Teresa C. Fort
Research Statement
May 2024

Overview

I study how firms organize their production across space and firm boundaries, and the effects of these decisions on a broad range of outcomes, such as productivity, welfare, and innovation. I relate technological improvements, labor cost differences, and reductions in trade barriers to fragmentation of production within and across countries. I show that this fragmentation raises domestic productivity and welfare, and induces reallocation towards knowledge-intensive occupations and industries. My work therefore links increased economic integration with low-wage countries to high-income countries' shift into innovation-related activities. It also suggests that production fragmentation has the potential to increase innovation as firms and locations specialize in design stages.

My research centers on analyzing firms' decisions, which I study using detailed micro-data. I have made several contributions to the US Census Bureau's data infrastructure, including developing methods and code employed in the production of widely used confidential datasets available to other researchers through the US Federal Statistical Research Data Centers.

Firms' Global Production Decisions

Production patterns have changed significantly over the last several decades, with firms performing different stages in distinct geographic locations that often span multiple countries. In [1], I exploit new US micro-data to provide some of the first evidence demonstrating how improvements in communication technology facilitate this fragmentation. I find that US manufacturing plants are more likely to contract for manufacturing from other plants when they use electronic networks to control or coordinate their shipments.[1] I focus on identifying a specific causal channel for this relationship: technology's potential to lower coordination costs. In line with this mechanism, I find that plant use of technology facilitates fragmentation disproportionately more in industries whose production specifications are easier to codify in an electronic format. This result contrasts with the assumption in many offshoring models that all industries benefit equally from technological improvements and suggests instead that fragmentation will evolve differently across sectors. I also find that technology's impact on offshoring is increasing in supplier human capital. These results suggest that low-human capital countries may be excluded from global value chains to the extent that their labor supply is not equipped to work in the types of firms and industries for which technology lowers coordination costs.

Firms' global sourcing decisions may affect industry productivity and welfare. In [2], my coauthors and I study firms' decisions to import inputs from many potential countries. We first provide new facts on US firms' imports that suggest firms incur substantial and heterogeneous country-level fixed costs to source inputs abroad. In such an environment, a firm's sourcing decisions are interdependent across markets, since importing from one country reduces a firm's marginal costs thereby affecting the optimality of importing from another country. Determining the optimal set of countries from which a firm sources inputs is thus a large combinatorial problem, which had not been solved by prior papers.[2] We next provide a simple theoretical condition under which importing inputs from one country is complementary to importing from other countries.

---

[1] Electronic networks include the internet, an electronic data interchange, or other online system.

[2] The firm's problem entails 2^N possible choices, where N is the number of countries from which a firm might source.

Finally, we present evidence that this condition holds for US manufacturers and adapt an iterative algorithm from the industrial organization literature to solve for firms' sourcing decisions. A counterfactual analysis designed to match China's integration into global markets predicts falling US prices and higher productivity as US importers from China lower their costs, increase their input purchases from the US and third markets, and expand. We provide supporting causal evidence of these mechanisms, which highlight additional reallocation across firms (relative to standard export models) from trade liberalization when source countries are complementary.

In the paper above, we assumed that firms only produce final goods in the United States. However, US manufacturers with foreign plants dominate trade flows, so interdependencies across their plants' import and export decisions may affect aggregate responses to trade policy. In [3] and [4], my coauthors and I extend our framework on foreign sourcing by allowing firms to export to new markets and, most importantly, to open foreign assembly plants. We first exploit a novel dataset to show that US multinationals are more likely to trade not only with countries in which they operate manufacturing plants, but also with countries that are proximate to – in terms of geographic distance and lower bilateral trade costs – the countries in which they manufacture. These facts are at odds with canonical models of export-platform foreign direct investment in which production locations are substitutes. We develop a new framework in which firms incur country-level fixed costs that are shared across all their manufacturing plants to source inputs from, or sell products in, particular markets. These shared fixed costs deliver predictions in line with our new facts and have distinct implications for the effects of trade policy. For example, we show that a bilateral trade agreement that induces new multinational production may in turn generate increased trade with third markets. Such trade creation differs from the standard trade diversion effects in past work and illustrates the importance of global production networks when analyzing trade wars or other forms of trade cost changes (such as Covid or the Ukraine War).

Global Production and Trade Policy

The rising importance of production fragmentation raises new questions about optimal trade policy. Real-world tariffs are systematically higher on final goods than inputs. However, existing theory does not show that this "tariff escalation" maximizes welfare and instead finds that optimal tariffs are uniform across sectors of differentiated goods (even when they feature input-output linkages). In [5], my co-authors and I show that increasing returns to scale in final-good production generates a welfare-maximizing motive for relatively higher final-good tariffs. We study environments in which inputs and final goods are both tradable and produced under increasing returns to scale. The key distinction in our vertical model is that the social planner faces an open-economy tradeoff between exporting inputs directly versus embodying them in final goods that are then exported. Since the inputs are produced in either case, the extent of increasing returns to scale for inputs is irrelevant in this choice. By contrast, increasing returns to scale in final-good production creates an incentive to export more inputs embodied in final goods, since doing so raises the final-good sector's efficiency. We show that the planner can use a final-good tariff to internalize these benefits and achieve the first-best welfare allocation, whereas an input tariff is never sufficient. In second-best settings in which import tariffs are the only available instruments, this asymmetry continues to motivate relatively higher final-good tariffs. We show that tariff escalation is optimal in the second-best whenever the degree of increasing returns to scale for final goods is at least as large as that for inputs, as well when inputs are sufficiently important in final-good production. Production fragmentation thus changes the effects of trade policy on welfare, highlighting the importance of including these firm-level decisions in policy debates.

Globalization and US Manufacturing

My research into how firms fragment production across country and firm boundaries changes our understanding of the US manufacturing sector's response to globalization and its overall health. A large body of work links increased Chinese imports to reductions in US manufacturing employment, and this is often cited as evidence that globalization has destroyed much of the sector. I show that US manufacturers have instead evolved by reallocating employment to different US regions and expanding into related service sectors.

In [6], my co-authors and I use the long time-series of US establishment- and firm-level data to provide new perspectives on the decline in US manufacturing employment.[3] We show that the majority (75 percent) of the employment decline from 1977 to 2012 occurs in continuing firms, predominantly as these firms shut down manufacturing plants. Although net firm death comprises only a quarter of the total decline, it is concentrated in just two regions – New England and the Mid-Atlantic. By contrast, other regions experienced considerable manufacturing job loss but without losing the entire firm. Moreover, continuing firms in these areas opened non-manufacturing establishments, particularly in retail and business services. Indeed, these firms' non-manufacturing employment growth more than offset all the manufacturing employment declines over the period. These patterns point to a key role for firms in mediating reallocation across industries and space. They also demonstrate that focusing exclusively on manufacturing plants may miss manufacturing firms' activities in product design and distribution, which actually grew over the period.

Focusing on these pre- and post-production activities, my research advances the literature by documenting the existence and rise of "factoryless-goods producers". A factoryless-goods producer is a firm that contracts for all of its physical transformation activities from other domestic or foreign firms, while focusing on innovation and marketing. For example, Apple is deeply involved in manufacturing physical goods, but does so by means of third-party contract manufacturing suppliers primarily in foreign countries. Similarly, Nike reports 640 manufacturing locations across 38 countries, all of which involve outsourced relationships with contract manufacturers. Because these firms do not manufacture inhouse, they are missing from most empirical trade studies. In [7], my coauthor and I show that factoryless-goods production represents a significant portion of aggregate activity. We estimate that reclassifying wholesale factoryless-goods producers into manufacturing would have increased reported manufacturing employment between 4.0 – 9.0 percent in 2002 and 3.2 – 14.4 percent in 2007 (a change the US Census Bureau considered at the time). In [8], we show that factoryless-goods producers in 2007 pay higher wages, but are on average *younger* than traditional wholesalers. In addition, the subset of these factoryless-goods producers present in 1992 was more heavily involved in manufacturing activity in the past than traditional wholesalers. In [9] I show that factoryless-goods producers are more likely to design goods than traditional wholesale firms, and particularly so if they source from foreign suppliers. The rise of factoryless-goods producers and transition by manufacturing firms into this new form of production suggests that the US has maintained manufacturing-related capabilities in higher value-added production stages, such as R&D and marketing, even as it employs fewer workers to perform physical transformation activities.

In 2022, the *Journal of Economic Perspectives* invited me to propose an article with new results on how global supply chains are changing the nature of the firm. In [10], I provide a comprehensive analysis of US manufacturing and its interaction with global value chains. Building on my research on US multinational firms and factoryless-good producers, I document two facts

[3] We also show that some of the same sectors that experienced large employment declines and increased Chinese imports concurrently experienced significant gains in their real value added.

about how US firms fragment their production across firm and country boundaries. First, I exploit newly merged data on the universe of all US firms that manufacture inhouse anywhere in the world. Contrary to the fear that US multinationals have offshored most manufacturing jobs, I show that almost all US firms that own foreign manufacturing plants in 2007 maintain domestic production; moreover, manufacturing comprises their primary US activity. Second, I construct a new dataset to identify factoryless-goods producers in 2017 that design and distribute goods, but contract for physical manufacturing stages from other firms. I find that these factoryless-goods producers are a relatively new type of firm organization that is increasingly reliant on low-wage imports. The divergence between these two firm types indicates that when firms maintain manufacturing within their firm boundary, they also maintain a substantial presence of those activities within their home country; by contrast, when firms outsource manufacturing to other firms, they are increasingly likely to source offshore. Despite these differences, both firm types are relatively import-intensive and employ disproportionately high shares of US knowledge workers, suggesting that US firms leverage domestic knowledge creation using low-wage foreign labor.

Global Production and Innovation

I study the relationship between global production sharing and innovation more directly in [11]. My coauthors and I exploit a novel offshoring survey and matched employer-employee data to study how Danish firms' decisions to relocate production affect their domestic activities. We find that between 2001 and 2006, Danish firms primarily offshored to the Eastern European countries that became members of the European Union in that period, as well as to China. Although firms increased their imports of the same goods they produced domestically after such offshoring, the value of their domestic production did not fall. Instead, and in contrast to predictions from canonical offshoring models, offshoring firms sourced low-price varieties from low-wage countries, while maintaining production of high-priced varieties at home. Firms' reallocation of production across countries was accompanied by reallocation of their domestic workforce. Firms with increased offshoring opportunities in Eastern Europe shed production workers, but increased both the shares and levels of employment in technology occupations. These gains in technology occupations have not been documented in past work and highlight the possibility for offshoring to encourage innovation.

The fact that Danish firms continue domestic production of high-price varieties after importing low-price varieties from low-wage countries echoes the evidence in [3] and [10] that shows US multinationals import the same goods they manufacture at home. The detailed Danish data rule out multi-product firms as an explanation for this pattern and instead suggest that firms produce vertically differentiated varieties of similar goods across countries. Firms' continued domestic production after offshoring also points to benefits of colocating some manufacturing activity with R&D. Indeed, the Danish pump manufacturer Grundfos opened two new production plants in Hungary in 2000 and 2001, while it focused development and production of pumps with new digital monitoring systems in Denmark.

In working paper [12], my coauthors and I study whether firms patent more effectively when their manufacturing and innovation plants are proximate. Using data on the geographic distribution of US firms' US plants and patenting over time, we study how firm and country boundaries relate to patenting. Although the average distance between a firm's manufacturing and innovation plants is large and grows over time, the median firm has a minimum distance between such plants that ranges from just 3 to 6 miles from 1977 to 2012. Consistent with this colocation increasing patenting efficiency, we also find that firms patent relatively more when their manufacturing and innovation plants are within 5 miles of each other. We are revising this paper to study whether firm patenting

occurs in colocated commuting zones, to exploit plausibly exogenous variation in R&D tax credits to assess whether colocation affects the elasticity of patenting to R&D, and to evaluate whether colocation benefits may exist across firm boundaries. The latter is especially relevant for analyzing the potential for industrial policy to improve US innovation; for example, there could be benefits to subsidizing US manufacturing firms if they raise the innovative efficiency of neighboring firms.

Firm Heterogeneity and Dynamics

My research also advances the literature on how firm heterogeneity influences aggregate responses to shocks. In [13], my coauthors and I make two contributions to a long-standing debate about how firms of different size respond to aggregate macroeconomic shocks. First, we introduce a key distinction between firm size and age and show that young/small businesses are more sensitive to the cycle than older/larger businesses. Second, we show that young/small businesses were hit especially hard in the Great Recession, and that the collapse in housing prices over that period accounts for a significant part of their decline. Our results hold using a panel vector autoregression to control for changes in national and local business cycle conditions. Since small/young firms rely on home equity for financing, these patterns suggest that housing price shocks affect young/small firms through a collateral channel. More generally, our paper demonstrates a key role for firm heterogeneity in mediating aggregate responses to changing macroeconomic conditions.

In current working paper [14], my coauthors and I study how US manufacturing firms have transformed themselves over the last four decades. We show that a small set of continuing manufacturing firms has transitioned from a focus on physical transformation tasks towards more knowledge-intensive pre-production tasks, such as R&D, Engineering, and Computer Systems Design. These patterns suggest that firms are not simply a collection of random productivity draws across sectors, but instead accumulate knowledge in particular manufacturing industries that they redeploy in related non-manufacturing activities in response to shocks. We identify dedicated inhouse service establishments as a new measure of this accumulated expertise and show that it plays a key role in mediating firm-level responses to changes in their output and input prices. Firms with these inhouse knowledge inputs are the only ones that increase their non-manufacturing employment and sales when China gains market share abroad in their inputs after its 2001 accession to the World Trade Organization. Our findings indicate that firms' accumulated knowledge is a key determinant of how they respond to shocks and provide a new link between increased integration with low-wage countries and the US transition towards knowledge-intensive service inputs.

To pursue my current focus on the effects of firms' global production decisions on innovation, I am also studying the interaction between firm dynamics and innovation in [15]. I have work-in-progress with coauthors in which we link the universe of the Longitudinal Business Database to the US Patent Office data on all patent applications and grants from 1977 to 2022. We use the new data to revisit the question about whether ideas are getting harder to find. Recent work argues that declining aggregate productivity can be explained by declining researcher efficiency. Our contribution is to develop new measures of R&D inputs available for all US firms, document the relationship between various measures of R&D inputs and patenting output across firm types and over time, and examine the link between patenting output and productivity growth. In contrast to past work, we find that ideas do not seem to be harder to find, though valuable ideas may be getting rarer.

Contributions to US Census Bureau Data Products

I have made three significant contributions to US microdata on firms and establishments. First, I developed the method and code to assign a consistent industry code to every private, non-farm employer establishment in the United States from 1977 to the present. In [16], my coauthor and I explain the transition from the Standard Industrial Classification to the North American Industrial Classification System (NAICS), the implications of this transition for measures of aggregate activity, and our method to assign all US establishments a consistent NAICS code. In [17], we describe how these codes are integrated into the Longitudinal Business Database. The LBD is used to produce the Census Bureau's Business Dynamics Database and has been requested by 280 individual research projects using Census micro data since 2001.

Second, I helped develop the method and code to merge the Bureau of Economic Analysis data on multinational enterprises to the US Census Bureau's firm and establishment datasets. These concordances are available to researchers through the Federal Statistical Research Data Centers.

Third, my coauthors and I have developed a new concordance between the US Census firm data and the US Patent Office data on US patent applications and grants. Ours is the first bridge to span the entire time period (1977 to present) and ensure longitudinal validity in the matches. This bridge is being used to produce a new Census data product for the Business Dynamics Statistics on patenting firms and will be available to researchers through the Federal Statistical Research Data Centers in 2025.

I have also contributed to public data infrastructure by providing a user-friendly panel of the Census Bureau's public County Business Patterns Database with employment imputations for all the suppressed cells. In [18], my coauthors and I describe a new algorithm to impute suppressed values and our method to concord the data to a vintage-consistent industry code. We are currently calculating standard measures of industry agglomeration for manufacturing and extending these measures to services. The *Journal of Urban Economics* has expressed interest in this work.

Summary and Future Work

A unifying theme that emerges from my research is that developed-country firms leverage domestic knowledge workers by exploiting low-wage manufacturing locations to produce their goods. While some firms produce vertically differentiated varieties of similar goods across countries, others outsource all their manufacturing to third parties.

I am most excited by the fact that both types of these globally integrated 'manufacturing' firms are disproportionately involved in innovation. In future work, I plan to study the role of global production sharing in both the creation and diffusion of knowledge across countries. To do so, I am developing a new proposal to use employee-employer data on US firms and workers in conjunction with my newly linked data on US patents and inventors. I intend to study the role of the firm in accumulating expertise via worker and inventor teams, the extent to which knowledge travels farther within firm boundaries both within and across countries, and how firms' global activities interact with changes in their domestic innovation efficiency and output.

REFERENCES

1. "Technology and Production Fragmentation: Domestic versus Foreign Sourcing"
Review of Economic Studies, 2017. 84(2): 650-687.

2. "The Margins of Global Sourcing: Theory and Evidence from US Firms"
American Economic Review, 2017. 107(9): 2514-64. (with Pol Antràs and Felix Tintelnot)

3. "Exporting, Global Sourcing, and Multinational Activity: Theory and Evidence from the United States" ***The Review of Economics and Statistics,*** forthcoming. (with Pol Antràs, Evgenii Fadeev, and Felix Tintelnot)

4. "Export-Platform FDI: Cannibalization or Complementarity?"
American Economic Association Papers and Proceedings, 2024. 114:130-135. (with Pol Antràs, Evgenii Fadeev, and Felix Tintelnot)

5. "Trade Policy and Global Sourcing: An Efficiency Rationale for Tariff Escalation"
Journal of Political Economy Macroeconomics, 2024. 2(1):1-44. (with Pol Antràs, Agustín Gutiérrez, and Felix Tintelnot)

6. "New Perspectives on the Decline of US Manufacturing Employment"
Journal of Economic Perspectives, 2018. 32(2): 47-72. (with Justin R. Pierce and Peter K. Schott)
Featured in the *Financial Times* (1/2019) and *The Economist* (11/2022)

7. "Factoryless Goods Producers in the US"
In Lionel Fontagne and Ann Harrison (eds.), The Factory-Free Economy (chapter 5). Oxford University Press, 2017. Featured in the *Washington Post*'s Wonkblog (9/ 2013) and the *Wall Street Journal* (3/2014). (with Andrew Bernard)

8. "Factoryless Goods Producing Firms"
American Economic Review: Papers & Proceedings, 2015, 105(5): 518-23. (with Andrew Bernard)

9. Comment on Fariha Kamal's "A Portrait of US Factoryless Goods Producers," in "Challenges of Globalization in the Measurement of National Accounts," National Bureau of Economic Research, Nadim Ahmad and Brent Moulton and J. David Richardson and Peter van de Ven eds., p. 447-450. University of Chicago Press, 2019.

10. "The Changing Firm and Country Boundaries of US Manufacturers in Global Value Chains"
Journal of Economic Perspectives, 2023. 37(1): 31-58.

11. "Heterogeneous Globalization: Offshoring and Reorganization"
January 2024. NBER Working Paper 26854. (with Andrew Bernard, Valerie Smeets, and Frederic Warzynski) Featured in *Bloomberg* (5/2019)
Revision Requested by ***The Review of Economics and Statistics***

12. "Colocation of R&D and Production: Evidence from the United States"
December 2020. (with Wolfgang Keller, Peter K. Schott, Stephen Yeaple, and Nikolas Zolas)
Featured in *The Economist* (11/2022)

13. "How Firms Respond to Business Cycles: The Role of Firm Age and Firm Size"
IMF Economic Review, 2013, 61, p. 520-559. (with John Haltiwanger, Ron Jarmin and Javier Miranda)
Featured in *The NBER Digest* (10/2013) and *International Business Times* (03/2016)

14. "Structural Change Within Versus Across Firms: Evidence from the United States"
May 2022. NBER Working Paper 30127. (with Xiang Ding, Stephen J. Redding, and Peter K. Schott)

15. "Are Ideas Getting Harder to Find, or Just Less Valuable?" (with Nathan Goldschlag, Jack Liang, Peter K. Schott, and Nikolas Zolas), *In Progress*.

16. "The Effects of Industry Classification Changes on US Employment Composition"
2018. CES Working Paper 18-28. (with Shawn Klimek)

17. "Redesigning the Longitudinal Business Database"
May 2021. CES Working Paper 21-08. (with Melissa Chow, Christopher Goetz, Nathan Goldschlag, James Lawrence, Elisabeth Ruth Perlman, Martha Stinson, and T. Kirk White)

18. "Imputing Missing Values in the US Census Bureau's County Business Patterns"
January 2021. NBER Working Paper 26632. (with Fabian Eckert, Peter K. Schott, and Natalie Yang)

19. National Academy of Sciences, Engineering, and Medicine. 2021. "A Satellite Account to Measure the Retail Transformation: Organizational, Conceptual, and Data Foundations." Washington D.C.: *The National Academies Press*. (with J. S. Landefeld, C. Corrado, G. Duncan, J. Haltiwanger, D. Jorgensen, M. Mandel, K. McConville, L. Nakamura, W. Yung).