NBER WORKING PAPER SERIES

THE INDUSTRIAL REVOLUTION IN SERVICES

Chang-Tai Hsieh
Esteban Rossi-Hansberg

Working Paper 25968
http://www.nber.org/papers/w25968

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
June 2019

We thank Feng Lin, Harry Li, and Jihoon Sung for extraordinary research assistance. We also thank Rodrigo Adao, Audre Bagnall, Dan Adelman, Pete Klenow, Raghuram Rajan, Richard Rogerson, and Chad Syverson for helpful discussions. The data from the US Census has been reviewed by the U.S. Census Bureau to ensure no confidential information is disclosed. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

At least one co-author has disclosed a financial relationship of potential relevance for this research. Further information is available online at http://www.nber.org/papers/w25968.ack

The Industrial Revolution in Services
Chang-Tai Hsieh and Esteban Rossi-Hansberg
NBER Working Paper No. 25968
June 2019
JEL No. E23,E24,L11,L22,L25,R11,R12

ABSTRACT

The rise in national industry concentration in the US between 1977 and 2013 is driven by a new industrial revolution in three broad non-traded sectors: services, retail, and wholesale. Sectors where national concentration is rising have increased their share of employment, and the expansion is entirely driven by the number of local markets served by firms. Firm employment per market has either increased slightly at the MSA level, or decreased substantially at the county or establishment levels. In industries with increasing concentration, the expansion into more markets is more pronounced for the top 10%firms, but is present for the bottom 90% as well. These trends have not been accompanied by economy-wide concentration. Top U.S. firms are increasingly specialized in sectors with rising industry concentration, but their aggregate employment share has remained roughly stable. We argue that these facts are consistent with the availability of a new set of fixed-cost technologies that enable adopters to produce at lower marginal costs in all markets. We present a simple model of firm size and market entry to describe the menu of new technologies and trace its implications.

Chang-Tai Hsieh
Booth School of Business
University of Chicago
5807 S Woodlawn Ave
Chicago, IL 60637
and NBER
chsieh@chicagoBooth.edu

Esteban Rossi-Hansberg
Princeton University
Department of Economics
289 Julis Romo Rabinowitz Building
Princeton, NJ 08544-1021
and CEPR
and also NBER
erossi@princeton.edu

1. Introduction

Modern production relies on scale: The ability to use a technology to produce the same product or service innumerable times. In manufacturing industries, the steam-engine, electricity, and Ford's assembly line, together with a number of other inventions, allowed firms to scale production in a single location. For many goods, the cost advantages of the larger scale overwhelmed the cost of transporting the goods to their final consumers. This ability to scale production in a single plant was, however, of little use outside of manufacturing. Producing many cups of coffee, retail or health services in the same location is of no value, since it is impractical to take them to their final consumers. Modern scale production in these sectors had to wait for a different technology, one that allowed firms to replicate the same production process in multiple locations close to consumers.

In this paper we argue that new ICT-based technologies have finally made it possible for firms outside of manufacturing to scale production over a large number of locations. The resulting expansion led to an increase in the national market share of top firms in many industries; a central fact about the US economy in the last three or four decades documented by Autor et al. (2017). This paper argues that this fact, among several others we document, is the result of a new industrial revolution that has taken place in many non-traded service sectors.

Consider Gawande (2012)'s account of how the Cheesecake Factory brought "chain production to complicated sit-down meals." The Cheesecake Factory has invested in technologies that determine optimal staffing and food purchases for each restaurant and each day. The company also has a well-oiled process via which they introduce new items on their menu. This process starts in a centralized "kitchen" in Calabasas, CA – their R&D facility so to speak – where Cheesecake's top cooks cull ideas for new dishes and "figure out how to make each recipe reproducible, appealing, and affordable." The cooks in the R&D

facility then teach the new recipes to the kitchen managers of each restaurant at a bi-annual meeting in California. The kitchen managers then follow a finely honed procedure to teach the new recipes to the cooks in each restaurant. The roll out time, from the time the kitchen managers arrive at Cheesecake's central kitchen in California to when the new dishes are put on the menu in each restaurant, is 7 weeks.

The standardization of production over a large number of establishments that has taken place in sit-down restaurant meals due to companies such as the Cheesecake Factory has taken place in many non-traded sectors. Take hospitals as another example. Four decades ago, about 85% of hospitals were single establishment non-profits. Today, more than 60% of hospitals are owned by for-profit chains or are part of a large network of hospitals owned by an academic institution (such as the University of Chicago Hospitals).[1] As an example of the former, consider the Steward Health Care Group. This company was created by the Cerberus private equity fund in 2010 when it purchased 6 Catholic hospitals in Boston. In Gawande (2012)'s account, Cerberus' goal was to create the "Southwest Airlines of healthcare" by figuring out and codifying best practices and implementing these practices over a large scale. Gawande (2012) describes the scene in Steward's remote intensive care unit (ICU) in a Boston suburb that monitors the ICUs in all of Steward's hospitals:

> "Banks of computer screens carried a live feed of cardiac-monitor readings, radiology-imaging scans, and laboratory results from ICU patients throughout Steward's hospitals. Software monitored the stream and produced yellow and red alerts when it detected patterns that raised concerns. Doctors and nurses manned consoles where they could toggle on high-definition video cameras that allowed them to zoom into any ICU room and talk directly to the staff on the scene or to the patients themselves."

Technologies such as the remote ICU has enabled Steward to provide consistent care in all the ICUs in its hospitals. By 2019, Steward had expanded from its 6

[1]The employment-weighted share of multi-establishment hospitals in the Longitudinal Business Database increased from 15% in 1977 to 62% in 2013.

original hospitals in Boston to 36 hospitals located in 9 states and Malta.[2]

We argue that the rise in industry concentration is due to companies similar to the Cheesecake Factory and Steward Healthcare that have adopted technologies that enable them to standardize and scale up the delivery of non-traded *services*. In this sense, what has happened in non-traded services is akin to the industrial revolution unleashed by Henry Ford more than a hundred years ago when Ford introduced mass production to a car industry dominated by independent artisans. We use micro-data from the Longitudinal Business Database from 1977 to 2013 to document the following facts. First, we show that the phenomena of rising concentration documented by Autor et al. (2017) is only seen in three broad sectors – services, wholesale, and retail. As Autor et al. (2017) suggest, top firms have become more efficient over time, but our evidence indicates that this is only true for top firms in these three sectors. In manufacturing, for example, concentration has fallen.

Second, rising concentration in these sectors is entirely driven by an increase the number of local markets served by the top firms. Within a typical market served by a top firm in sectors with increasing concentration, we find that employment of top firms is either constant or falling. Specifically, we find that average employment per establishment of top firms *falls* in sectors with rising concentration. The same is true for employment of top firms in each county they serve.[3]

Third, we find that *total* employment rises substantially in industries with rising concentration. This is true even when we look at total employment of the smaller firms in these industries. This evidence is consistent with our view that increasing concentration is driven by new ICT-enabled technologies that ultimately raise aggregate industry TFP. It is not consistent with the view that

[2]Steward's hospitals are in Massachusetts, New York, Ohio, Florida, Arkansas, Louisiana, Texas, Arizona, and New Mexico. Steward also has two hospitals in Malta.

[3]In a related finding Rossi-Hansberg et al. (2018) show, using the National Establishment Time Series (NETS) data-set, that although sales and employment concentration have increased in most sectors, local concentration has fallen significantly, particularly in Services, Retail and Wholesale.

concentration is due to declining competition or entry barriers, as suggested by Gutierrez and Philippon (2017) and Furman and Orszag (2018), as these forces will result in a *decline* in industry employment.

Fourth, we show that the top firms in the economy as a whole have become increasingly specialized in narrow set of sectors, and these are precisely the non-traded sectors that have undergone an industrial revolution. At the same time, top firms have exited many sectors. The net effect is that there is essentially no change in concentration by the top firms in the economy as a whole. The "super-star" firms of today's economy are larger in their chosen sectors and have unleashed productivity growth in these sectors, but they are not any larger as a share of the aggregate economy.

In order to make precise the type of technological change that we hypothesize is behind all these secular changes, we first propose a simple theory of firm size and market entry.[4] Using the theory, we show that a key ingredient of the industrial revolution in services that we document is a new fixed cost technology that lowers the marginal cost in all markets served by the firm. The adoption decision of firms involves a trade-off between a proportional reduction in variable costs and an increase in the fixed cost of the firm. With a large enough fixed cost, only the most efficient firms find it profitable to adopt the new technology, which leads to more concentration in the industry. If firms can decide the extent to which they want to implement the new technological advances, more productive firms will adopt the new technology more fully, also leading to concentration in the industry. Firms that adopt the fixed cost technology serve new markets because the new technology makes it profitable to serve local markets that were previously not viable. Rising input prices due to the expansion of firms that adopt the new technology forces multi-product firms to leave other sectors where the new technology has not occurred, or where their relative productivity is low, so the net effect on total employment

[4]Our theory is reminiscent of Gaubert (2018), but it allows firms to serve multiple local markets, as Ramondo (2014) does in an international context.

of top firms is ambiguous.

The rest of the paper is organized as follows. Section 2 presents our empirical findings organized in five Facts. Section 3 presents the theory and derives the implications of the availability of a menu of new technologies offering combinations of fixed and variable costs. Section 4 discusses the previous literature from the perspective of our empirical findings and their conceptual interpretation and provides some initial computations of the contribution of the industrial revolution in services to aggregate TFP growth. Section 5 concludes.

2. Facts

We use micro-data from the U.S. Census Longitudinal Business Database (LBD). The LBD is based on administrative employment records of every nonfarm private establishment in the U.S. economy. The advantages of the LBD are its broad coverage and quality. The establishment-level variables we use are employment, county, industry (4-digit SIC or 6-digit NAICS), and the ID of the firm that owns the establishment. We restrict to sample to observations from 1977 to 2013 and drop establishments in the public, educational, and mining sectors. We classify each 4-digit SIC and 6-digit NAICS industry into 450 consistently defined industries from 1977 to 2013. Hereafter, when we refer to an industry we mean these 450 industries. We also group counties into metropolitan areas (MSAs) defined consistently over time. We use the firm ID to aggregate employment of establishments to a firm in an industry or in the aggregate economy.

Table 1 shows total employment, number of establishments, and number of firms in the first and last years of our sample. We highlights five facts from the LBD data.

Fact 1. Increase in Industry Concentration

Our first fact, shown in Table 2, is the increase in concentration in the average industry. Table 2 presents the employment share of top 10% firms in an

ing growth due to new industries as the product of $1/(\rho-1)$ and the sum over all the new industries of the log of the inverse of 1 minus the employment share of the new industry in that city, where ρ is the elasticity of substitution across industries.[17] Total missing growth in the given location is the sum of missing growth due to entry into incumbent industries and entry into new industries. Finally, we aggregate missing growth in each city using the employment share of each city in the final year.

The results are shown in Table 16 using two definitions of cities: MSAs and counties. As can be seen, there is more missing growth in the non-manufacturing sectors. Missing growth in non-manufacturing averages 0.8% per year from 1977 to 2013. Missing growth in all sectors, including manufacturing, is lower at $.6\%$ to $.7\%$ per year from 1977 to 2013. The difference is, obviously, missing growth in manufacturing, which is essentially zero. Thus, "missing growth" due to local market entry, can account for about half of the difference between the BLS estimates of aggregate TFP growth and our results in Table 14. The remaining difference measures the aggregate effect of the service revolution on the productivity of incumbent establishments and new establishments *within* these local markets, particularly those of top firms.

5. Conclusion

We show that new technologies have enabled firms that adopt them to scale production over a large number of establishments dispersed across space. Firms that adopt this technology grow by increasing the number of local markets that they serve, but on average are smaller in the markets that they do serve. Unlike Henry Ford's revolution in manufacturing more than a hundred years ago when manufacturing firms grew by concentrating production in a given location, the new industrial revolution in non-traded sectors takes the form of horizontal expansion across more locations. At the same time, multi-product firms are forced

[17] We assume $\rho = 2$.

to exit industries where their productivity is low or where the new technology has had no effect. Empirically we see that top firms in the overall economy are more focused and have larger market shares in their chosen sectors, but their size as a share of employment in the overall economy has not changed.

The result of this new industrial revolution affecting many non-traded sectors is an increase in concentration and employment in these sectors. We see that employment increases even for the bottom 90% of firms in an industry with increasing concentration, suggesting that the new industrial revolution in these sectors is broad based, but obviously has a larger effect on the top 10% of firms.

We leaves three important questions for further work. First, it is important to say more precisely what this new technology is. The timing of these trends suggests that general purpose innovations in information and communication technologies have probably facilitated these fixed-cost based sectoral innovations. We also give some hints in our narrative in the introduction about the Cheesecake Factory and the Steward Health Care Group, but that only scratches the surface. We believe that a blend of quantitative and narrative accounts of this new industrial revolution, in the style of Chandler (1993)'s seminal work on the history of the industrial revolution in U.S. manufacturing, would be very useful. We hope that others (or perhaps we will) take up this challenge in the future.

Second, our story potentially has implications for the distribution of income and the distribution of employment of workers of different skills across locations. On the latter, the fixed cost technology is likely to be skilled worker intensive and top firms may choose to locate these services in larger and skill intensive cities. On the other hand, the expansion of top firms into smaller local markets improves the quality of local services, which may make these locations more attractive.

Third, we provided a back of the envelope calculation of the implication of increased concentration on aggregate TFP for the economy as a whole. It is possible to do something similar for intangible investment using the assumptions

of the model we laid out. But it should be clear that these calculations are only the beginning, and our hope is that more reliable numbers will be forthcoming in the future.

References

Aghion, Philippe, Antonin Bergeaud, Timo Boppart, Peter Klenow, and Huiyu Li, "Missing Growth from Creative Destruction," *Working Paper*, 2019.

_ , _ , _ , _ , and _ , "A Theory of Falling Growth and Rising Rents," *Working Paper*, 2019.

Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen, "The Fall of the Labor Share and the Rise of Superstar Firms," *NBER Working Papers No. 23396*, 2017.

Bresnahan, Timothy F., Erik Brynjolfsson, and Lorin M. Hitt, "Information Technology, Workplace Organization, and the Demand for Skilled Labor: Firm-Level Evidence," *The Quarterly Journal of Economics*, 2002, *117* (1), 339376.

Buera, Francisco J. and Joseph P. Kaboski, "The Rise of the Service Economy," *American Economic Review*, May 2012, *102* (6), 2540–69.

Cao, Dan, Henry R. Hyatt, Toshihiko Mukoyama, and Erick Sager, "Firm Growth Through New Establishments," *Working Paper*, 2019.

Caroli, Eve and John Van Reenen, "Skill-Biased Organizational Change? Evidence from A Panel of British and French Establishments," *The Quarterly Journal of Economics*, 2001, *116* (4), 14491492.

Chandler, Alfred D., Jr., *The Visible Hand: The Managerial Revolution in American Business*, Harvard University Press, 1993.

Decker, Ryan A., John Haltiwanger, Ron S. Jarmin, and Javier Miranda, "Declining Dynamism, Allocative Efficiency, and the Productivity Slowdown," *American Economic Review*, 2017, *107* (5), 322–326.

Edmond, Chris, Virgiliu Midrigan, and Daniel Yi Xu, "How Costly Are Markups?," *Working Paper*, 2019.

Furman, Jason and Peter Orszag, "Slower Productivity and Higher Inequality: Are They Related?," *Working Paper Series WP18-4*, 2018.

Ganapati, Sharat, "The Modern Wholesaler: Global Sourcing, Domestic Distribution, and Scale Economies," *Working Paper*, 2018.

Garicano, Luis and Esteban Rossi-Hansberg, "Inequality and the Organization of Knowledge," *American Economic Review*, 2004, *94* (2), 197–202.

__ and __ , "Organization and Inequality in a Knowledge Economy," *The Quarterly Journal of Economics*, 2006, *121* (4), 1383–1435.

Gaubert, Cecile, "Firm Sorting and Agglomeration," *American Economic Review*, November 2018, *108* (11), 3117–53.

Gawande, Atul, "Big Med," *New Yorker*, 2012.

Gutierrez, German and Thomas Philippon, "Declining Competition and Investment in the U.S.," *NBER Working Paper No. 23583*, 2017.

__ and __ , "Fading Stars," *NBER Working Paper No. 25529*, 2019.

Haskel, Jonathan and Stian Westlake, *Capitalism without Capital: The Rise of the Intangible Economy*, Princeton University Press, 2017.

Hobijn, Bart and Boyan Jovanovic, "The Information-Technology Revolution and the Stock Market: Evidence," *American Economic Review*, 2001, *91* (5), 1203–1220.

Holmes, Thomas J., "The Diffusion of Wal-Mart and Economies of Density," *Econometrica*, 2011, *79* (1), 253–302.

Hopenhayn, Hugo, Julian Neira, and Rish Singhania, "From Population Growth to Firm Demographics: Implications for Concentration, Entrepreneurship and the Labor Share," *NBER Working Papers No. 25382*, 2018.

Hortaçsu, Ali and Chad Syverson, "The Ongoing Evolution of US Retail: A Format Tug-of-War," *Journal of Economic Perspectives*, 2015, *29* (4), 89–112.

Karabarbounis, Loukas and Brent Neiman, "Accounting for Factorless Income," *NBER Working Papers No. 24404*, 2018.

Loecker, Jan De, Jan Eeckhout, and Gabriel Unger, "The Rise of Market Power and the Macroeconomic Implications," *Working Paper*, 2018.

Rajan, Raghuram and Julie Wulf, "The Flattening Firm: Evidence from Panel Data on the Changing Nature of Corporate Hierarchies," *The Review of Economics and Statistics*, 2006, *88* (4), 759–773.

Ramondo, Natalia, "A quantitative approach to multinational production," *Journal of International Economics*, 2014, *93* (1), 108 – 122.

Rosenberg, Nathan and Manuel Trajtenberg, "A General-Purpose Technology at Work: The Corliss Steam Engine in the Late-Nineteenth-Century United States," *The Journal of Economic History*, 2004, *64* (1), 61–99.

Rossi-Hansberg, Esteban, Pierre-Daniel Sarte, and Nicholas Trachter, "Diverging Trends in National and Local Concentration," *NBER Working Papers No. 25418*, 2018.

Sutton, John, *Sunk Costs and Market Structure: Price Competition, Advertising, and the Evolution of Concentration*, MIT Press, 1991.

Syverson, Chad, "Macroeconomics and Market Power: Facts, Potential Explanations and Open Questions," 2019.

Traina, James, "Is Aggregate Market Power Increasing? Production Trends Using Financial Statements," *New Working Paper Series No. 17*, 2018.