokers shall not make prices under any pretence whatever or carry on a joint account with, or divide profit and losses…with a member of a Provincial Stock Exchange." In effect, the new rule banned stockbrokers (but not stock jobbers) from arbitrage trading between London and any of the provincial stock exchanges in Britain, though the committee did include a provision that arbitrage with members of recognized stock exchanges outside of Britain could continue if firms applied for special permission from the committee. It was a massive blow to the large brokerage houses of the exchange that trafficked heavily in arbitrage trading.

Far from a simple technicality, banning brokers from arbitrage trading in Britain called into question almost all of the basic practices of the London Stock Exchange that had emerged over the last century. Core assumptions, from the division of labor between jobbers and brokers, to the arrangement and provision of communications infrastructure and technology, to how market rules and regulations were enforced, were exposed as questions of power: power over what an "efficient" and "free" market actually looked like and who it served.

The battle lines were not drawn between jobbers and brokers, nor yet arbitrageurs and non-arbitrageurs, but between small firms and large firms. For once, it was the small firms who finally had the advantage. The managers' search for new subscription revenue, coupled with an increase in business, had created massive growth in the London Stock Exchange since the 1870s. Between 1877 and 1904, membership of the stock exchange had increased from 3,245 to 7,446.[106] This growth was primarily driven by the addition of smaller firms who now decisively outnumbered their larger counterparts. Smaller firms tended to be jobbers and not brokers, though this was not always the case. The two petitions drawn up by the those for and against the new rule were indicative of the social make-up of each side. A petition in favor of the new rule was signed by 1120 members of the exchange and included around 900 jobbers and 200 brokers.[107] The petition filed against the rule change was only signed by 903 members including 377 brokers and 526 jobbers. Cecil Braithwaite, the senior partner of Foster and Braithwaite, one of the largest and most storied brokerage firms of the London Stock Exchange, argued that while the petition against the rule change may only have been signed by a "minority of the members" this minority represented "the great majority of the biggest firms…who have been and are the making of the Stock Exchange." [108] The implication was clear. Small firms saw the new rule as a way to break the domination that large firms had over the exchange's business and infrastructure, while the larger firms believed that the volume of business they did was evidence of, and justification for, their predominance in the hierarchy of the London Stock Exchange. What was at stake was not a technical question about the rules, nor a debate about the role of arbitrageurs in the market. What was at stake was whether or not the infrastructures of modern financial markets that had been built over the course of a century would be concentrated in the hands of a few or made more open to every member of the London Stock Exchange.

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[105] Ibid. 285-287.
[106] Michie, *London Stock Exchange*, 104; Duguid, *Story of the Stock Exchange*, 443.
[107] London Stock Exchange, Committee for General Purposes Minutes,1907-1908, 370, MS/14600/081 GL.
[108] Ibid 396-397.

The debate in the stock exchange quickly turned acrimonious. The group of large firms proposed a counter resolution that would eliminate the distinction between brokers and jobbers entirely. According to Cecil Braithwaite, enabling brokers to make price and giving arbitrageurs free rein was the principal reason the London Stock Exchange was the "*universal and free market*," of the world, where the public could purchase "many securities which would otherwise only be locally dealt in. The (arbitrageur) had made it possible to deal in anything in which there is a market everywhere, often at a moment's notice or within a very short space of time."[109] One of the foremost arbitrageurs of the exchange, Alfred Hicks, spelled out the logic behind the counterproposal even more clearly.[110] Hicks argued that the separation of market-making and market-taking between jobbers and brokers respectively had been useful because jobbers were incentivized to provide liquidity to the market. But the advent of arbitrage trading had made such a separation superfluous. Arbitraging brokers had begun competing with jobbers by offering closer prices on securities they had received from arbitrage operations, which in turn drove an increase in jobbing firms undertaking arbitrage work. These jobbers, (Hicks included) were akin to "merchants, taking big risks and running big books," funneling securities from all over the world to the London Stock Exchange. In doing so, arbitraging jobbers "were very useful alike to smaller jobbers and to brokers." Brokers could place orders at closer prices in a wider variety of securities and smaller jobbers benefited from a more generally liquid market. In Hicks' view, the practice of arbitrage led to a more efficient and liquid market that no longer needed the outdated division of activities between jobber and broker to ensure its proper functioning. "The logical effect of present business conditions was to abolish the distinction," Hicks argued.[111] Not only should the market efficiency that arbitrage produced not be hampered by a new rule, but all of the old regulations separating the activities of jobbers and brokers could be done away with too. Freedom and market efficiency were synonymous.

In a hypothetical stock exchange without the division between jobbers and brokers, and with unlimited ability for firms to conduct arbitrage trading, it was clear to the smaller firms that they would be cannibalized by larger firms. "It is the big firm that is endeavoring to kill the small man now," one firm claimed. [112] Another firm directly condemned the hypocrisy of those trying to end the distinction between brokers and jobbers. "The traditions of the stock exchange," they argued, "were only attacked by a small body of men with their own interests to serve."[113] The separation between brokers and jobbers enabled the existence of small jobbing firms to get by simply by competently navigating the market and its changes: buying low and selling high. But in a world where brokers could make prices too, the volume of orders large firms controlled coupled with their communications infrastructure, threatened to eliminate any use that the market had for small jobbers

The efficient market envisioned by the small firms was substantially different than that envisioned by the larger firms. One small jobber by the name of John Yule argued that the new rule banning arbitrage with British markets "will not hamper nor restrict business but will

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[109] Ibid. 396 original emphasis.

[110] Hicks was infamous for being one of 4 arbitrageurs arrested during the "Battle of Throgmorton St." in 1895. Police arrived to shut down the arbitrage trading in American shares that occurred in the middle of the street after stock exchange hours. When police confronted Hicks, he refused to move or cease his trading and was arrested for obstruction. Duguid, *Story of the Stock Exchange,* 148.

[111] London Stock Exchange, Committee for General Purposes Minutes,1907-1908, 382-383, MS/14600/081 GL.

[112] London Stock Exchange, Committee for General Purposes Minutes,1908, 376, MS/14600/082 GL.

[113] London Stock Exchange, Committee for General Purposes Minutes,1907-1908, 395, MS/14600/081 GL.

regulate it to the benefit of the whole house."[114] Instead of achieving an efficient market through unlimited arbitrage undertaken only by the largest firms, small firms believed that the best way to create an efficient market was by protecting the jobbers of the London Stock Exchange. According to the small firms, London's central position in the global financial system had not been won through indiscriminate arbitrage trading, but because the exchange had a vast, and unique, ecosystem of market-making jobbers who competed with each other to provide the best prices and hence produced the most liquid and efficient market in the world.[115] Protecting the network of London jobbers, and the efficient market they created via competition amongst themselves, would force other exchanges to do business in London regardless of any restrictions on arbitrage trading. Instead of arbitrage benefiting "the interests of a few privileged persons," the new rule would force provincial exchanges to send their business to London but spread the benefits of that business to the entire exchange.[116] In this vision, proper market regulation and enforcement of the rules would create a fair and efficient market that was not overrun by a few large firms that dictated the terms of business to the entire exchange.

Looming over both competing visions was the problem of infrastructure. For large firms, the new rule threatened years of painstaking, expensive infrastructural expansion. "We have expended an immense amount of time, money, and thought in developing this class of business," one arbitrage firm complained, "it has taken us years to secure advantageous positions for the telephones and telephone boxes and to do this we have had to enter into contracts in some cases for five and even seven years which are still running."[117] Not only would firms be stuck with contracts for telephones that were now useless, but it would also be a "death blow to…(the) large staff of clerks," and "special partners," that were the primary labor force of arbitrage trading.[118] Large firms believed the proposed rule was an explicit punishment of their own success. According to Cecil Braithwaite, the new rule was simply an attempt to "shift the business now done from those who have for many years by hard and progressive means built up their position," by "others who seek to force (business) out of its natural channels into narrower ones." Arbitrage firms that had the "pluck to acquire facilities at great cost," were "entitled to the reward of their expertise," Braithwaite believed.[119] The new rule directly threatened nearly a century of infrastructural power that had been slowly accumulated by a select set of firms.

Large firms also believed that confirming the new rule was not just punishing the successful, but also threw into question the London Stock Exchange's infrastructural supremacy as a whole. With arbitrage between the provinces and London circumscribed, the communications network would necessarily begin to develop in different ways. One threat was that the provincial stock exchanges would form a more coherent bloc to challenge London. "The provincial exchanges were yearly growing stronger and the tendency of the rule would be to make them more independent of London and to encourage them to deal between themselves," one report warned.[120] Indeed, according to another arbitrage firm who surveyed his correspondents in the country, provincial stock exchanges were already planning to take

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[114] Ibid. 424. Yule was notable for his crusade against the ticker tape too, which was undertaken with a similar logic.
[115] No other market had the London Stock Exchange's separation between market makers and market takers. See Michie, *London Stock Exchange,* and the Introduction of this dissertation.
[116] London Stock Exchange, Committee for General Purposes Minutes,1907-1908, 422, MS/14600/081 GL.
[117] Ibid. 386
[118] Ibid.
[119] Ibid. 396-397.
[120] Ibid. 407.

advantage of the new limitations the rule imposed on business in London by "open(ing) up direct communication with one another." [121] Not only would the new rule erode London's advantageous infrastructural position in relation to provincial exchanges, but it would also erode its position globally. One London arbitrageur gloomily predicted that the result of the new rule "would be to bring Paris and Glasgow together and London would lose in business and in freedom of the market."[122] Limiting who could conduct arbitrage in London would simply encourage provincial exchanges to forge new connections with other exchanges throughout the world and erode London's importance to the global financial system.

The small firms, on the other hand, believed that the overwhelming infrastructural advantages amassed by large firms were the original problem. Because of the unequal and path dependent way telecommunications had been introduced to the London Stock Exchange, small firms not only faced financial difficulties in accessing telecommunications facilities, but they faced material and spatial ones as well. One small jobbing firm had applied for a private telephone line in the early 1900s only to find that so many lines had already been laid from London Stock Exchange to provincial exchanges that "the post office were not granting any further private lines."[123] Private telephone lines were so prevalent among the large arbitrage firms that they made public infrastructure almost superfluous. The "4 direct public telephones from (the London Stock Exchange) to the provincial exchanges were hardly used at all," one firm reported.[124] Another small jobbing firm summed up the entire debate over the new rule and its relationship to communications infrastructure succinctly: "the minority who had obtained private telephones which their fellow members were unable to obtain were asking the committee to confirm them in the monopoly which they had created by breaking the rules."[125]

On July 23, 1908, after 8 months of hearings, testimonies, petitions, counter-petitions, and wrangling in the financial press, the London Stock Exchange passed a series of rules banning brokers from conducting arbitrage with provincial stock exchanges.[126] For all the sound and fury of large firms throughout the process, the rules were ratified and confirmed with ease. "It has…been so clearly in demonstrated during the past few weeks that the great majority of the members are in favour of the new rules that any substantial changes in them need not be anticipated," the *Financial Times* reported.[127] The large firms had still managed to secure some concessions. Arbitrage with stock exchanges outside of Britain was still allowed, and the implementation of the new rule was delayed until February of 1909 to give firms time reconfigure their operations, but the damage was done.

Overall, the passage of the new rules was a remarkable victory for the small firms of the London Stock Exchange. They imposed a new vision of what an efficient and fair market looked like. They challenged the infrastructural supremacy that large firms had amassed over a century and left arbitrageurs with telephone contracts, provincial contacts, and staff that were now superfluous. But most importantly, they had exposed the infrastructures of finance for what they really were. Far from neutral, efficient responses to new technology, a new investing public, economic incentives, or global trading opportunities, the infrastructures of finance that had been built up over the 19th century were the product of power whereby a select number of firms and

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[121] London Stock Exchange, Committee for General Purposes Minutes,1908, 327, MS/14600/082 GL.
[122] Ibid.
[123] London Stock Exchange, Committee for General Purposes Minutes,1907-1908, 422, MS/14600/081 GL.
[124] Ibid. 419.
[125] Ibid. 396.
[126] London Stock Exchange, Committee for General Purposes Minutes,1908, 38-384, MS/14600/082 GL.
[127] *Financial Times*, July 24, 1908, 4.

exchanges imposed their vision of an efficient market on the world around them. It was an open question how much the new regulations would actually curb the power of the London Stock Exchange and its large arbitrage firms, but the fiction that the financial system had arisen naturally and served everyone within it equally was discredited for good.

Conclusion

This chapter has argued that the infrastructures that enabled arbitrage trading and the integration of financial markets during the late 19th and early 20th century were products of politics and power relations. New technology did not facilitate a seamless connection between markets that made them more efficient. Instead, stock exchanges competed with one another as well with (and occasionally alongside) states to create infrastructural networks that gave them an economic advantage over their competitors. One level down, firms competed against each other to amass infrastructural advantages: from private telegraph wires, to skilled clerks, and trusted arbitrage partners. The stock exchanges and firms that won these infrastructural fights were the ones who benefitted from the business of arbitrage and from the "efficiency" of global financial integration. But even they remained constrained. Technological limits of telegraphy constantly limited the ability of arbitrageurs, as did the skills of their messenger boys, clerks, and brokers who were saddled with executing complex tasks in a highly competitive environment. And, as the final section demonstrated, infrastructural advantages were never safe from political reprisal. At every level, arbitrage trading was shaped and constrained by the limits and politics of the infrastructure that enabled it.

Why does this matter? While this chapter obviously aims to provide a more empirical and historically rooted account of the emergence of arbitrage trading than previous economic histories, one could argue that it does nothing more than perform a now familiar cultural historical or STS conjuring trick that shows how a seemingly natural phenomenon (like the integration of markets via advanced technology) was actually contingent and political.[128] Markets still became more integrated by the beginning of the twentieth century—what does it matter how?

This chapter, and this entire dissertation, argues that the technopolitics of financial infrastructure—from the infrastructural dynamics of the entire financial network, to the particularities within one node, like the London Stock Exchange—matter for understanding how global capital moved, who moved it, and who benefitted from its movement. A recent study by Barry Eichengreen, Romain Lafarguette, and Arnaud Mehl demonstrates that high speed internet connectivity, far from flattening financial transactions and rendering distance irrelevant, has concentrated financial business in centers that have benefitted from the geography of where high-speed cables are laid. They highlight London and Singapore as two financial centers near oceans, that benefit from a convergence of different cables.[129] This is not a recent phenomenon but rather a product of history: of how financial centers benefited from imperial origins of global telegraphy, of how financial institutions shaped those infrastructural networks, and how those infrastructural networks shaped the everyday practice of financial capitalism.

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[128] I borrow this formulation from James Vernon, *Hunger: A Modern History* (Cambridge, MA: Harvard University Press, 2007) 3.

[129] Eichengreen, Lafarguette, Mehl, "Cables, Sharks, and Servers: Technology and the Geography of the Foreign Exchange Market," *NBER* working paper no. 21884 (January 2016).

Afterword:
The Longue Durée of Financial Infrastructure

Financial infrastructures have a way of outlasting temporary political shocks. Perhaps the most sudden of such shocks was the outbreak of WWI in late July of 1914. The Great War severed communications between nations, hardened national borders, and ended the free-flowing movement of both people and capital. The effects on the financial system in the City of London were especially great. Foreign deposits were frozen. The Bank of England had to intervene to prevent a run on the banking sector. The London Stock Exchange shut its doors for five months and even when it returned, it banned arbitrage trading and could only process transactions for cash, not for the typical two-weeks of credit. Gaspard Ferrer, a senior partner at the Baring Bros. was shocked not just at the "general cataclysm," of the war but also at how "instantaneously the credit edifice which we have been building for generations could tumble to pieces in a night."[1]

Any return to normalcy that was achieved after the war was fleeting. WWI had shifted the center of financial gravity away from London and to New York. J.P. Morgan became the leading merchant bank of the world and the New York Stock Exchange became the key facilitator of the global provision of capital. When Britain left the gold-standard for good in 1931, its era of financial hegemony was officially over. The decline of British finance was even further cemented after WWII. It was the American financial sector that bankrolled the rebuilding of Europe, not Britain's. The global activities of British finance were further restricted by the imposition of capital controls and the peg to the now dominant dollar at Bretton Woods. The nationalization of the industries that had previously been the center of financial speculation, like the railways, by Clement Attlee's Labour government restricted the realm of financial activity even more. The financial world of the 19th century had ended.[2]

While WWI, the interwar period, and WWII are typically narrated as a sharp caesura in the history of finance, there are some surprising continuities. The infrastructures that underpinned the operation of markets throughout the 19th century continued well into the 20th, even if the broader global context within which those infrastructures functioned had changed. One stockbroker, reminiscing on life in the mid-20th century London Stock Exchange, claimed that "a dealer of the 1880s coming into a broker's office in 1945 could have picked up his book and gone down to the House and dealt."[3] As Ranald Michie has argued, the various challenges to the supremacy of the London Stock Exchange in this period resulted not in an embrace of innovation and change but a defensive posture. "The membership as a whole became much more conservative, seeking to maintain what they had, rather than expand into new areas."[4] The

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[1] Quoted in "Exhibition: Barings and the First World War," https://www.baringarchive.org.uk/exhibitions/barings_and_the_first_world_war/

[2] These paragraphs are drawn from Ranald Michie, *The London Stock Exchange: A History,* (New York: Oxford University Press, 1999) 143-325; Youssef Cassis, *Capitals of Capital: A History of International Financial Centres 1780-2005,* (Cambridge: Cambridge University Press, 2006); 143-199; Adam Tooze, *The Deluge: The Great War, America, and the Remaking of the Global Order, 1916-1931* (New York: Penguin, 2015); Barry Eichengreen, *Globalizing Capital: A History of the International Monetary System,* (Princeton: Princeton University Press, 2019) 41-126.

[3] Philips and Drew, Records Relating to the History of the Firm: Notes from interview with Arthur Beard, December 6, 1983, MS/4606/H/01/001 LMA.

[4] Michie, *London Stock Exchange,* 234.

changes that did happen to the infrastructures of finance in the mid-20th century were additive rather than disruptive. They were incorporated into the existing order of things rather than fundamentally challenging it.

One of the key shifts in this period was the introduction of women more fully into the financial workforce. As this dissertation has shown, women were always present within financial markets during the 19th century, but the scale at which they participated and the range of jobs open to them expanded dramatically beginning in WWI. As young men and boys were sent to the Western front, women took jobs as telegraphists, telephone operators, and even clerks for stockbroking firms.[5] By 1942, women composed about 20% of the City's workforce.[6] Even though women were becoming more and more critical to financial operations, the London Stock Exchange found a way to curb any deeper challenges that the inclusion of women may have posed to the cultural order of the exchange. Women clerks and staff were not granted admission to the actual confines of the exchange itself nor were they admitted to the exchange as stockbrokers until 1973.[7]

Women were also excluded from other aspects of critical financial service work, namely, the ranks of waiters. Waiters continued to staff the London Stock Exchange until the Big Bang of October 1986 when the London Stock Exchange's trading went digital. Their loud voices and austere appearance remained a crucial part of the exchange's homosocial, gentlemanly capitalist culture. "Most people talk about members being the old characters," one stock jobber named Anthony Jenkins recalled, but it was really the waiters who were "characters in themselves." One such waiter was named Churchill and was well known throughout the exchange because he "actually looked like Churchill." What was more, any technological change that happened in the mid-20th century still relied on the mediation of the waiters (See Figure 1). Waiters were still responsible for delivering messages and orders on the floor of the exchange and for calling out the names of members in powerful voices.

> If I wanted to speak to (the firm) of Walker Cripps…I would have to go to the main door and I would walk up the steps which had a little tiny…rail up so that you didn't get in the way of the members going in and out of the building and you had to ask the waiter 'Can I speak to Mr. Byford of Walker Cripps?' and he used to get his speaking tube out and blow down it…the waiter would call out three times 'Byford Walker Cripps,' and if he didn't answer he would then put the light up which was a 3 digit number allocated to that firm…so communications were very, very primitive in the old days.[8]

The paternalistic culture of domestic service work shaped the London Stock Exchange's infrastructural operations throughout the mid-twentieth century. Indeed, as late as the 1970s, one

[5] For a few examples see Pneumatic Tubes Between Threadneedle Street Branch Office and 'Stands' in the Stock Exchange: Provision, Maintenance and Staffing, New Agreement, January 7, 1916; see also Newland report, July 17, 1916 File XIV Post/30/1362 PM; Hurford Janes, *de Zoete & Gorton: A History* (London: Harley Publishing Co., 1963) 57.
[6] Michie, *London Stock Exchange,* 298.
[7] Ibid. 484.
[8] Bernard Attard, "The Jobbing System of the London Stock Exchange: An Oral History. Interview No. 6: Anthony Jenkins." London: Institute of Historical Research, (1990).

stock exchange worker described life on the exchange as dominated by "master-servant," relationships.[9]



Figure 18: A Waiter at his stand in the mid-20th century

[9] Quoted in Juan Pablo Pardo-Guerra, *Automating Finance: Infrastructures, Engineers, and the Making of Electronic Markets*, (Cambridge: Cambridge University Press, 2019) 90.

Technological changes were also built on top of 19th century infrastructures rather than replacing them. As Juan Pablo Pardo-Guerra has argued, infrastructural change in the London Stock Exchange "was gradual rather than abrupt, driven by tinkering instead of rational planning, maintenance as opposed to purposeful innovation."[10] For instance, beginning in the late 1950s, stockbroking firms began using basic video circuits to informally transmit prices from the floor of the exchange to their offices and clients. The system depended on clerks walking around the floor, gathering prices, and then writing them on a whiteboard that was videotaped and broadcast on closed-circuit TV. Aside from the video camera trained on the whiteboard, the system was essentially no different than how waiters and clerks like Wetenhall had kept track of prices by marking them on blackboards in view of the whole exchange. This process was formalized in 1968 with the introduction of the "Market Price Display Service," (MPDS). Like the shift from the telegraph to the ticker tape before it, the MPDS relied on a handful of professional reporters on the trading floor who collected prices in specific markets and then input those prices into computer terminals that were installed on the exchange's perimeter. The prices they reported were then broadcast on closed circuit TVs to all who subscribed.

Similar processes were put in place to automate the settling of accounts. Instead of hundreds of male clerks meeting in the basement settlement room every fortnight to check bargains and net-out transactions, they were replaced by an army of women clerks who plugged bargain tickets into computers which then calculated net settlements. These settlement procedures were further centralized and digitized by two more initiatives in the 1970s, "Transfer Accounting and Lodgment for Investors, Stock Management for Jobbers," (TALISMAN) and the "Checking, Accounting and Reporting for Member Firms," (CHARM). TALISMAN and CHARM allowed firms to input their executed deals into a central computing system (rather than passing tickets to clerks for input into a separate computer system). But yet again, these systems were primarily concerned not with efficiency or innovation as such, but rather the accurate "mirroring (of) the relations produced on the floor in the electronic tickers and bargains represented by the machine."[11] Rather than ever developing a digital or automated system that matched buyers and sellers in real time or truly tried to "disrupt" the business of the exchange, the technological changes of the mid-20th century simply built on the 19th century infrastructures that had amplified the price-making power of the jobbers and projected their prices *outward* as manifestations of the market on the ticker tape.

The real transformation in financial infrastructures came during the Big Bang in 1986 with the introduction of the "Stock Exchange Automated Quotations," (SEAQ) platform. SEAQ introduced real-time, bidirectional distribution of quotations between brokers and jobbers alike. That is, rather than simply seeing a price on the screen, jobbers and brokers continually uploaded prices they were either offering or desired. Yet, new infrastructures could still never rid themselves of the past. When a broker saw a price they wanted on the SEAQ, they still had to pick up the phone and call the jobber who offered it. Names of the firms offering certain prices remained listed on the screen until 1989 when they were anonymized. Even after the move to anonymization, brokers could take a price they saw on the screen and shop it around to jobbers they were friendly with and see if they could get a better price. These transactions happened over the telephone, not through the SEAQ on the computer.

Re-engineering financial infrastructures after 1986 began a broader re-organization of stock exchange governance structures. Rather than serving as national or local marketplaces

[10] Ibid. 87.
[11] Ibid. 110.

where individuals met to buy and sell securities, stock exchanges became more and more synonymous with their digital and automated trading infrastructures that could enable transactions at larger distances and faster speeds. Beginning in the 1990s, this led to the "de-mutualization" of exchanges. Instead of remaining privately-owned organizations that serviced the needs of their members, exchanges became publicly traded, profit-seeking corporations. De-mutualization led to agglomeration. In a furor of mergers and acquisitions, the most powerful exchanges in the world gobbled up smaller, local exchanges and incorporated their listings and business into centralized electronic infrastructures.[12] One of the most prominent examples is the rise of the Intercontinental Exchange group (ICE). Founded in 2000 by a power-plant developer named Jeffrey Sprecher, ICE was initially intended as an electronic exchange to help standardize and facilitate the trading of energy contracts. ICE's trading infrastructures quickly grew to encompass commodity as well as financial derivatives trading.

In 2012, ICE pulled off one of the most notable mergers and acquisitions in the industry: the acquisition of the New York Stock Exchange. Under ICE's ownership, the New York Stock Exchange went from a global powerhouse to just one part of a much broader conglomeration of electronic exchange infrastructures. As of the writing of this dissertation, ICE was the largest exchange operator in the world with a total market capitalization of $67.8 billion. Similar mergers and acquisitions proliferated across the sector. NASDAQ acquired what was formerly a collection of different Nordic stock exchanges, including the Copenhagen, Stockholm and Helsinki exchanges, as well as some regional United States exchanges, including those at Boston and Philadelphia. Euronext was formed by merging the Paris, Amsterdam, and Belgian stock exchanges in 2000, and has since expanded by acquiring the Dublin, Lisbon, Oslo and Milan stock exchanges. By 2017, there were 6 "global exchange groups" whose profits accounted for over 50% of those made by the entire stock exchange sector.[13] The same year the combined total revenue for this group of 6 exchanges had surpassed the combined revenue of the *12 largest* investment banks.[14] Exchanges had returned to a position of financial supremacy.

How did exchanges do it? Ironically, automation, digitization, and agglomeration made the profits exchanges derived from facilitating the execution of trades negligible. At a conference on the future of financial services, Sprecher argued that facilitating "execution is not particularly valuable…I think over time finding a buyer and a seller in a world where we have the Internet is really the most simple thing in the world, and networks can form up overnight to find buyers and sellers." In other words, the power of exchanges would not be found in mediating the act of exchange but rather in the provision of financial infrastructure. How did exchanges make money? "Data, listings, connectivity, information, catering, we print banners, I mean, everything *around* the execution is where we make money," Sprecher answered.[15] In short, the key infrastructures that stock exchanges had helped forge in the 19th century—the provision of quantified financial information, the monitoring of listings, the physical conduits of exchange, post-trade services like settling accounts—were the very same ones that made them profitable and powerful in the 21st.

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[12] For the best account of this process see Johannes Petry, "From National Marketplaces to Global Providers of Financial Infrastructures: Exchanges, Infrastructures and Structural Power in Global Finance," *New Political Economy* vol 26. No. 4. (July 2021) 574-597.
[13] Ibid.
[14] Marc Rubinstein, "The New Power Brokers," *Net Interest* https://www.netinterest.co/p/the-new-power-brokers
[15] Goldman Sachs U.S. Financial Services Conference, December 11, 2019, https://s2.q4cdn.com/154085107/files/doc_events/2019/CORRECTED-TRANSCRIPT-Intercontinental-Exchange-IncICEUS-Goldman-Sachs-US-Financial-Services-Conferen.pdf

There are few better examples of the centrality of financial infrastructure in the 21st century than the London Stock Exchange. In August of 2019, the London Stock Exchange pulled off the largest acquisition in the history of the exchange sector, acquiring the financial data company, Refinitiv, for a total of $27 billion. It is hard to overstate how dramatic of an acquisition it was. The London Stock Exchange had recently fought off a hostile takeover attempt by the Hong Kong Stock Exchange.[16] At the time of the acquisition, Refinitiv's revenues were double that of the London Stock Exchange's and its workforce four times as large.[17] What was more, the acquisition was only just able to pass intense, post-Brexit scrutiny from the European Union on the condition that the London Stock Exchange sell off Borsa Italiana, a conglomerate of Italian stock exchanges that the London Stock Exchange owned.[18]

By not merging with the Hong Kong Stock Exchange and selling off Borsa Italiana, the London Stock Exchange sacrificed trading functionality in a bid to become the "new global financial markets infrastructure leader."[19] The trading functionalities of the London Stock Exchange would be married to a suite of financial infrastructures run by Refinitiv. For instance, one of the London Stock Exchange's most profitable branches is the FTSE Russell Index. Similar to the S&P 500, the inclusion or exclusion from the FTSE Russell can make or break companies. Being included in the index gives companies global prominence and steers passive investment capital into their shares. [20]

In addition to steering capital into the securities listed on its index, FTSE Russell also provides data about the performance of the underlying securities. Acquiring Refintiv allowed the London Stock Exchange to marry this data provision to an exclusive physical infrastructure that transmitted it: Refinitiv's "Eikon" terminal, the second largest financial computer terminal behind the famous Bloomberg model. Another key aspect of the merger is the London Stock Exchange's entrance into the market for foreign exchange (FX) currency transactions. Before the acquisition of Refinitiv, the London Stock Exchange was already the key clearinghouse for Euro-denominated FX transactions.[21] Rather than buyers and sellers of different currency contracts constantly settling up with one another, the London Stock Exchange's clearinghouse nets-out the total amount of transactions for clients. With the acquisition of Refinitiv, the London Stock Exchange gained a new FX trading and execution platform. Once again, different aspects of financial infrastructure were coupled together: a platform for executing trades was combined with a platform to net-out and settle accounts post-trade.

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[16] "Hong Kong Exchange Drops its $39 Billion Bid to Buy the London Stock Exchange," *CNBC* (October 8, 2019) https://www.cnbc.com/2019/10/08/hong-kong-exchange-drops-its-39-billion-bid-to-buy-the-london-stock-exchange.html

[17] Philip Stafford and Alex Barker, "Refinitiv Deal Loses Some of its Lustre for LSE as Challenges Mount," *Financial Times*, June 29, 2021, https://www.ft.com/content/0c7c6931-9f56-4e43-87cf-91422630a146

[18] Maya Nikolaeva and Rachel Armstrong, "LSE Agrees to Sell Borsa Italiana to Euronext for $5 Billion," *Reuters*, October 9, 2020, https://www.reuters.com/article/us-lse-borsa-italiana-m-a/lse-agrees-to-sell-borsa-italiana-to-euronext-for-5-billion-idUSKBN26U0HF

[19] "Creating a Financial Markets Infrastructure Leader of the Future: All Share Acquisition of Refinitiv," *London Stock Exchange Group* (August 2019) 9. https://www.lseg.com/sites/default/files/content/documents/LSEG%20Proposed%20all%20share%20acquisition%20of%20Refinitiv%20Presentation%201Aug2019.pdf

[20] Johannes Petry, Jan Fichtner, and Eelke Heemskerk, "Steering Capital: The Growing Private Authority of Index Providers in the Age of Passive Asset Management," *Review of International Political Economy* vol. 28. no. 1 (January 2021) 152-176.

[21] Manolis Kalaitzake, "Resilience or Relocation? Expectations and Reality in the City of London since the Brexit Referendum," *Max Planck Institut* (2020) 12-15.

The importance of the London Stock Exchange's role in facilitating FX transactions was further reinforced by another key infrastructure, itself a legacy of the 19th century: high speed cable connectivity. The fastest cables from New York still land on the west coast of Britain and lead into London before they pass into Europe, making the London Stock Exchange and its servers the best exchange for those engaged in Euro-Dollar FX trading to operate (See Figure 19).[22] A focus on financial infrastructure allowed the London Stock Exchange to create a feedback loop of profits: their trading platforms that facilitated the act of exchange created data about those transactions and the underlying securities, which was then fed back through the financial infrastructures of post-trade account settlement, risk management, and the physical infrastructures of data provision.[23] Clients would be charged for both sets of services and become ever more dependent on the London Stock Exchange as a one-stop-shop for financial services.



Figure 19: The current routes of fiber optic cables between New York, London, and Europe

The monetization of financial infrastructures and the London Stock Exchange's ambition to become the "financial markets infrastructure leader" of the world is not a new phenomenon. It is instead an explicit reminder of the power financial infrastructures have always possessed. During the 19th century, the power of financial infrastructures was obvious to all those who were first involved in their construction. Waiters, messenger boys, and minor clerks like Wetenhall realized the power they had over critical market infrastructures and leveraged it for their own advancement and fought to protect the privileges it bestowed on them. States, stock exchanges, telecommunications companies, and financial firms battled over technical details, like the laying of a cable, the design of an office, or the battery power and amperage used to send financial transmissions. The various market actors spared no expense in trying to influence the construction of financial infrastructures and bend the system's profits towards themselves. By the end of the 19th century, what looked like the development of globally integrated, efficient markets thanks to the affordances of financial infrastructure was really an effect of market power. The imposition of a particular infrastructural system was the result of the political

[22] See Barry Eichengreen, Romain Lafarguette, Arnaud Mehl, "Cables, Sharks, and Servers: Technology and the Geography of the Foreign Exchange Market," *NBER* working paper no. 21884 (January 2016).
[23] "Creating a Financial Markets Infrastructure Leader of the Future," 17.

struggle between different market actors. The most powerful exchanges and firms tended to win these battles, but the levers and internal mechanics of financial infrastructure provided a wide field of agency and tools for resistance. Waiters could lower their voices, clerks could refuse to mark a price, smaller exchanges could flood the telegraph lines of larger exchanges or refuse to upgrade their technology.

When the 19th century financial world faded into history, so too did our memory of the political battles over financial infrastructure. Finance seemed to become "de-peopled."[24] Instead of brokers and jobbers jostling each other on the crowded trading floor, algorithms now interact with one another in server boxes. Server farms in northern New Jersey have replaced Wall St. as the hub of American securities trading. The telegraph, the ticker tape, and the telephone have long since given way to fiber optic cables, microwaves, and powerful microchip processors as the leading edge of financial technology. Prices are continually relayed in real time by computers rather than laboriously assembled at the end of the day by an overworked clerk. The black box of financial markets that had been open and contested throughout the 19th century, was closed.

As the key infrastructures of finance became (literally) smaller, more technical, de-peopled, and removed from view, our political ability to understand, regulate, and reshape them likewise diminished. When Occupy Wall St. protests erupted in September of 2011, the protestors were concentrated in Zuccotti Park and the historic financial district of Wall St. While Occupy protestors were busy demonstrating against the *symbolic* center of global finance, 25 miles away in New Jersey the New York Stock Exchange's servers continued their operations undisturbed. 10 years later in January of 2021, day-traders using the discount brokerage Robinhood, sent the price of GameStop shares from around $20 to nearly $350 in a matter of days. As frenzied trading escalated, Robinhood was forced to freeze all trading in GameStop shares. The reason why was quite predictable: an exponential increase in GameStop share prices also increased the costs of the initial margin collateral Robinhood had to post to the Depository Trust Company (DTC), America's security clearinghouse where trade risk is managed, and trades are netted-out and cleared. Robinhood could no longer afford these costs and had to shut down trading until it could. Yet those on both the left and the right offered other explanations. David "Davey Day-Trader" Portnoy, an avid day-trader and the right-wing founder of Barstool Sports, alleged to his 2.6 million twitter followers that Robinhood was colluding with hedge funds to prevent day traders from buying more GameStop shares and demanded "prison time" for their "blatant, illegal, (and) unfathomable" actions.[25] The exact same line was taken up by the Democratic chairwoman of the House Financial Services Committee, Maxine Waters, who held hearings to find out "whether or not Robinhood restricted the trading because there was collusion between Robinhood and some of the hedge funds that were involved with this."[26] Similarly, Destin Jenkins has argued in his recent history of the municipal bond market in 20th century

[24] Of course, it has not actually been de-peopled. But the type of work that people do within financial markets has changed and become less visible. For the best accounts of this see Pardo Guerra, *Automating Finance*; Caitlin Zaloom, *Out of the Pits: Traders and Technology from Chicago to London* (Chicago: University of Chicago Press, 2006); Daniel Beunza, *Taking the Floor: Models, Morals, and Management in a Wall Street Trading Room*, (Princeton: Princeton University Press, 2019); Donald Mackenzie, *Trading at the Speed of Light: How Ultrafast Algorithms are Transforming Financial Markets*, (Princeton: Princeton University Press, 2021).

[25] Quoted in Thornton McEnery, "Steve Cohen and Dave Portnoy Feud over GameStop on Twitter," *New York Post*, January 28, 2021, https://nypost.com/2021/01/28/steve-cohen-and-dave-portnoy-feud-over-gamestop-on-twitter/

[26] Quoted in Zachary Warmbrodt, "Robinhood CEO Expected to Testify before Maxine Waters' Panel on GameStop," *Politico*, February 1, 2021, https://www.politico.com/news/2021/02/01/robinhood-ceo-testify-maxine-waters-464491

America that the "the profound insulation of municipal debt from popular awareness conditioned the forms of political engagement among residents fed up with the burdens of debt…(producing) popcorn politics: revolts in different directions that never hit the pressure points of the borrower-creditor arrangement."[27] The populist protests of Occupy, the outrage of right-wing day-traders, and the high politics of congress's financial oversight committee, were all blunted by the infrastructural invisibility of financial infrastructure. Simple comprehension of financial infrastructures, to say nothing of resistance to or reform of them, was foreclosed.

We live in a financialized world. Any attempt to change that fact cannot begin with the assumption that we can rip out finance from the structures of our political, social, and economic lives root and branch. The infrastructures of finance that have shaped so much of our economic system were not born overnight. They cannot be easily disrupted by technical innovation nor dismantled by brute political force. The first step is to see the infrastructures of finance for what they are: to understand how, and for whom, they work. That is what this dissertation has attempted to do. And it is my hope that by more clearly seeing the invisible power of the infrastructures of finance we may begin to find new ways to exert our agency over them.

[27] Jenkins, *The Bonds of Inequality: Debt and the Making of the American City*, (Chicago: University of Chicago Press, 2021) 224.

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