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THE CHANGING FIRM AND COUNTRY BOUNDARIES OF US MANUFACTURERS IN GLOBAL VALUE CHAINS

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ABSTRACT

This paper documents how US firms organize goods production across firm and country boundaries. Most US firms that perform physical transformation tasks in-house using foreign manufacturing plants in 2007 also own US manufacturing plants; moreover manufacturing comprises their main domestic activity. By contrast, "factoryless goods producers" outsource all physical transformation tasks to arm's-length contractors, focusing their in-house efforts on design and marketing. This distinct firm type is missing from standard analyses of manufacturing, growing in importance, and increasingly reliant on foreign suppliers. Physical transformation "within-the-firm" thus coincides with substantial physical transformation "within-the-country," whereas its performance "outside-the-firm" often also implies "outside-the-country." Despite these differences, factoryless goods producers and firms with foreign and domestic manufacturing plants both employ relatively high shares of US knowledge workers. These patterns call for new models and data to capture the potential for foreign production to support domestic innovation, which US firms leverage around the world.

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A data appendix is available at http://www.nber.org/data-appendix/w31319

1 Introduction

There are two main concerns about US manufacturing and globalization: the loss of US jobs to foreign places and the loss of a US knowledge base connected to manufacturing. In this paper, I document the full range of US manufacturing firms' domestic and global operations, providing a broader context for these concerns.

My perspective emphasizes that manufacturing involves three major stages: 1) product design and innovation; 2) a series of physical transformation activities, such as making inputs and assembling them; and 3) sales, marketing, and distribution. Most trade models implicitly (or even explicitly) include all three stages, but government statistics only classify physical transformation tasks as manufacturing. This mismatch from theory to data was not problematic when all three stages were performed inside a particular firm and country. However, dramatic improvements in information and communication technology have made it increasingly possible to fragment these stages across multiple countries and firms. This fragmentation has made measuring the complete production process for manufactured goods difficult (or even impossible) with traditional datasets.

Figure 1 illustrates a firm's choices to fragment production across countries and firms, building on a diagram introduced by Feenstra (2010). The horizontal axis captures the firm boundary decision for physical transformation tasks: the firm may "outsource" tasks to other firms, or maintain integrated production. The vertical axis captures the firm's location choice for these tasks: the firm may "offshore" by locating production in one or more foreign countries, or produce domestically.

A US firm with manufacturing plants in the United States necessarily occupies quadrant 1, since it performs physical transformation tasks in-house. A firm that owns foreign manufacturing plants occupies quadrant 3. However, a single firm may occupy multiple quadrants. For example, consider Texas Instruments, a US semiconductor manufacturer that owns and operates multiple wafer fabs in the United States, along with 11 other production sites in Mexico, Europe, and Asia. The Ford Motor Company has 30 manufacturing plants, 20 of which are in foreign countries. Since these firms manufacture in-house in the United States and abroad, they span quadrants 1 and 3. Both Texas Instruments and Ford also work extensively with arm's-length partners, such that they also span quadrants 2 and 4, thus covering the entire matrix.[1]

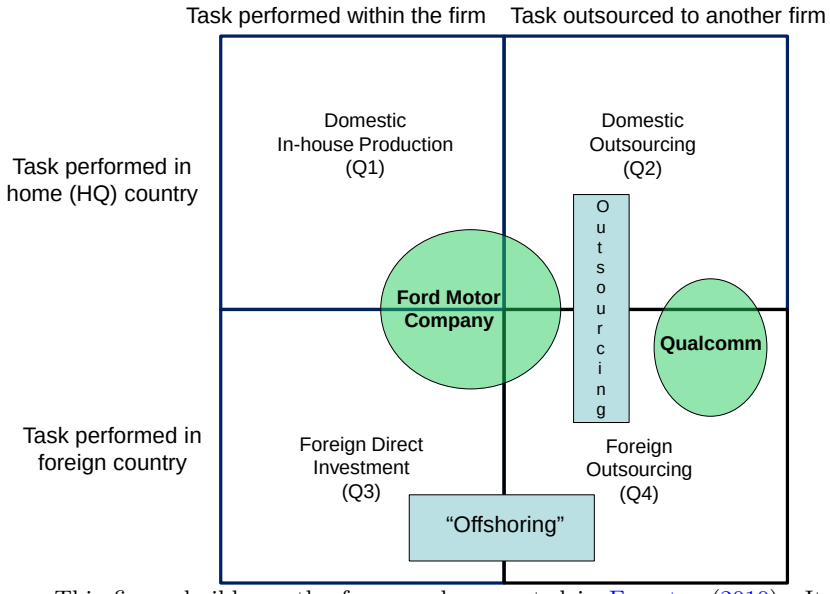
In contrast to firms that perform physical transformation tasks in-house, a "factoryless goods producer" is a firm that contracts for *all* of its physical transformation activities, and as such occupies only quadrants 2 and/or 4, depending on whether its suppliers are domestic, foreign, or both. For example, Apple is deeply involved in manufacturing physical goods, but does so via 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. Qualcomm is one of many "fabless" semiconductor firms that design chips and rely on predominantly Korean and Taiwanese contract manufacturers for their production; indeed, Ba-

[1] See https://www.ti.com/about-ti/company/ti-at-a-glance/manufacturing.html for TI plants, https://www.ti.com/about-ti/suppliers/supplier-portal.html?keyMatch=SUPPLIERS for TI supplier portal, https://corporate.ford.com/operations/locations/global-plants.html for Ford plants, and https://fsp.portal.covisint.com/web/portal for the Ford Supplier Portal.

yard et al. (2015) attribute 25 percent of global semiconductor sales in 2012 to such factoryless goods producers.[2]

It is worth clarifying that fragmenting production does not just refer to purchasing inputs. For example, a Belgian candy-maker's imports of chocolate are generally not considered fragmented production in studies on outsourcing and offshoring. Instead, fragmented production entails a splitting apart of the production process by a firm that used to, or could reasonably have, produced the fragmented part.

Figure 1: Firm integration and location decisions for physical transformation tasks



Source: This figure builds on the framework presented in Feenstra (2010). It depicts the firm (horizontal axis) and country (vertical axis) boundary decisions made by firms involved in the broader manufacturing process for the stage 2, physical transformation tasks required to manufacture goods.

Firms with no domestic manufacturing plants have no activity in quadrant 1. They tend to be missing from research on production fragmentation and offshoring, because there is no clear way in standard datasets to identify their direct involvement in manufacturing. In the paper, I begin by describing the limitations of standard datasets in identifying such firms. I then exploit two novel US data sources to identify two organizational forms missing from many analyses on global value chains: US firms that perform physical transformation tasks within the firm boundary using exclusively foreign manufacturing plants, and factoryless goods producers that outsource all their physical transformation tasks to arm's-length contract manufacturers.

Contrary to the fear that US multinationals have offshored most of their jobs, I find that the vast majority of US firms that own foreign manufacturing plants in 2007 also maintain domestic production; moreover, manufacturing comprises their primary domestic activity. Contrary to the fear that participation in global value chains entails a loss of technological skills, I find that firms

[2]For Apple, see https://www.wsj.com/articles/BL-DGB-25630; for Nike, see https://manufacturingmap.nikeinc.com/#; and for Qualcomm, see https://www.qualcomm.com/company/corporate-responsibility/acting-responsibly/sustainable-product-design/supply-chain.

with global in-house manufacturing plants and factoryless goods producers both employ relatively high shares of US 'knowledge' workers. Indeed, multinational enterprises that manufacture goods are disproportionate contributors to R&D and patenting, and factoryless goods producers are far more likely to design goods than other firms in their sector, and have also been linked to greater R&D, patenting, and trademarks (Kamal, 2020).

A complete picture of US firms' involvement in global value chains is necessary to understand the effects of globalization. Take for example Berman et al. (1994), who ruled out trade as an explanation for the shift towards non-production workers in US manufacturing plants during the 1980s and 1990s because those changes occurred in some of the same industries with surging imports, notably computer and electronics. They reasoned that a trade explanation must entail reallocation across industries consistent with US comparative advantage, whereas within-industry adjustments dominated in the data. We now know, however, that computer and electronic manufacturing is one of the first industries in which factoryless good production arose, as some firms focused on innovation and shifted physical production to foreign suppliers. It is notable that computer and electronics also accounts for the greatest growth in breakthrough patents over the last two decades (Kelly et al., 2021) and the majority of real value added growth in US manufacturing from 1992 to 2011, even as imports of computers and electronics surged (Fort et al., 2017).

I conclude with a discussion on how trade statistics and theory need to expand to capture the realities of goods production across firm and country boundaries. These activities affect our understanding of trade and foreign direct investment, as well as aggregate measures of domestic value added and GDP. The potential implications are far-reaching: increased specialization within the production of a particular industry or good provides additional gains from trade (Jones and Kierzkowski, 2001). When such specialization entails reallocation into early production stages, such as design and innovation, offshoring can even lead to dynamic gains, as the returns to innovation rise, inducing growth in R&D and ideas that beget more ideas (Grossman and Helpman, 1991; Rodríguez-Clare, 2010).

2 Measuring the Range of Manufacturers' Organizational Forms

The traditional data on manufacturing firms collected by US statistical agencies make it difficult to capture firms that are involved in the manufacturing process either by producing goods exclusively outside the United States, exclusively outside their firm boundaries via contracts, or both. I review the existing data on US establishments and firms, on international trade by firms, and on multinational firms, explaining the benefits and limitations of each data source.

2.1 Standard Measures of US Establishments and Firms

The Census Bureau defines an "establishment" as a physical location at which employment and payroll records are kept. A firm can thus have multiple establishments – and these establishments need not be classified in the same industry.

The US Census Bureau constructs the Longitudinal Business Database, which is a comprehensive, establishment-level dataset of all private, non-farm employer establishments from 1976 to 2019. The

dataset provides employment, payroll, location, and a unique industry code for the primary activity of every establishment (see Jarmin and Miranda, 2002; Chow et al., 2021, for details). All employees of an establishment are assigned to its industry. The data also identify the firm to which each establishment belongs, making it possible to measure the full range of a firm's activities across industries and sectors.

The Longitudinal Business Database can be merged to the Economic Censuses, which are collected in years that end in 2 or 7. These censuses contain detailed information on establishment sales, input use, and other sector-specific metrics, such as technology.

An establishment's industry is the primary means that government agencies and researchers use to identify manufacturing activity. US statistical agencies use the North American Industry Classification System, commonly referred to as NAICS (and described at https://www.census.gov/naics) to classify establishments. The guiding principle of NAICS is to assign an industry code to an establishment based on the main activities performed by its employees. By contrast, the Standard Industrial Classification System (SIC) classified establishments that provided support services for other establishments of their firm to those establishments' industry. For example, an R&D lab is always in Services under NAICS, but would have been classified in manufacturing under SIC if its R&D was to support the firm's manufacturing plants. US Census data transitioned from NAICS to SIC between 1997 to 2002, a period that coincides with China's entry to the World Trade Organization, making this issue particularly relevant for research on globalization. The current Longitudinal Business Database now includes the most recent vintage of NAICS codes for every establishment over the entire period using the methods developed in Fort and Klimek (2018).

Factoryless goods producers are hard to identify with these data. To be classified in manufacturing, an establishment must perform 'mechanical, physical, or chemical transformation of materials or components into new products'. As a result, an establishment that contracts for manufacturing services will generally be classified in non-manufacturing sectors, such as wholesale trade.[3] Similarly, establishments that perform support activities for manufacturing, such as an R&D lab or an Engineering services establishment are classified in services. Given the ongoing fragmentation of design and production, we need ways to identify establishments and firms involved in the broader manufacturing process.

2.2 Merchandise Trade Data by Firm

Starting in 1992, the Census firm data can be merged to firm-level data from US Customs that record the universe of trade transactions above $2,500 of merchandise goods that enter or leave the United States. This Longitudinal Firm Trade Transactions Database (LFTTD) provides detailed information on the products shipped, as well as the source (for imports) or destination (for exports). These data were first linked by Bernard et al. (2009); Kamal and Ouyang (2020) provide details on the latest linking efforts.

One unique feature of these US trade data is that they contain an identifier for transactions

[3]For an explanation from the Census Bureau, see https://www.census.gov/naics/?input=31&year=2022&details=31. An exception is 'jobbers' in certain apparel manufacturing industries. These establishments perform the 'entrepreneurial functions involved in apparel manufacturing,' but contract for the transformation activities from other firms.

between related parties. Export transactions in which one of the parties has at least 10 percent ownership of the other party, or imports between parties with a 5 percent ownership threshold are flagged as "related-party" transactions.[4] Thus, arm's-length trade can be distinguished from flows between related parties. However, for the present purpose of studying whether US firms have integrated manufacturing plants in foreign countries, these data have well-known shortcomings; they have no information on activities of affiliates of multinational enterprises; they do not distinguish US multinational enterprises from foreign-owned firms; and they are based on very low ownership thresholds.

2.3 Multinational Firms in the United States

The US Bureau of Economic Analysis carries out the Annual Survey of US Direct Investment Abroad, known as BE-11, which provides information on all US-based firms' outward foreign affiliate employment, local sales, sales back to the United States (and whether these are intra-firm), and sales to third markets, by the affiliate country and industry. This survey thus captures *outward* foreign direct investment information. The Bureau of Economic Analysis also carries out the Benchmark Survey of Foreign Direct Investment in the United States, known as BE-12, which is conducted every five years and provides *inward* foreign direct investment. This survey makes it possible to identify foreign-owned firms operating in the United States.

For 2007, the year of my analysis, these two surveys provide the most detailed and comprehensive information available about multinational firms operating in the United States. In contrast to the Census Bureau's related-party trade data, these data include share-of-ownership information, as well as foreign affiliates' industries, and their local, US, and third-market sales.

Despite their advantages, these data alone are not sufficient to study the full range of US firms' manufacturing activities. First, these data only include multinationals so there is no information on domestic manufacturers. Second, they are reported at the firm level, and therefore do not contain the establishment-level information necessary to analyze the full range of firms' domestic establishments. Finally, the data lack country and product-level information on the universe of firms' imports and exports.

In the next section, I combine the 2007 US Census Bureau and Bureau of Economic Analysis data described here to identify all US firms with integrated manufacturing plants anywhere in the world. Such an analysis ensures coverage of all firms with any activity in quadrants 1 or 3 of Figure 1. In the subsequent section, I exploit detailed questions from the 2017 Economic Census of Wholesale Trade to identify firms that are involved in the broader manufacturing process by contracting for production from arm-s-length suppliers, thus capturing firms specialized in quadrants 2 and/or 4.

3 Country Boundaries of Integrated US Manufacturers

In this section, I focus on US firms that are directly involved in manufacturing because they have majority-ownership shares in manufacturing plants in the United States, in foreign countries, or both.

[4] Related-party imports may include other relationships, see Kamal and Ouyang (2020) for details.

As such, these firms necessarily occupy quadrants 1 or 3 of Figure 1. In the next section, I turn to factoryless goods producers such as Apple and Nike.

3.1 Novel Data on all In-house Manufacturing by US Firms

I use new data merged and analyzed by Kamal et al. (2022) and Antràs et al. (2023) to provide a complete picture of US firms that perform physical transformation tasks in-house *anywhere* in the world. A key contribution of my analysis is to include firms with no domestic manufacturing plants, which are missing from studies using traditional datasets. I measure firms' employment, sales, and trade activity across sectors by linking the 2007 Longitudinal Business Database, Economic Censuses, and Longitudinal Firm Trade Transactions Database (excluding trade of minerals, fuels, and oil (HS 27)). I identify multinational enterprises as all US firms with majority-owned foreign affiliates using the "outward" foreign direct investment survey. I use the "inward" survey to remove all US establishments that are majority-owned by a foreign firm.

In 2007, there are 243,700 US firms that own manufacturing plants somewhere in the world (about 5.6 percent of all firms), which account for 88 percent of total US manufacturing employment (foreign multinational enterprises employ the remainder), 20 percent of total employment, and 29 percent of total sales. These firms mediate 42 percent of US imports and 58 percent of exports, which highlights the disproportionate involvement of goods-producing firms in international trade. Appendix Table A.1 provides a more detailed decomposition of these statistics.

3.2 Domestic versus offshored integrated manufacturing

A common perception is that US multinational enterprises have relocated the bulk of their manufacturing plants offshore. To evaluate this claim, I use the new data to categorize all US firms with majority-owned manufacturing plants *anywhere* in the world into four categories: 1) domestic manufacturing firms without any majority-owned foreign affiliates; 2) US multinational enterprises that have only US manufacturing plants (their foreign affiliates are outside manufacturing); 3) US multinational enterprises that have both US and foreign manufacturing plants; and 4) US multinational enterprises that have only foreign manufacturing plants. (All these firm types may also outsource some tasks from domestic or foreign suppliers.)

The first row of Table 1 presents the number of US firms that manufacture in-house in 2007 across these four categories. Of the 243,700 US manufacturing firms, only 1,700 have majority-owned foreign establishments (columns 2 to 4). Among these multinationals, 1,200 firms own US and foreign manufacturing plants, versus 350 firms with just domestic plants, and only 150 firms with exclusively foreign in-house manufacturing. Firms with both domestic and foreign manufacturing plants are thus the most prevalent type of US multinational manufacturing enterprise.

Panel A of Table 1 present total sales for these firms. The first row contains global sales, which are the sum of firms' US and foreign-establishment sales, each of which is presented separately in the next two rows. I include firms' total sales here, regardless of whether they are booked by manufacturing or non-manufacturing establishments.

The sales data deliver two stark messages. First, US firms with both domestic and foreign manu-

Table 1: Sales, employment, and trade flows for all US firms that manufacture in-house

Firm Type: Majority-Owned Manufacturing Plants In:	(1) Domestic US Only	(2) MNE US Only	(3) MNE US & Foreign	(4) MNE Foreign Only
Firms	242,000	350	1,200	150
Panel A: Sales ($billions)				
Global Sales	2,629	1,695	6,710	345
Sales by US Estabs	2,629	1,446	3,853	173
Sales by Foreign Estabs	-	249	2,857	172
Panel B: Employment (thousands)				
Global Employment	11,059	5,338	11,883	732
Employment in US Estabs	11,059	4,349	6,556	361
Employment in Foreign Estabs	-	989	5,327	371
Panel C: US Trade Flows ($billions)				
Imports	126	39	410	12
Arm's-Length	89	33	160	6
Related-Party	37	7	250	6
Exports	123	22	437	3
Arm's-Length	103	16	253	2
Related-Party	19	5	184	1

Source: 2007 Longitudinal Business Database, Economic Censuses, Longitudinal Firm Trade Transactions Database, BEA inward and outward surveys. Table presents total number of firms and their global sales, global employment, and US merchandise good trade flows by firm type and manufacturing plant locations. Sample is all US firms with one or more majority-owned manufacturing plants anywhere in the world.

facturing plants dominate both global and US sales, with global sales of $6.7 trillion – more than the other three categories combined – despite the fact that they are only 1,200 out of the 243,700 firms in the sample. Second, US manufacturers that only produce in-house in foreign plants account for a mere 3 percent US manufacturers' global sales.

The dominance of firms with both US and foreign in-house production is reinforced by firms' employment differences. Panel B shows that transnational manufacturers – those that perform in-house physical transformation activities in the United States and abroad – employ more workers than all other firm types, with just over half of these workers employed at their US plants. Firms that manufacture exclusively in foreign plants employ less than one million workers worldwide and account for just 2.5 percent of all US manufacturing firms' global employment. In short, the notion that US firms moved almost all of their integrated manufacturing plants overseas in response to China's accession to the World Trade Organization in 2001, and then used those plants to serve their US customers, is simply not supported by the 2007 data. Instead, when a firm integrates physical transformation tasks, it also maintains domestic production.

I also assess the importance of manufacturing for these firm types. Table 2 shows that domestic manufacturers are the most specialized in physical transformation tasks, with 69 percent of their sales and employment in manufacturing plants. Firms that manufacture in the United States and abroad have the next highest share, with 57 percent of their global sales and 66 percent of employment in manufacturing plants. By contrast, US multinationals that only manufacture in the United States or abroad have manufacturing sales and employment shares that range from just 8 to 21 percent. Among US multinationals that manufacture goods, physical transformation tasks are thus only a significant activity for those with manufacturing plants both at home and abroad.

Table 2 also shows that the majority of these transnational manufacturers' *US* sales and employment is in manufacturing plants. 55 percent of their US employees work in manufacturing plants, compared to 79 percent of their foreign workers. Their foreign workforce is thus geared more towards production work, but these firms still maintain physical transformation tasks as their primary US activity. Finally, I use the data from Tables 1 and 2 to calculate that transnational manufacturers' US plants account for 55 of their total manufacturing sales and 46 of their global manufacturing employment.

To summarize, even seven years after China's accession to the World Trade Organization, US multinationals that manufacture in-house tend to do so in both the United States and foreign countries, and their US manufacturing plants comprise the majority of their domestic activities. These firms' global manufacturing activities are roughly split across their US and foreign plants, with just over half of their total manufacturing plant sales originating from US establishments and just under half of their manufacturing plant workers located in the United States. These patterns highlight a potential interdependence between the organizational and national boundary decisions of US manufacturers: 'in the firm' also entails a substantial share 'in the home country.'

Table 2: US manufacturers' sales and employment shares by sector and establishment locations

Firm Type: Majority-Owned Manufacturing Plants In:	(1) Domestic US Only	(2) MNE US Only	(3) MNE US & Foreign	(4) MNE Foreign Only
Global Manufacturing Sales/Global Sales	0.69	0.10	0.57	0.07
US Estabs	0.69	0.12	0.54	-
Foreign Estabs	-	-	0.60	0.14
Global Manufacturing Emp/Global Emp	0.69	0.06	0.66	0.11
US Estabs	0.69	0.08	0.55	-
Foreign Estabs	-	-	0.79	0.21
US Professional & Management Emp/US Emp	0.03	0.10	0.19	0.15

Source: 2007 Longitudinal Business Database, Economic Censuses, Longitudinal Firm Trade Transactions Database, BEA inward and outward surveys. Table presents shares of firm sales and employment in manufacturing establishments for all establishments, and by US or foreign establishments. Bottom row presents US establishment employment in Professional, Scientific, and Technical Services (NAICS 54) and Management (NAICS 55) over total US employment. Sample is all US firms with one or more majority-owned manufacturing plants anywhere in the world.

3.3 Relationship between domestic and foreign production

Transnational manufacturers also dominate trade flows. Panel C of Table 1 presents exports and imports for the same four categories of firms. Transnational manufacturers import $410 billion in goods and export $437 billion, which is almost four times the amount of either trade flow for all the other firm categories combined. Their trade dominance is due not only to their size, but also to their disproportionate trade intensity. The ratio of total exports to sales for these firms is 0.10, compared to 0.05 for non-multinational enterprises and 0.01 for US multinational enterprises that only manufacture in the United States.

Recall that the trade data distinguish between intra- and across-firm transactions. Unlike the ownership threshold of at least 50 percent I use to classify the status of multinational enterprises, a "related party" in the trade data denotes exports to partners with a 10 percent ownership threshold, or imports from parties with a 5 percent ownership threshold. As such, it is possible for domestic firms to engage in related-party trade, which they do to some extent. Panel C of Table 1 decomposes imports and exports along these lines and shows that the majority (0.58) of transnational manufacturers' exports go to arm's-length partners. These arm's-length shipments suggest that multinational enterprises' US manufacturing plants also serve foreign customers.

Further insight on the motives for multinationals' US exports can be gained by studying the countries to which they sell. Exploiting the novel country-level trade dimension of these merged data, Antràs et al. (2023) show that US multinationals are much more likely to export not only to the countries in which they have affiliates, but also to countries that are proximate to their affiliates or that share a free trade agreement with them. Those authors use a framework in which firms must incur a fixed cost to sell their goods in a particular country, for example to learn about a country's legal institutions, demand (Foster et al., 2008), or specific customers (Bernard et al., 2022). They

show that when this fixed cost is shared by *all* of the multinational firm's manufacturing plants, a firm's US plants will be more likely to export to markets that are proximate to its affiliates. This tilting arises because countries that are proximate to a foreign affiliate enjoy lower bilateral trade costs with the affiliate, thus increasing the marginal benefit of activating the market.

The same intuition applies to a firm's decision to source inputs. If the country-specific fixed cost to find suppliers and source inputs from a particular country is shared across all of the firm's plants, then firms with domestic and foreign production plants will source from more countries and use more imported inputs. The data indicate that transnational manufacturers are also the most import-intensive, with a ratio of imports to sales of 0.11, which is again more than double the ratio for domestic firms. As for exports, Antràs et al. (2023) show that the number of countries from which US manufacturers' import is increasing in the number of foreign countries in which they manufacture, and that multinationals are more likely to import from countries that are proximate to their foreign production plants.

Of course a transnational manufacturing firm's US imports need not consist solely of inputs. Indeed, Table 1 shows that 61 percent of transnational manufacturers' imports are from related parties, which could be inputs or final goods produced by affiliates. For example, Ford produces SUVs in the United States, but imports its Fiesta from Mexico. I use information from the Census of Manufacturers 'product and material trailer files' to identify goods that the firms' US establishments produce and inputs that they purchase. I compare these goods and inputs to the products firms import (using the Customs data) and find that a significant portion of multinationals' imports consists of the same goods they manufacture in the United States, while another large share appears to be both produced goods and inputs.[5] This overlap, however, may reflect the fact that US trade, input, and production data are all collected using different classification systems and concording across them requires aggregating the data such that we can no longer distinguish an input from an output.

Related evidence from Danish data, however, suggests that a large portion of the apparent overlap at the coarse industry level represents trade of the same goods produced by the firm at home. Using a novel offshoring survey along with detailed production and import data that are collected using the same classification system, Bernard et al. (2023) find that Danish firms grow their imports of the same products they manufacture at home when they relocate production to low-wage countries. (Those authors also show that these imports of domestically produced goods appear also to be inputs when aggregating the data.) The Danish firms continue domestic production of the imported goods, but the domestic varieties have higher unit values that grow after importing begins, consistent with firms producing lower quality or less technologically advanced varieties in lower-wage countries

An interesting venue for future work is to assess whether US manufacturers similarly use their global production plants to produce vertically differentiated products in different countries. This type of vertical differentiation contrasts with the standard 'proximity-concentration' tradeoff at the heart of many models about foreign direct investment, in which a US firm chooses to serve a particular market either via exports or a plant in the foreign market; it may also explain recent evidence that a

[5] Ramondo et al. (2016) use the outward multinational data and find that intrafirm shipments from affiliates to their US parent are rare and do not seem to comprise inputs, though their data lack the full range of a US firm's activities and rely on input-output tables to identify inputs.

US multinational's affiliates in one foreign country do not seem to compete with its affiliates in other countries (Garetto et al., 2019). Perhaps most exciting is the possibility that this 'vertical offshoring' may foster innovation up the quality ladder (e.g., as shown in Braguinsky et al., 2021, for Japan), thus providing a new way in which globalization allows firms to push out the knowledge frontier. Indeed, Bernard et al. (2023) show that Danish firms with new production-cost savings opportunities in Eastern Europe reallocate their domestic workforce into R&D and technology occupations. US firms with an expertise in manufacturing goods may also leverage their domestic design capabilities by manufacturing similar goods across multiple countries.

3.4 Leveraging Knowledge Workers Around the World

To assess the extent to which transnational manufacturers' domestic employment is in 'knowledge-related' activities such as design and marketing, I calculate firms' total employment in establishments classified in Professional, Scientific, and Technical Services (NAICS 54) and Management (NAICS 55). These two sectors capture workers in knowledge-intensive activities, such as research and development, as well as marketing. The last row of Table 2 depicts US manufacturing firms' share of workers in these sectors. Consistent with prior evidence on the importance of multinational enterprises in innovation, the employment shares of US multinationals in these sectors are substantially higher than domestic firm shares. While domestic firms have only 3 percent of their total employment in Professional Services or Management establishments, multinationals' shares range from 10 to 19 percent. US multinationals with both domestic and foreign manufacturing plants have the highest share across all firm types: 19 percent of their employment is in these "knowledge" establishments, consistent with them performing pre- and post-production tasks in the United States and leveraging their expertise to manufacture across multiple countries.

US firms with domestic and foreign manufacturing plants maintain manufacturing as their primary domestic activity. In contrast to canonical models of horizontal foreign direct investment, in which firms serve foreign markets via exports or foreign affiliates, they use their US plants to serve markets that are close to their foreign plants, and ship goods from their foreign plants back to the United States. These patterns, along with evidence from Danish firms, suggest that US firms with integrated global manufacturing have a core competence in manufacturing particular goods that they leverage around the world with support from their US 'knowledge' workers. By contrast, US manufacturers with exclusively foreign manufacturing plants are small in number, employment, sales, and trade flows. "In the firm" goes hand-in-hand with a significant portion also "in the country."

4 New Facts and Patterns on Factoryless Goods Producers

Factoryless goods producers differ from in-house manufacturers because they outsource all physical transformation activities to other firms. Although this type of firm includes examples as prominent as Apple, Nike, and Qualcomm, they are hard – or even impossible – to identify using standard datasets. Because these firms' establishments do not perform physical transformation activities themselves, they are classified in sectors such as Retail, Wholesale, and Professional Services, and generally cannot be

distinguished from other establishments in those sectors that have no involvement with the broader manufacturing process.

Statistical agencies across the world understand the current data limitations and have undertaken significant efforts to measure contract manufacturing and factoryless goods production. The US Census Bureau began asking establishments in the 2002 Census of Wholesale Trade about their involvement in product design and use of contract manufacturing, and continued this practice in the 2007, 2012, and 2017 surveys. In some years, the Census also asked about purchases of contract manufacturing services in some of the Census of Services and in its annual Company Organization Survey sent to large, multi-unit firms. Unfortunately, the questions and samples are sufficiently different across years to make time series analyses infeasible.

In 2010, the US Office of Management's Economic Classification Policy Committee recommended classifying a factoryless goods producer as a firm that "outsources all transformation steps that traditionally have been considered manufacturing, but undertakes all of the entrepreneurial steps and arranges for all required capital, labor, and material inputs required to make a good" (OMB, 2011). Moreover, the committee recommended re-classifying establishments that performed those related tasks into manufacturing for the 2012 Economic Census (Doherty, 2015) to facilitate collection of additional information about use of inputs and sales by product, which are already part of the Census of Manufactures survey questions. However, this proposal was met with strong opposition from the US manufacturing lobby, and the reclassification effort was abandoned.[6] The Census Bureau has continued some of its data collection efforts for identifying factoryless goods producer, which I exploit in this paper.

4.1 Novel Data

I define a factoryless goods producer as a firm with no US manufacturing plants, but that is nevertheless involved in producing goods by contracting for manufacturing from other firms. I obtain data on firms' use of contract manufacturing using the 2017 Census of Wholesale Trade, which is sent to all establishments in the wholesale trade sector (NAICS 42) in years that end in 2 and 7. Wholesale establishments are traditionally intermediaries: they sell goods to other firms rather than to consumers, and they do not manufacture or transform the goods they sell. Wholesale establishments are primarily classified into two general categories: merchant wholesalers that buy and sell goods for other firms and manufacturing sales' branches that sell merchandise manufactured by other establishments in their firm. I focus only on firms *without* in-house manufacturing plants, which cover 89 percent of firms in the 2017 published totals for the Wholesale Trade Sector and 68 percent of their employment.[7]

I exploit several questions from the "Special Inquiries" section in the 2017 Census of Wholesale

[6] For example, the director of industry research and technology at the Precision Machined Products Association stated, "We think it would be bad for policy makers to say, 'Look at these numbers, we have great manufacturing." See https://www.wsj.com/articles/SB10001424052702303546204579439170777269630.

[7] Although wholesale establishments are often warehouses, they differ from establishments classified as 'warehouses' (NAICS 493) because wholesale establishments are responsible for the sale for their goods, whereas warehouses simply store merchandise, perhaps providing logistics and distribution support. See Appendix Section B.1 for additional details. The exact questions from the Census of Wholesale Trade I use are presented in Appendix Figure C.1.

Trade that ask whether the establishment had any manufacturing done on its behalf by other companies inside the United States and/or by other companies outside the United States; and whether the establishment determined the *design* or *specifications* of the products that were manufactured on its behalf. These questions thus capture purchases of contract manufacturing services by wholesale establishments, which are precisely the services purchased by firms like Apple and Nike that design their products, coordinate the production process, but locate physical transformation activities outside their firm boundary.

To analyze these firms' activities across sectors and over time, I merge the 2017 Census of Wholesale Trade data to a panel of establishment-level employment and sales by sector from 1992 to 2017 using the Longitudinal Business Database and other Economic Censuses. I aggregate these data to the firm level and augment them with yearly firm-level imports and exports from the Longitudinal Firm Trade Transactions Database (recall that 1992 is the first year for which the Customs Trade data are available). I limit the sample to firms without any manufacturing establishments, and with at least one wholesale establishment that responded to one or more of the contract manufacturing questions in the Census of Wholesale Trade in 2017. Although I am missing these firms' foreign operations, the results in the prior section provide reassuring evidence that firms without US manufacturing plants tend not to have foreign manufacturing plants.

This sample of factoryless goods producers covers approximately half of all firms (and employment at firms) with one or more wholesale establishments and no manufacturing plants in 2017 (see Appendix Table B.1). Thus, the sample is sufficiently large to perform a meaningful comparison of factoryless goods producers and their characteristics, but cannot be used to assess the aggregate importance of this organizational form. This limitation arises not only because approximately half of the wholesale sector is outside the sample, but also because factoryless goods producers may exist in other sectors for which the Census Bureau has not collected comparable data.

4.2 Characteristics of Factoryless Goods Producers

I first compare factoryless goods producers to the traditional merchant wholesalers in my sample, which do not contract for production from other firms. Again, this sample excludes all firms with any US manufacturing plants, and the earlier data on multinational firms suggests that firms with exclusively foreign manufacturing plants are rare.

Table 3 presents weighted averages of firm characteristics for factoryless goods producers (27 percent of the sample) and for the rest. Factoryless goods producers are smaller on average than traditional wholesalers, with a weighted average of 26 workers per firm compared to 41 workers at other wholesalers. The average wage of factoryless goods producers is over 30 percent higher than the comparison group, and their sales per worker is over 10 percent larger. At the factoryless goods producers, 75 percent of the workforce is in wholesale establishments and 11 percent is in retail stores; by contrast, traditional merchant wholesalers have 46 percent of their employment in wholesale establishments and one quarter in retail outlets.

Factoryless goods producers are also more trade-intensive than traditional wholesalers in the sample. The bottom panel of Table 3 presents these firms' exports-to-sales and imports-to-sales ratios,

and their shares of related-party trade. Most notably, the imports-to-sales ratio is 0.25 for factoryless goods producers, compared to just 0.05 for the comparison group. This ratio of imports-to-sales for factoryless goods producers is also more than double the ratio of 0.11 at firms with transnational manufacturing plants. Factoryless goods producers also have higher import shares from China than traditional wholesalers: over one-third of their imports are Chinese.

Table 3: Characteristics of 2017 Firms by Factoryless Goods Production Status

	Avg Emp	$\frac{Pay}{Emp}$	$\frac{Sales}{Emp}$	Share of Emp in Wholesale	Retail
Factoryless Goods Producers	26	76	773	0.75	0.11
Merchant Wholesalers	41	56	696	0.46	0.25
	$\frac{Exports}{Sales}$	$\frac{RPExports}{Exports}$	$\frac{Imports}{Sales}$	$\frac{RPImports}{Imports}$	$\frac{ChinaImports}{Imports}$
Factoryless Goods Producers	0.05	0.31	0.25	0.49	0.36
Merchant Wholesalers	0.03	0.19	0.05	0.31	0.27

Source: 2017 Longitudinal Business Database, Longitudinal Firm Trade Transactions Database, Economic Census, Special Inquiry data from the Census of Wholesale Trade. Table presents weighted averages for factoryless goods producters (FGPs) and merchant wholesalers. FGPs are firms that contract for manufacturing services from other firms. Sales in $1000s. Sample consists of all firms with one or more wholesale establishments that responded to the 2017 special inquires questions on contract manufacturing and with no US manufacturing plants. There are 37,300 FGPs and 99,500 merchant wholesalers.

4.3 Evolution of Factoryless-Goods Producers

Prior work finds that factoryless goods producers tend to be younger (Bernard and Fort, 2015, 2017), suggesting that the prevalence of this organization form may be growing. To investigate this possibility, I classify the firms in Table 3, which presents data for 2017, based on the first Economic Census year in which they enter the data, starting in 1992. Factoryless goods producers become more prevalent and have higher shares of employment in the later cohorts. Table 4 shows that 10 percent of the 2017 employment in factoryless goods producers is accounted for by firms that were born between 2012 and 2017, versus just 5 percent for other wholesalers. Traditional wholesalers are more likely to have entered prior to 2002: 75 percent of their 2017 employment is in firms alive prior to 2002, compared to only 58 percent for factoryless goods producers. Table 4 also shows that, at least since 2007, factoryless goods producers are similarly sized to traditional wholesalers within their same cohort. The average size of both types of firms born between 2012 and 2017 is just 10 workers. The smaller size of factoryless goods producers in Table 3 is thus at least partly due to the fact that these firms are younger.

To assess whether factoryless goods producers and merchant wholesalers evolve differently, I trace the 2017 firms in my sample back in time, focusing only on those firms that also existed in 1992 (the firms in the first row of Table 4). While factoryless goods producers among these early entrants may still be younger, limiting the analysis to the subset of 25+ year-old firms reduces the selection effects

Table 4: 2017 Firms and Employment by Factoryless Goods Production Status and Cohort

	Factoryless Goods Producers			Merchant Wholesalers		
Entry Cohort	Firms	Share of Emp	Avg Emp	Firms	Share of Emp	Avg Emp
1992	7,700	0.50	62	27,000	0.65	99
1997	3,700	0.08	21	10,000	0.10	39
2002	4,500	0.10	21	12,000	0.08	27
2007	6,000	0.12	19	14,500	0.07	19
2012	6,500	0.11	17	15,500	0.06	15
2017	8,900	0.10	10	20,500	0.05	10
Totals	37,300	1.00	26	99,500	1.00	41

Source: 2017 Longitudinal Business Database, Longitudinal Firm Trade Transactions Database, Economic Census, Special Inquiry data from the Census of Wholesale Trade. Table presents the number of firms, share of employment, and average employment in 2017 based on firms' 2017 factoryless goods production status and the first Economic Census year in which they are alive. Firms listed in 1992 enter before or in 1992. Firms in the 1997 entry cohort enter between 1992 and 1997, etc.

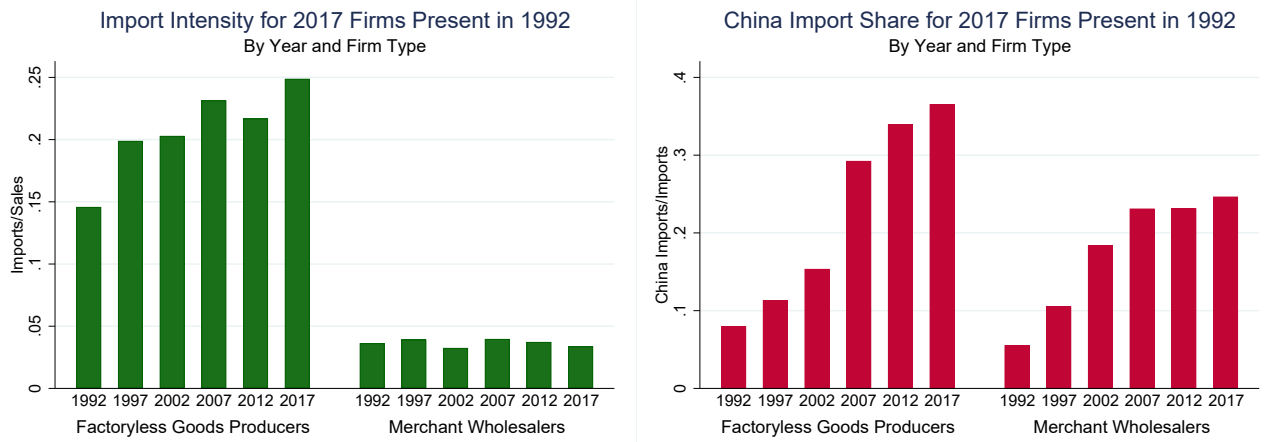
due to differences in firm age.

Figure 2 reveals stark differences between factoryless goods producers and traditional wholesalers' import intensity that grow over time. The 2017 factoryless good producers that were alive in 1992 start with a high import intensity (0.15) in 1992 that grows 10 percentage points to reach 0.25 by 2017. By contrast, the 2017 merchant wholesalers also alive in 1992 maintain an imports-to-sales ratio below 0.05 throughout the period. The right panel of Figure 2 shows that factoryless goods producers are also more specialized in trade from China. Although the two types of firms have similar shares of imports from China in early years, the 2017 factoryless goods producers experience a much sharper increase following China's accession to the World Trade Organization in 2001. Factoryless goods producers are thus more outwardly oriented, with a larger share of their imports from China, one of the top low-wage manufacturing locations in the world.

I also use the data on 2017 firms that were alive by 1992 to analyze how firms' employment across sectors has evolved over time. Figure 3 presents the distribution of firms' employment across Wholesale (NAICS 42), Manufacturing (NAICS 31-33), Retail (NAICS 44-45), and Professional, Scientific, and Technical Services and Management (NAICS 54 - 55) sectors. Recall that by definition, firms in the sample have no manufacturing employment in 2017.

Perhaps the most striking message from Figure 3 is that the 2017 factoryless goods producers that were present in 1992 were considerably more involved in manufacturing. Indeed, these factoryless goods producers had over one-third of their workforce in manufacturing plants in 1992. The traditional wholesale firms in this sample (again, tracing them back from 2017 to 1992) have much lower manufacturing employment shares and instead are more retail-intensive than factoryless goods producers. Their share of retail employment remains quite constant at about one-third over the last

Figure 2: Import Activity for 2017 Firms by Factoryless Goods Production Status and Year



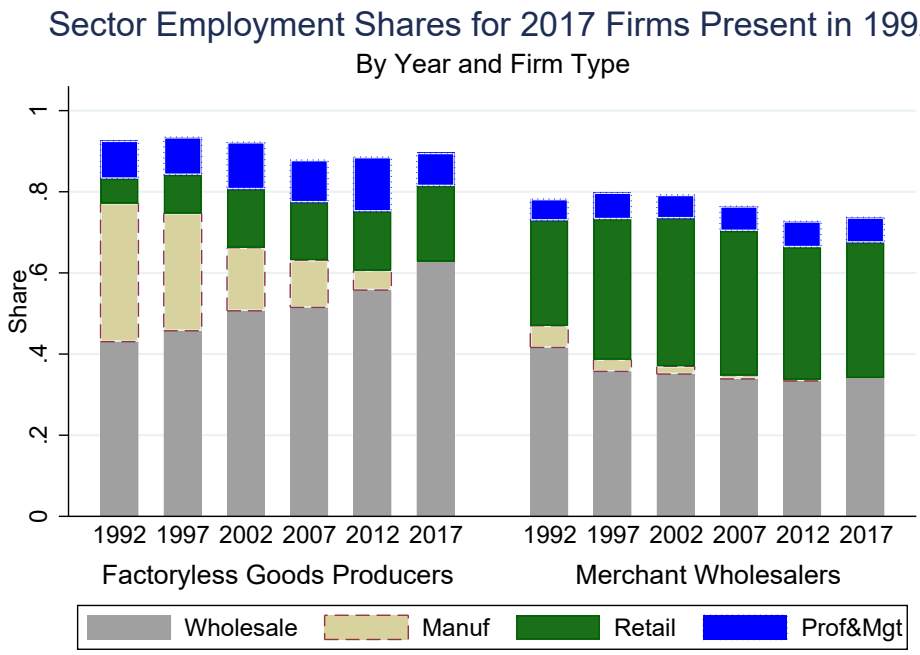
Source: 2017 Longitudinal Business Database, Longitudinal Firm Trade Transactions Database, Economic Census, Special Inquiry data from the Census of Wholesale Trade. Figure presents the ratio of imports to sales (left panel) and the share of firm imports from China over total imports (right panel). Factoryless goods producers are firms with one or more wholesale estabs that contract for manufacturing services in 2017. Merchant Wholesalers are firms with at least one estab that reports not contracting for manufacturing and none that do. Sample is all firms with at least one wholesale estab that responds to the 2017 question on contract manufacturing services and with no manufacturing plants in 2017.

two decades. By contrast, the retail share of employment at factoryless goods producers doubles from 9.5 to 19 percent over that period.

Factoryless goods producers' share of employment in the knowledge-related categories of Professional and Management workers (NAICS 54 - 55) grows steadily from 9.3 to 13.4 percent from 1997 to 2012, though then falls in 2017. It remains higher than the share of the comparison group, which hovers around 6 percent throughout. Factoryless goods producers share of such 'knowledge workers' is thus not as high as the share of 0.19 at transnational manufacturers, but still substantially greater than the 0.03 share of purely domestic manufacturing firms.

These patterns suggest that the longer-lasting factoryless goods producers considered here were more directly involved in manufacturing in the past, and have transitioned towards the pre- and post-production stages as they increasingly import the goods they used to manufacture domestically. At least in these in these aggregate figures, however, the growth in imports trails the decline in manufacturing employment. While both firm types grow their total employment over the period, the factoryless goods producers grow from a weighted average of 40 workers per firm in 1992 to 62 workers by 2017 versus 44 to 99 for the comparison group (see Table B.3).

Figure 3: Sector Employment Shares for 2017 Firms by Factoryless Goods Production Status



2017 Longitudinal Business Database, Longitudinal Firm Trade Transactions Database, Economic Census, Special Inquiry data from the Census of Wholesale Trade. Figure plots firms' employment shares by sector. Factoryless Goods Producers are firms with one or more wholesale estabs that contract for manufacturing services in 2017. Merchant Wholesalers are firms with at least one estab that reports not contracting for manufacturing and none that do. Sample is all firms with at least one wholesale estab that responds to the 2017 question on contract manufacturing services and with no manufacturing plants in 2017.

The falling manufacturing employment shares at what become factoryless goods producers by 2017 suggest that these firms may have contributed to the decline in US manufacturing over the last several decades. Indeed, Fort et al. (2017) find that 75 percent of the decline in US manufacturing employment from 1997 to 2012 occurs in continuing firms, with two-thirds attributable to continuing firms' closure of manufacturing plants. Before concluding that this new organizational form has led to net declines in total employment, two caveats are in order. First, the set of continuing factoryless goods producers has grown its total employment over the period. Second, the information in Table 4 indicates that factoryless goods producers are relatively young, and examining those entrants' initial manufacturing employment suggests they may never have manufactured in-house.[8] Assessing the net employment effects of these former manufacturing firms and entering factoryless goods producers that never manufacture is an interesting question for future work, especially in light of their greater import intensity.

The higher employment shares of factoryless goods producers in knowledge-related activities resonates with the higher shares in these activities by multinational enterprises, and with the prior findings that factoryless goods producers are more innovative. For example, Kamal (2020) finds that

[8]Appendix Figure B.1 shows that after 1997, the entering cohorts of eventual 2017 factoryless goods producers have lower manufacturing employment shares than the 1992 cohort (and than merchant wholesalers in the same cohort).

they have higher R&D expenditures, are more R&D intensive, patent more, and own more trademarks than comparison service firms, using the 2011 Company Organization Survey and the 2012 Censuses of Wholesale and Services to identify factoryless goods producers. These patterns suggest that factoryless goods producers specialize in pre-production tasks, while outsourcing physical transformation tasks to other firms, often in other countries.

4.4 Sourcing Location Decisions by Factoryless Goods Producers

For additional evidence on the global orientation of factoryless goods producers, I calculate the extent to which they contract for manufacturing from domestic or foreign providers. An important caveat is that my data on firms' purchase location are limited to firms that also responded to the question about whether they designed the products they outsourced. These firms cover 68 percent of the factoryless goods producers in my sample, and 75, 73, and 86 percent of their employment, sales, and imports, respectively. Table 5 presents the distribution of factoryless goods producers and their employment, sales and imports based on whether their contracted manufacturing is performed in the United States, in foreign countries, or both. For each activity, the shares do not sum to one, due to the missing design and location information in the data.

The primary message from Table 5 is the dominance of contracting from foreign countries for factoryless goods producers: as the figure shows, at least 53 percent of factoryless goods producers and over 60 percent of their employment, sales, and imports are accounted for by firms that contract either exclusively or partly abroad. Indeed, a majority of all factoryless goods producers contract from foreign suppliers. For these firms, "outside the firm" also relates to "outside the country'".

Reassuringly, Table 5 also shows that factoryless goods producers' imports are concentrated in firms that contract with suppliers in foreign countries. Firms that only contract with domestic suppliers account for only 2.9 percent of total imports by these firms. This high import share demonstrates that foreign purchases of contract manufacturing services and wholesale firms' merchandise imports are related.

Table 5: 2017 Factoryless Goods Producer Characteristics by Supplier Location

	Share of Factoryless Good Producer				Firm Characteristics			
Supplier Locations	Firms	Employment	Sales	Imports	Avg Emp	$\frac{Pay}{Emp}$	$\frac{Sales}{Emp}$	$\frac{Imports}{Sales}$
Domestic Only	0.14	0.15	0.13	0.03	26	67	673	0.06
Foreign Only	0.42	0.40	0.41	0.63	25	70	794	0.38
Domestic & Foreign	0.12	0.21	0.19	0.21	45	99	728	0.27

Source: 2017 Longitudinal Business Database, Longitudinal Firm Trade Transactions Database, Economic Census, Special Inquiry data from the Census of Wholesale Trade. Table presents activity shares and weighted averages for factoryless goods producters (FGPs) and merchant wholesalers. FGPs are firms that contract for manufacturing services from other firms. Sales in $1000s. Sample in this table consists of the 25,200 factoryless goods producers that responded to the product design question.

Factoryless goods producers' sourcing patterns do not align well with standard trade models that

rely on higher fixed costs of foreign sourcing to explain heterogeneous firms' selection into foreign markets. First, Table 5 indicates that firms with purely domestic or purely foreign sourcing are similarly sized (about 25 workers per firm) and pay comparable wages (about $70k). Second, firms that rely exclusively on foreign suppliers are the most prevalent organizational form. Comparing these patters to those for firms with manufacturing plants poses even bigger challenges for standard models: there seem to be far more domestic manufacturing firms than factoryless goods producers, they are larger on average (about 46 workers per firm), their foreign sourcing (from in-house foreign plants or other firms) is rare, and the vast majority of those that offshore maintain significant domestic production.

4.5 Comparisons with Previous Findings on Factoryless Goods Producers

Past work on use of contract manufacturing services by manufacturing and wholesale firm must be compared to the present evidence with caution, given differences across data and samples, but several suggestive patterns emerge. First, factoryless goods producers seem much more outwardly oriented than manufacturing firms. Fort (2017) shows that approximately 30 percent of US manufacturing plants contract for manufacturing services from other firms in 2007, but among these firms, less than 7 percent do so from foreign suppliers. By contrast, one-quarter of all wholesale establishments that purchase contract manufacturing in 2007 also offshore (for details, see Appendix Figure C.3). This establishment comparison thus reinforces the conclusion that "out of the firm" and "out of the country" tend to go together.

Second, the prevalence of factoryless goods producers seems to have increased significantly from 2007 to 2017. While Bernard and Fort (2015) calculate that 12 percent of firms in their sample were factoryless goods producers in 2007, I use a reasonably similar calculation that implies approximately 27 percent of wholesale firms without manufacturing plants are factoryless goods producers by 2017.

Third, the foreign orientation of factoryless goods producers has also risen over this time period. In 2007, 3.7 percent of wholesale establishments contracted from foreign suppliers. Since 15 percent of wholesale establishments purchased any contract manufacturing services that year, about a quarter of the 2007 factoryless goods producers sourced from foreign suppliers. As shown in Table 5, this rate more than doubled by 2017, when at least 53 percent of factoryless goods producers source from foreign suppliers.

Finally, firms' use of contract manufacturing seems strongly related to their focus on innovation. In 2007, 45 percent of wholesale establishments that designed goods also purchased contract manufacturing services, compared to only 10 percent among non-designers. Among the 2007 wholesale establishments that contracted for manufacturing, 29 percent that designed their own goods offshored, versus only 21 percent of establishments that did not design. Similarly, a majority of factoryless goods producers in 2017 design the goods they sell, and those that design are more likely to contract with foreign suppliers. These patterns are all consistent with the premise that factoryless goods producers tend to focus on pre-production manufacturing stages in the United States, while locating physical transformation tasks outside both the firm and the country.

5 The Interdependence between Integration and Location Decisions

US manufacturing firms have divided their manufacturing both across countries and across firms in ways that suggest interdependencies between these decisions. When firms perform physical transformation activities within the firm in foreign countries, the majority of their US sales and employment is also in manufacturing plants. However, when factoryless goods producers outsource physical transformation activities, they are increasingly likely to locate them in foreign countries. "In-the-firm" also translates to a significant portion "in-the-country," while "outsourcing" maps to "offshoring."

The disproportionate focus on domestic innovation by both types of firm suggests that intellectual property is a key factor in their production processes. Some firms may specialize in design to increase their R&D efficiency, for example if there are increasing and convex costs to managerial scope, as in Lucas (1978). This type of specialization has been documented within manufacturing firms in response to increased foreign competition (Bernard et al., 2011; Mayer et al., 2013) and new offshoring opportunities (Bernard et al., 2023). From this view, factoryless goods producers just represent a more extreme form of specialization in pre- and post-production tasks.

By contrast, other firms may improve research efficiency by using integrated manufacturing plants that are proximate to their headquarters and research centers. These plants may produce complex goods that are near the technology frontier, or products for which manufacturing feeds back into research. While mature, stable products can be made far from the innovation hubs (Duranton and Puga, 2001) and perhaps at arm's length, those at the technology frontier may benefit from face-to-face interactions with researchers. Boeing supports it 'Design-to-Build' ethos by training the engineers at its South Carolina Propulsion plant as mechanics and tasking them with building parts to identify design opportunities to enhance production efficiency. Texas Instruments stresses synergies between their technology groups and manufacturing operations to ensure "manufacturability and cost efficiency." Although firms' US manufacturing plants are an average of several hundred miles away from their US R&D labs, firms tend to have at least one manufacturing plant co-located with R&D; moreover those firms patent relatively more in those regions and time periods in which their manufacturing and knowledge establishments are co-located (Fort et al., 2020).

The importance of protecting intellectual property may also relate to firms' location and integration decisions. Firms for which theft is not a concern may be more likely both to outsource and offshore. This situation may arise either because their innovation is effectively excludable, as in the case of enforceable patents such as for pharmaceuticals, or because the product life cycle is sufficiently short, such as for fashion and phones. Indeed, US multinational enterprises disproportionately locate their in-house manufacturing affiliates in industries with long product lifecycles only in those countries with strong intellectual property protection (Bilir, 2014).

Such industry differences, however, seem insufficient to explain the bifurcation in firms' integration and location decisions documented here. In 2007, Electrical Machinery and Equipment (HS 85) and Machine and Mechanical Appliances and Computers (HS 84) accounted for over 40 percent of imports of factoryless goods producers, compared to just 30 percent for the comparison group of firms (Bernard and Fort, 2015). Multinational enterprises in these sectors comprise 17 percent of US employment by manufacturing multinationals in 2017, according to data from the Bureau of Economic Analysis.

Thus, some US firms in computer and electronics and machinery maintain integrated manufacturing around the globe, while others outsource physical transformation tasks. For example, Apple and IBM both shed their personal computer manufacturing in 2004, but IBM continues to manufacture mainframes in the United States, while Apple ceased all in-house production tasks.

This bifurcation is evident even for a narrowly defined (and increasingly salient) product: the semiconductor chip. Texas Instruments and Qualcomm both sell chips, yet the former maintains integrated production, while the latter focuses solely on design and innovation. According to Kyle Flessner of Texas Instruments, "A core element of our strategy is to invest in increasing our internal manufacturing capacity – in wafer fabs and assembly-test sites we own – rather than relying only on external suppliers," whereas Qualcomm considers itself "a company of inventors with diverse skills and backgrounds.'[9] These anecdotes point to an important role for firm-level core competence and strategic focus in determining how firms organize their production across firms and countries.

Specialization in design may also arise when firms have differential access to capital and there are large fixed costs to manufacture — as for semiconductor manufacturing — such that one large contract manufacturer can potentially serve multiple designers more efficiently. Indeed, recent work finds that within-industry heterogeneity in firms' reliance on outsourcing is negatively correlated with their use of leverage, which is consistent with the presence of high fixed costs that need to be financed (Moon and Phillilps, 2020). Since physical capital is often easier to sell and transfer than intangible capital, it is perhaps not surprising that lower-wage countries have specialized in the parts of the production that require that capital, while US firms increasingly specialize in intangibles.

Existing models that study a firm's decision to outsource or offshore feature firm heterogeneity, but only in one dimension. For example, in extensions of the Melitz (2003) model of international trade, a firm can open horizontal replicas of its domestic manufacturing plants abroad as an alternative to exports for serving foreign customers (Helpman et al., 2004); or it can procure inputs in low-wage countries to lower production costs, in its own plants or from arm's-length suppliers (Antràs and Helpman, 2004). These models capture salient features about US manufacturers – namely that exporters and importers are larger and more productive than non-traders, and only the biggest, most productive own foreign plants Bernard et al. (2007, 2018). However, there is no interaction between firms' location and integration decisions, and the fixed-cost ordering that can explain multinationals' behavior does not rationalize the patterns of factoryless good producers documented here.

The divergence in firm types documented here thus calls for a new framework to analyze both of the firm's boundary decisions jointly. If integration and location decisions are interdependent, then changes in trade policy will not only affect the location of production, but also influence the scope of firms' integrated activities. Similarly, changes in monitoring or other technologies that reduce contracting frictions (for example, Baker and Hubbard, 2004) may also change production location decisions. Such interactions create new challenges and opportunities for assessing the effects of changing trade costs. At a broader level, they relate to insights from Holmstrom and Milgrom (1991), who emphasize the role of complementarities across tasks in optimal job design and firm

[9] See https://news.ti.com/blog/2022/11/01/qa-how-ti-is-investing-in-manufacturing-capacity-to-support-growth-for- and https://www.qualcomm.com/company#about

structure.

The interdependence in firms' outsourcing and offshoring decisions also has important implications for empirical work. A common approach to analyze the effects of trade is regressing industry-level changes in outcomes (such as employment) on instrumented trade flows. When reallocation occurs across firms and industries, however, this method may paint an incomplete picture. For example, this method would capture Apple's exit from US manufacturing, but miss its related growth in innovation and retail sectors. Recent work documents decreased US patenting by public manufacturing firms in response to increased Chinese imports (Autor et al., 2020). Yet results from a new dataset of US patents from 1977 to 2016 by all firms in the United States indicate that the share of patents granted to manufacturing firms has fallen dramatically, from 91 to 54 percent between 1977 to 2016, while patents by former manufacturing firms have grown steadily, especially for firms that grew their Chinese imports after 2007 (Fort et al., 2020).

Apple's shift from manufacturing to design also highlights the importance of distinguishing global value chain trade from import competition. It is now well established that trade flows from fragmented production have potentially different effects from the more standard 'wine-for-cloth' exchange of final goods. For example, Feenstra and Hanson (1999) showed that US input trade with lower skill countries could increase the demand for skilled workers within an industry as domestic producers focused on a subset of higher skill tasks and sourced lower skilled tasks from abroad. Ding et al. (2022) document precisely this reallocation in response to cheaper inputs from China. They show that US firms that relied on inputs for which China gained market share in Europe increased both the shares and levels of their non-manufacturing employment. However, input trade misses final-good trade by both transnational manufacturers and factoryless goods producers. Yesterday's efforts to measure global value chains and fragmentation using trade in intermediate inputs simply do not capture today's reality in which US firms sell final goods manufactured abroad but designed, distributed, and marketed using domestic labor and ideas.

6 Conclusion

US manufacturers are connected to global value chains in multiple ways. Some firms have opened in-house manufacturing plants in foreign countries, yet maintain domestic manufacturing as a primary domestic activity. Other firms both outsource and offshore the traditional manufacturing stages, yet remain involved in the broader production process by designing and marketing their goods and coordinating across their arm's-length suppliers. Despite their contrasting organizational forms, both transnational in-house manufacturers and factoryless goods producers hire disproportionately more knowledge workers in the United States. They also spend more on R&D and receive more patent grants. These patterns highlight the need for new trade models in which low-wage manufacturing locations enable the entry of more ideas by firms that specialize in domestic innovation.

Understanding how US firms leverage their domestic knowledge creation across countries is also necessary for producing reliable estimates of GDP, value-added, and productivity. When US firms sell their products directly to foreign customers from their foreign suppliers or plants, those goods never

cross into US commercial space. The ensuing profits are counted in US GNP, but the value-added by US designers and software engineers may be excluded from GDP. Guvenen et al. (2022) estimate that US multinationals shift between $150 to $200 billion per year in profits using their foreign affiliates, with most of the shifting in R&D-intensive industries and firms. This issue may be most severe for factoryless goods producers, because they are fully specialized in the pre- and post-production stages that add considerable value to the final product, yet are not readily observable in aggregate statistics. As an example, Bayard et al. (2015) use Apple's global revenue from iPad sales reported in its 2011 annual report to calculate that (under plausible assumptions about the gross margins on sales of different products) value added in the US Computer industry would have been approximately $6 billion higher if Apple's value-added from its iPads were included, roughly offsetting the decline in domestic computer manufacturing that year.

The results in this paper thus also point to the need for statistical agencies to improve the available data for studying the fragmentation of knowledge production and manufacturing. First, statistical agencies could collect sales, inputs, imports, and exports using the same classification systems, which would allow for more accurate assessments of what firms buy, sell, import, export, and produce. Second, collection of these elements could be expanded across sectors, perhaps using techniques that allow for automatic recording and transmission of transactions, rather than the traditional survey approach. Third, a flag could be added to the US Customs import form asking whether the goods were produced by contract manufacturers for the importer.[10] Finally, data on firms' technology use would facilitate studies about the ways in which cross-county teams form and operate.

Such expansions of data collection are crucial for a complete picture of global production sharing and accurate assessments of US supply-chain risk. Past work cleverly leverages input-output tables to document production sharing across countries (Hummels et al., 2001; Johnson and Noguera, 2012), but those metrics will remain incomplete until the underlying data sources link the value added by firms in one country to the output of different firms in other countries and across sectors. These links are essential to analyze the costs and benefits of potential changes in trade costs, such as the recent proposal by the US National Security Advisor, Jake Sullivan, to protect US technology "...with a small yard and high fence." Such proposals may upset the current balance between domestic innovation and foreign physical transformation. Factoryless goods producers may be particularly susceptible, since they cannot relocate their suppliers' unilaterally.

Perhaps the most exciting direction for future work is how foreign outsourcing of physical transformation tasks affects the creation and diffusion of knowledge. Research on foreign direct investment studies these transfers explicitly (Javorcik, 2004; Ramondo and Rodríguez-Clare, 2013; Arkolakis et al., 2018). Since excluding knowledge from rivals is one motive for integration (Ding et al., 2022), the largest flows may occur when arm's-length relationships form. Factoryless goods production thus represents a new form of global manufacturing with the potential to spread ideas around the world.

[10]The administrative value-added tax data collected in a number of countries might also be used to distinguish factoryless goods producers from traditional service firms. For instance, if countries with those data could collect information on sourcing for the firm's own goods via contract manufacturers, we could assess whether factoryless goods producers tend to have more long-lasting and concentrated relationships with their suppliers. Improvements in text-based algorithms that allow for detailed concordances across classification systems may be a short-term solution to the concordance challenges from using US data.

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