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Penalties and premiums:

An investigation of inter-firm transactions and wages across industries in the U.S.

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Abstract: This paper explores the correlation between inter-firm transactions (IFT) and workers' wages across industries in the U.S., in order to further our understanding of outsourcing-related wage penalties. Using a new typology and methodology for measuring IFT, I find that the aggregate correlation between IFT and wages is positive across all industries, but that a dummy variable identifying services that could feasibly be produced in-house by the purchaser has a negative pull on the correlation. Further analysis of IFT and wages for specific occupations and industries reveals a complex and heterogeneous relationship, and points to the importance of exploring additional qualitative aspects of transactions between firms, as well as other factors that have affected workers' wages. This analysis helps us refine our understanding of which type of IFT are relevant for understanding wage penalties related to domestic outsourcing.

Keywords: input-output, outsourcing, subcontracting, fissuring, organization of production, wages

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A growing body of research has identified a wage penalty associated with domestic outsourcing for certain industries and occupations, but there has been limited exploration of the full scope of this relationship across the economy. Research on firms and wages in the U.S. has been constrained in part by the limited availability of firm-level data, and in part by a lack of clarity and consistency in the diverse bodies of literature related to domestic outsourcing. In a previous paper, I proposed a new conceptual and methodological framework for assessing trends in inter-firm transactions (IFT) at the industry level, and relating these trends to our understanding of domestic outsourcing (Hammerling 2021). In this paper, I use these tools to explore the descriptive relationship between IFT and wages, in the process generating a series of hypotheses about the factors affecting wage setting for different occupations in relation to industry trends, including – but not limited to – domestic outsourcing.

This paper considers the following questions: Is there a broad relationship between IFT and workers' wages across industries in the U.S? In which industries and occupations do we find evidence pointing to an outsourcing-related wage penalty? I answer these questions for aggregate groups of industries, based on my typology of IFT; and for individual occupations, looking across the industries in which they are employed. The typology of IFT includes three groupings of industries that vary in scope: the broadest group includes transactions for all goods and services; the next group includes transactions for services only. In the narrowest grouping, I include transactions only for a subset of industries identified as providers of services that could feasibly be produced in-house by the purchaser. For my occupation case studies I consider a low-wage occupation (janitors) and a high-wage occupation (technology workers).

I use the Bureau of Economic Analysis (BEA) National Input-Output Accounts data to construct the industry-level measure of domestic IFT. These data capture market-based

transactions between industries, allowing us to track changes in how much each industry in the U.S. purchases from or produces for each other industry or end-user. I link my industry-level IFT measure to wage and employment data from the American Community Survey (ACS). The BEA data offer a unique opportunity to examine changes in IFT across the U.S. economy, and to explore how these changes relate to wage trends by industry and occupation. While a handful of other researchers have used the BEA data to answer related questions, this study represents the first attempt to link IFT and wage data in the U.S.

This study provides an important bridge between case studies that look at specific examples of domestic outsourcing, and macro-level characterizations of changes in the organization of production and its effects on workers. It shows that defining domestic outsourcing is more than an issue of semantics; it has real consequences for our empirical understanding of the process. Using data on IFT to explore the relationship between domestic outsourcing and wages exposes some of the important distinctions between different types of transactions, and their possible implications for workers' wages. It also generates additional questions and hypotheses to guide and shape a research agenda on domestic outsourcing.

Literature review

I define IFT as **the sale of goods or services from one firm to another firm**[2] for use as an input to production. Domestic outsourcing is one type of IFT, among many. Researchers have defined and used the term outsourcing in a wide variety of ways,[3] but there are two distinct approaches that are important to highlight: one, which I refer to as the narrow approach,

[2] Firm in this case can also refer to another type of organization or government entity.
[3] I use the term outsourcing because it appears most common across industry and academic literature, especially in discussions of impacts on labor and employment. Other commonly-used terms used to describe similar processes include contracting out, subcontracting, vertical disintegration, and fissuring.

considers outsourcing as the result of a process in which a firm shifts production of a particular good or service from internal labor to an external supplier; the other, which I refer to as the broad approach, considers outsourcing to be the result of external sourcing practices in general, regardless of a firms' prior practices with regard to the production of particular inputs. In the latter approach, external sourcing of certain goods or services may be considered outsourcing while others are not, depending on the type of transaction or how a particular input fits within a firm's production model.

Regardless of the approach one uses to define outsourcing, a defining feature of any outsourcing process (in the broad or narrow sense) is that it involves a transaction between firms – a "buy" versus "make" decision.[4] Because of this, analyzing changes in IFT is an important way to understand the context in which changes in outsourcing occur.

Evidence of a wage penalty

There is no research on domestic IFT in the U.S. that comprehensively estimates its relationship to wages. This is in part due to definitional challenges, and in part due to a deficit of firm-level data in the U.S. that would allow for precise measurement and analysis of these dynamics.[5] However, in recent years researchers have explored the relationship between domestic outsourcing and wages for various industries and occupations, using a variety of analytic strategies and approaches to defining outsourcing. Taken together, this body of evidence

[4] See literature on Transaction Cost Economics (TCE), e.g. Coase, 1937; Chandler, 1977; Williamson, 1981

[5] For example, there are no data in the U.S. comparable to that used by Goldschmidt and Schmieder that allow tracking of firm-level outsourcing practices (Goldschmidt & Schmieder, 2017). The closest approximation is Dorn et al.'s use of the Longitudinal Employer Household Dynamics data to identify workers affected by outsourcing events (2018).

suggests that there could be a link between the rise of domestic IFT and wage stagnation for a wide range of occupations in the U.S., from janitors to truck drivers to accountants.

In his book *The Fissured Workplace*, Weil draws on a broad array of examples to illustrate how firms in many industries have increasingly transferred employment to contractor firms in order to cut costs, resulting in lower wages and reduced working conditions for workers (Weil 2014). Empirical case studies have identified a wage penalty for a specific groups of occupations when their jobs are outsourced to a contractor firm, including janitors, call center workers, security guards, foodservice workers and logistics workers (Batt and Nohara 2009; Dorn, Schmeider, and Spletzer 2018; Dube and Kaplan 2010; Goldschmidt and Schmieder 2017). Recent studies have also identified a connection between rising inequality between firms and rising inequality across the U.S., suggesting that wage penalties associated with domestic outsourcing may have contributed to the growing wage gap in the U.S. (Barth et al. 2016; Handwerker & Spletzer 2015; Song et al. 2016).

These studies lead us to believe that domestic inter-firm transactions (IFT) may be linked to negative consequences for wages for certain occupations under certain circumstances. However, we have limited information about how broadly this wage penalty may apply across industries, occupations, and types of transactions.

Explanations

Theories about outsourcing in the U.S. could lead us to expect that IFT lead to higher wages for certain workers, and lower wages for others. For instance, explanations of outsourcing that emphasize the improved efficiency and profitability of the model could lead to an expectation that IFT benefit some workers' wages, either because both firms are able to profit

from the transactional arrangement and they may share those gains with certain workers; and/or, because certain outsourced workers may have a more specialized skill set compared to comparable in-house workers, and therefore they can demand a higher wage.

What are some of the explanations for why IFT could be linked to lower wages for certain workers? One reason is that outsourcing introduces more competition into the production process, compared to in-house production, and as a result it may increase pressure for contractors to reduce costs and cut corners on labor standards (Weil 2014). Additionally, as union membership in the U.S. began to fall and unions grew weaker, firms were increasingly able to contract out for jobs that were previously covered by union contract (Batt et al. 2009; Belzer 1994; Card, Lemieux, & Riddell 2004; DiNardo & Lee 2004; Milkman 2006, 2008).

Other research has shown that low-wage workers typically experience better outcomes when they are employed in firms with higher-wage workers, rather than in firms with other low-wage workers (Akerlof & Yellen, 1990; Card et al., 2012; Rees 1993; cited in Dorn et al., 2018). This research points to two possible reasons why IFT might hurt workers' wages. First, low-wage workers employed in-house with high-wage workers may benefit from greater opportunities for career advancement, compared to workers employed by a contractor specialized in lower-wage work. Second, low-wage workers employed in-house may benefit from wage compression; in an effort to limit internal inequities, firms with high-wage workers may offer better wages and benefits to low-wage workers, compared to firms that employ only low-wage workers. Shifting workers to an outsourced employer therefore cuts them off from the initial firm's wage and benefit structure.

Inter-industry wage differentials

There are other reasons besides outsourcing that may result in similar types of workers earning different wages at different types of firms, of course. Decades of research on inter-industry wage differentials has documented persistent wage differences in occupational wages across industries, and explored the possible causes of these differences (Dickens & Katz 1987; Katz & Summers 1989; Krueger & Summers 1987, 1988; Slichter 1950). Some of these explanations may interact with changes in IFT – I discuss this in the occupation case studies. While there are many unanswered questions about the reasons why inter-industry wage differentials exist, researchers have suggested several possible explanations (see Osburn 2000).

In some cases, the level or specialization of skill required of the same occupation in different firms or industries may result in a different wage. Or, higher wages in a particular industry may reflect especially hazardous or undesirable working conditions. The efficiency wage theory posits that certain firms pay higher-than-average wages to ameliorate labor market issues like high turnover, and to encourage better performance (Katz 1986; Stiglitz 1986; Yellen 1984).

Other explanations for inter-industry wage differentials depart more clearly from standard economic theories, increasingly casting doubt on the assumption of a perfectly competitive labor market and suggesting "that individual wages are not solely determined by personal productive characteristics and task descriptions but also by employer features in each sector" (Rycx and Tojerow 2007). Higher union density, for instance, can improve wages for workers in that industry – even for workers in non-union firms (Dickens and Katz 1987). Another explanation is that workers in firms in high profit-margin industries may share rents with their employees, resulting in higher pay compared to low profit-margin industries. Additionally, some researchers have suggested that firms make a decision to compete either on low cost or on high quality, and

that workers are paid differential wages based on the competitive strategy of their employer (Klein 1988).

Research strategy

In a previous paper (Hammerling 2021) I develop a typology of IFT in relation to distinct approaches to defining outsourcing, and I generate a new methodology for measuring domestic IFT at the industry level using the BEA Input-Output data. I used this method to assess the prevalence of IFT over time for individual industries, and for the groupings of industries I specified in the typology. In this paper, I use the typology and the industry-level data on IFT to explore the relationship between IFT and workers' wages. In this section I briefly review my data sources, methodology, and typology of IFT – an extended discussion of methods can be found in (Hammerling 2021) and the Supplemental Technical Appendix.

It is important to emphasize at the outset that this analysis is an exploratory exercise, intended to help further our understanding of how we can use the IFT data to understand outsourcing-related wage penalties. I do not attempt to formally model this relationship here; rather, I offer a broad assessment of the descriptive correlation between IFT and workers' wages, considering economy-wide and industry-specific measures of IFT.

Data

I use the Input-Output (I-O) accounts data from the U.S. Bureau of Economic Analysis (BEA) to measure domestic IFT. The BEA's I-O data capture the flow of sales and purchases of commodities (goods, services, and government output) across industries, based primarily on data

from the Economic Census.[6] The I-O data feature two primary tables: the "make" (also referred to as "supply") table, which tabulates the monetary value (in dollars) of how much of each commodity is *produced* by each industry and the government; and the "use" table, which tabulates the monetary value of how much of each commodity is *purchased* by industries, government, or consumers. The transactions in the use table are classified as either intermediate or final use.[7] Intermediate use refers to goods or services that are sold by one firm to another firm or government, to be used as part of the purchaser's production process. Final use refers to goods and services consumed in their final state, by individual consumers and government.[8]

Along with the I-O data, I also use data from the American Community Survey (ACS) to analyze the relationship between IFT and wages. I combine the ACS's worker-level data on employment, occupation, wages, and other characteristics with the industry-level measures of domestic IFT, matching based on the industry in which a worker is employed, in order to compare similar workers in contractor industries to workers in other industries. I use the ACS rather than other sources of wage data because of its large sample size.

Typology

The typology of IFT includes three groupings of industries, which were developed based on a synthesis of existing theory related to IFT and outsourcing.

[6] See Technical Appendix 1. Data sources.
[7] See Technical Appendix 2. Note on investment. Also see (Robbins et al. 2013) for an in-depth discussion of the classification of intangibles in the BEA's IO data.
[8] For retail-related industries, only the commodity sales markup is recorded as the output of the retail industry, while the value of the commodity without markup is attributed to the producer.

Group 1. Domestic IFT for all goods and services

The first industry grouping is the broadest: this group includes all sales of goods and services from firms within the U.S. to other firms or the government within the U.S.

Group 2. Domestic IFT for services

The second industry grouping is narrower than the first: it includes all IFT for commodities classified as services[9] between firms (or between firms and the government) within the U.S. It does not include intermediate transactions for commodities classified as goods.

Group 3. Domestic IFT for feasibly in-house services

The final industry grouping is the narrowest in scope, including only the sale of services within the U.S. that could feasibly be produced by the purchasing firm (or government) in-house instead. I identify the industries classified as producers of "feasibly in-house" services in Technical Appendix 7, and I describe my classification process. An important pre-qualifying condition for the list of feasibly in-house (FIH) industries is that over half of the industry's output must be an intermediate input into other firms or the government. That is, industries producing services primarily for final use consumption are not considered FIH. I focus on the reasonable possibility that a service *could* be produced in-house by purchasers, regardless of whether it actually was.[10]

[9] See Technical Appendix 6 for a full list of industries in the detailed I-O data, their corresponding NAICS code, and the sector in which they are classified by the BLS. It is important to keep in mind here that the distinction between "goods" and "services" is not in all cases a tidy one, and that the way these distinctions are coded into the I-O data and other data using NAICS codes is imperfect. For example, the company IBM is classified as a manufacturer of computers (a "good"), but most of its revenue now comes from the sale of services. A more precise distinction, conceptually, would be to consider trade-able versus non-tradeable production, but the data do not include this information.

[10] An analysis focused on a narrow view of outsourcing would stipulate that a function was previously produced in-house, before it was contracted out to a separate firm. Measuring such a tighter definition, however, would require longitudinal data on the production process of individual firms, which are rare in the U.S.

Methods

I explore the relationship between IFT and wages in several different ways. First, I construct a measure of the ratio of each industry's IFT output, compared to its total output, and I aggregate this measure for the industries in the IFT typology. Then I estimate a basic regression as a simple descriptive technique to summarize the estimated correlation between the IFT ratio and wages for each grouping in the typology. Next, I select two case study occupations and examine the correlation between workers' wages and the IFT ratio for each industry in which they are employed.

Measuring IFT

In order to measure domestic IFT, I modify the BEA's make and use tables to construct a domestic industry-by-industry input-output matrix for each year of interest. The original make/use tables show the production and consumption (input and output) of commodities by industries, including imports and exports. I transform these tables into matrix that reflects domestic-only production and consumption between industries, as well as consumers and government.[11] This process involves removing the value of transactions for imports and exports entirely.

The modified matrix allows for detailed analysis of how much output each domestic industry produces for each other domestic industry to use as inputs. Technical Appendix 3 elaborates on the steps involved in constructing this matrix. Using the modified matrix, I calculate the *total amount of intermediate use output* produced by each industry, in dollars. This

[11] See Technical Appendix 3. Constructing the IFT ratio.

sum, divided by the *total gross output of each industry* (intermediate use and final use output combined), is the proportion of the industry's total output that is purchased for intermediate use transactions (inter-firm transactions), rather than final use transactions. The ratio of intermediate output to total gross output reflects the portion of an industry's production that is used for domestic IFT– I refer to this throughout the paper as the **IFT ratio**. I describe industries with an IFT ratio greater than 50% as intermediate-use industries, and industries with an IFT ratio less than 50% as final-use industries.

Table 1 shows the aggregate value of IFT for each group as a percent of total economic output in the U.S. See Technical Appendix 8 for summary data on IFT by industry. Domestic IFT for all goods and services (group 1) represented about half of all domestic output in the U.S. in 2007, domestic IFT for services (group 2) represented 30% of all output, and domestic IFT for FIH services (group 3) represented just over 10%.

Table 1. Inter-firm transactions as a share of economy-wide output, by industry group (2007)

Industry groups	Percent of total output
1. Inter-firm transactions for goods and services	53%
2. Inter-firm transactions for services	30%
3. Inter-firm transactions for feasibly in-house services	11%

Source data: Author's analysis of the Bureau of Economic Analysis make and use tables, 2007

Merging IFT and wage data

I link the industry IFT ratio with worker-level data from the ACS[12] by matching the industry IFT ratio to each worker based on the industry in which they are employed. I use the 2014 ACS data and the 2007 I-O data, which were both the most recent (detailed) data available

[12] I use a modified version of the ACS's hourly wage data.

at the time of analysis.[13] At this step I make the assumption that the prevalence of IFT for each industry is unchanged between 2007 and 2014. While there is some evidence that domestic outsourcing has increased in certain industries since the 2008 recession (Dorn et al., 2018), meaning that some industries' IFT would have increased between 2007 and 2014, my prior analysis (Hammerling 2021) leads me to believe that the pace of change of IFT is not fast enough to affect my findings within this time frame.[14]

It is important to understand the structure of the resulting merged data. Recall that the I-O data only allow us to estimate the prevalence of IFT as far down as the industry level, not the firm level. As a result, I am not able to directly identify workers employed by firms producing intermediate goods and services, and compare them to workers employed by firms producing goods and services for final use. I can only compare workers based on their *likelihood to be producing intermediate output*, as measured by the proportion intermediate output produced by the industry of their employment. Because of this, it is important that I use the most detailed industry data available so that I can identify as precisely as possible a workers' likelihood of working for a firm that is producing output that is intermediate use.[15] Unfortunately, the time-series data from BEA includes a much more limited set of industries compared to the 2007 benchmark data, so for this exploratory analysis I focus on a single year snapshot using the detailed data.

In the data, each worker in the ACS sample is assigned a value (ranging from 0-1) indicating the IFT ratio of the industry in which that worker is employed. To give an example: a

[13] At the time of analysis, the I-O data had available information for 389 industries in the benchmark year, 2007; since this analysis was completed the BEA has released 2012 benchmark data for 405 industries.
[14] It would be a valuable follow-up study to examine changes in IFT between the detailed 2007 and 2012 I-O data, and wages for workers in those years.
[15] Some firms produce both intermediate and final-use goods. However, most specialize in one or the other.

room cleaner employed in a hotel is working in the accommodations industry, which has an IFT ratio of 23%, making it a predominantly final-use industry. However, a room cleaner employed by a cleaning services company is classified in the services to buildings and dwellings industry, which has an IFT ratio of 90%, making it a predominantly intermediate-use industry (even if the cleaning services company is contracting with a hotel to provide cleaning services). Both of these workers are employed in the same occupation, but in different industries that produce different levels of intermediate versus final-use output.

Exploring IFT-wage relationships

For each of the three typology groupings I estimate the correlation between the IFT ratio and workers' wages, using ordinary least squares (OLS) regression as a descriptive tool. These regressions are run at the individual level – that is, I estimate a regression equation describing each workers' wages as a function of the IFT ratio of the industry in which they are employed. Again: these should *not* be interpreted as formal model of a causal relationship between two variables. Instead, the regressions are a tool that I am using as a simple entry point for exploring the correlation between the two variables.

For the occupation analyses I selected a predominantly low-wage occupation (janitors) and a predominantly high-wage occupation (technology workers[16]). I offer two additional case studies, on motor vehicle operators and financial clerks, in Technical Appendix 10. I selected these occupations because they vary in terms of their median wages and the typical level of education attained by workers, and because they are employed in a diverse set of industries which vary in their IFT ratios. For each occupation I compare workers' median wages when they

[16] Software developers, applications and systems software designers, computer programmers, and web developers.

are employed in predominantly intermediate-use industries, versus predominantly final-use industries. I also estimate the simple OLS regression for both occupation (i.e. selecting only workers in that occupation as the sample), including all industries in the sample.

Findings

In this section, I explore the correlation between an industry's IFT ratio and wages for workers in that industry. I first examine the correlation for the groupings of industries in the IFT typology, and then I examine two specific occupations.

IFT typology and workers' wages

In this analysis I am not formally testing a hypothesis about the relationship between IFT and wages. This analytic exercise is an attempt to inform further investigation of domestic outsourcing by exploring the relationship between industries' IFT ratio and wages, estimating the correlation between the two variables for different groups of industries and occupations. However, the purpose of this exercise is to further our understanding of *whether there may be a wage penalty* associated with the IFT ratio, and if so how widely that relationship may hold. That is to say, I did not expect to see a negative correlation between the IFT ratio and wages across all industries, but I did expect to see a negative correlation for certain industries, and I began this study with interest in learning more about the specific conditions under which the negative correlation appears.

Based on the literature on outsourcing and wages, we might reasonably expect that workers in certain industries with a high IFT ratio (intermediate-use industries) could experience lower wages compared to similar workers in other industries. Specifically, previous studies

would lead us to expect that a wage penalty associated with employment in an industry with a high IFT ratio is *most likely* found among industries in group 3 of the typology: FIH industries.[17] This group of industries overlaps most with other studies of domestic outsourcing, in which a wage penalty associated with outsourcing has been identified in specific industries and occupations, such as food services, cleaning, security, and logistics.

Analysis

Table 2 describes the two regressions that I estimate. The first is a simple OLS estimating the relationship between an industry's IFT ratio and wages for workers employed in that industry. The second is the same, but with the addition of dummy variables to control for key worker demographics. The purpose of the second regression is to observe the correlation between the IFT ratio and workers' wages for comparable groups of workers by holding constant various demographic factors which we can observe have an effect on workers' wages. I tested a variety of control variables using the ACS data, and arrived at the following list: race, citizenship, age, census region, sex, and level of education. These are described in greater detail in the full regression results in Technical Appendix 9.

Table 2. Estimated relationship between the industry IFT ratio and wages – Ordinary Least Squares (OLS) regression model

Simple linear regression	$ln(w) = \beta_1 X_{i1} + \varepsilon_i$
Linear regression with demographic controls	$ln(w) = \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \beta_7 X_{i7} + \varepsilon_i$
Dependent variable	w = hourly wage
Independent variable	X_{i1} = industry IFT ratio
Demographic control variables	X_{i2} = race (categorical)
	X_{i3} = U.S. citizen (y/n)
	X_{i4} = age

[17] Which, by definition, produce more intermediate than final use output.

	X_{i5} = region (categorical)
	X_{i6} = level of educational attainment
	X_{i7} = sex (m/f)
Unit of analysis	i = worker

I estimate both regressions for each industry grouping in the typology. For group 1, I compare the wages of workers in all industries in relation to the IFT ratio for their industry of employment. For group 2, I compare the wages for workers in service industries, in relation to the IFT ratio of each industry. In this version of the regression, all workers employed in goods-producing industries and the government are excluded from the sample, regardless of their occupation. Thus, an engineer working for a chemical manufacturing company would not be included, but an engineer working for an engineering services firm would be included – even if that engineering services firm is contracting with a chemical manufacturing company.

For group 3, I take a slightly different approach. I consider all services to be part of the sample, and I treat the designation of an industry as FIH service as an additional dummy variable. That is, I do not assess the correlation between the IFT ratio and wages within feasibly-house services; instead, I test whether being a FIH service has a significant effect on the overall correlation between the IFT ratio and wages for services. I take this approach here because the designation as FIH is a categorical designation relative to other services that I suspect may influence the correlation between the IFT ratio and wages, rather than an additional subset of industries in which I might expect to see a uniquely important relationship between the IFT ratio and wages. The reason for this is that being an intermediate-use industry (with an IFT ratio greater than or equal to 50%) is a precondition for being considered a FIH service.

Results

Table 3 summarizes the key results of the regression equations I estimated. Complete results are included in Technical Appendix 9. In this table I show the estimated coefficient on the IFT ratio variable (β_1 in table 1) for the simple and detailed regressions, for the first two industry groupings, and the coefficients on the IFT ratio and the dummy variable indicating whether or not the service is FIH for group 3. For each industry grouping, the estimated coefficient on the IFT ratio variable is positive and significant. This means that, for each sample of industries, with and without demographic controls, I estimate that wages for workers in industries with a *higher* portion of intermediate-use output tend to be *higher* than workers in industries with a lower portion of intermediate-use output.

The difference is larger for workers in services than across all industries combined. This shows that the positive relationship between the IFT ratio and wages is higher for services than for goods and services combined: a worker employed in a service industry with a high IFT ratio is *more likely* to have higher *wages* than a similar worker employed in a low IFT ratio service industry, compared to a worker employed in any high IFT ratio industry versus a low IFT ratio industry. Including demographic controls in the regression improves the overall r-squared and the significance of the IFT ratio coefficients for each industry grouping. It also reduces the coefficient on the IFT ratio variable in each case, although this is more pronounced within services industries. We know that demographic factors like race, gender, age, and geography are in many cases a strong predictor of wages; the results in table 3 indicate that the demographic factors are more strongly associated with wages in service-producing industries.

At first glance, these findings look very different from what other researchers have found in case studies of outsourcing, in which outsourced workers have experienced a wage penalty relative to in-house workers (Batt & Nohara, 2009; Dorn et al., 2018; Dube & Kaplan, 2010; Goldschmidt & Schmieder, 2017). However, in each of these studies the authors were comparing workers in specific occupations across a very limited selection of industries. In contrast, I am looking at all occupations across a much broader selection of industries, using the IFT ratio as an empirical tool for furthering our understanding the full scope of industries in which an industry's IFT *might* have consequences (positive or negative) for workers' wages.

The negative coefficient on the FIH services variable in industry group 3 suggests that this may be an important link between my approach and the approach taken in other studies of outsourcing. Although the positive relationship between the IFT ratio and wages for service industry workers is even more pronounced when FIH services are included as an explanatory variable (group 3), *the coefficient on the FIH variable is negative*. That means that FIH has a negative effect on the overall positive correlation between intermediate output in service industries and workers' wages. This suggests that some workers employed in industries producing FIH services have lower wages, on average, compared to workers in other service industries with high IFT ratios. This partially aligns with my expectations based on the literature on domestic outsourcing: there does appear to be a wage penalty associated with employment in a FIH industry (which by definition produce more intermediate than final use output) compared to other high IFT ratio industries, although the relationship between the IFT ratio and wages for services overall is positive. These results suggest that among high IFT ratio service industries there are (at least) two important groups: industries that produce FIH services and those that produce services that could not be feasibly produced in-house.

Table 3. Estimated relationship between industry IFT ratio and wages – coefficients for key variables (2007, 2014)

Industry groups	Variable	Coefficient in the simple OLS regression (R^2)	Coefficient in the OLS regression with demographic controls (R^2)
1. IFT for all goods and services	IFT ratio	.297* (.02)	.262** (.31)
2. IFT for services	IFT ratio	.475* (.05)	.305** (.31)
3. IFT for services, including a variable for FIH services	IFT ratio	.713** (.08)	.424** (.32)
	FIH[I]	-.343**	-.170**

*Significant at 0.05
**Significant at 0.005
[I] A dummy variable indicating whether or not an industry is FIH
Source data: Author's analysis of the Bureau of Economic Analysis make and use tables (2007) and the American Community Survey (2014)

Occupation case studies

I turn next to an analysis of the correlation between the IFT ratio and wages for two occupations. This part of the analysis develops an interpretation of the findings reported in table 3, and generates hypotheses for further investigation of the relationship between IFT and the wage determination process. This analysis also explores more closely the connection between my analysis of IFT and wages and prior studies on outsourcing and wages.

Again, the regression is used as a descriptive technique to explore the correlation between the IFT ratio and wages. The utility of these occupational case studies is that they allow us to explore the relationship between the IFT ratio and wages while holding occupation constant – this limits a lot of variation compared to the analysis of the IFT ratio based on industry groupings. While there is not a formal hypothesis that I test in these analyses, I explore the possibility that the IFT ratio is associated with lower wages in certain industries or groups of

industries. For instance, I expected to see that certain intermediate-use industries, specifically those that produce FIH services, tend to pay lower than median wages for an occupation.

Janitors

Janitors are an archetypal occupation where research has identified a wage penalty for certain forms of outsourcing. These jobs often require less highly-specialized skills or formal training, and as such they may be relatively easy for firms to contract out as a strategy for reducing labor costs. In a 2010 paper, Dube and Kaplan find that the outsourcing penalty ranged from 4 to 7% for janitors in the 1980s and 1990s (Dube and Kaplan 2010). Specifically, they compare wages for janitors and guards in the services to buildings and dwellings industry (the contractor industry, in this case) to workers in all other industries, tracking wages and employment over two decades. In this approach, they consider *only* janitors and guards employed in the services to buildings and dwellings industry to be "outsourced," meaning that janitors and guards in *all other industries* are considered to be employed "in-house," regardless of the extent to which the other industry produces intermediate-use output.

My analysis takes a different approach to defining the point of comparison between industries: instead of selecting a particular outsourced industry, I consider the extent to which *any* industry employing janitors is producing output that other firms are purchasing as intermediate inputs. That is not to suggest that all of these industries should be considered "outsourcing" industries per se, or that we would necessarily expect that Dube and Kaplan's findings about the wages building services industry will apply to all other intermediate-use industries as well. Instead, the purpose of my approach is to point out that there are many different types of industries selling their goods and services to other firms, and that, in order to understand the

potential reach of the relationship between domestic outsourcing and wages identified by Dube and Kaplan, we should start by exploring the relationship between IFT for all industries, and from there narrow our focus.

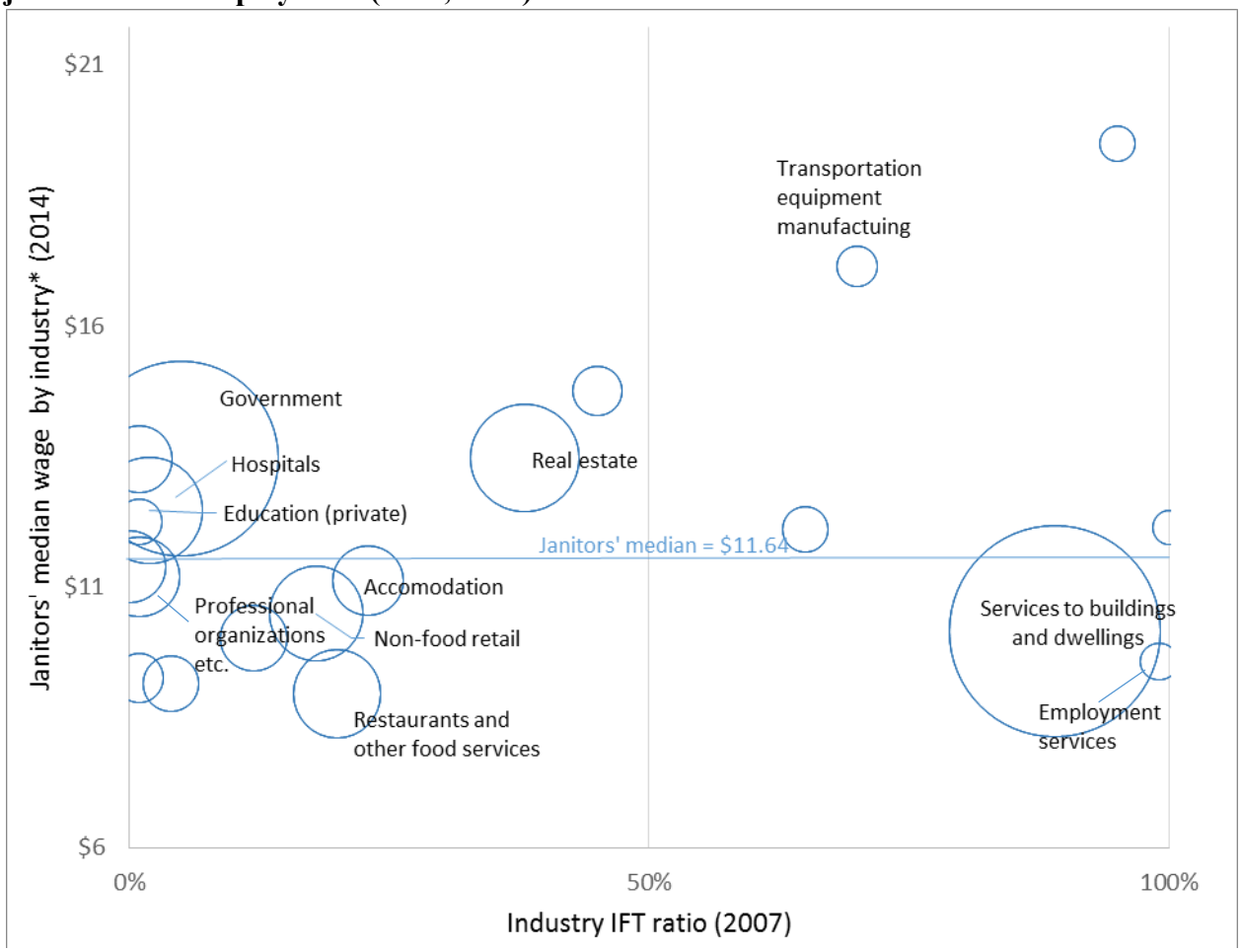
Figure 1 illustrates my approach, and how it differs from Dube and Kaplan's. In this chart, I plot janitors' median wages (2014) based on the industry in which they are employed against the IFT ratio for each industry (2007), weighting each point by the share of janitors employed in that industry in 2014. I also show the overall median wages for janitors in 2014, which was $11.64 per hour.

Here, we can see that janitors employed in the services to buildings and dwellings industry are paid lower wages than janitors overall, confirming Dube and Kaplan's findings. However, we can also identify other industries in which janitors are paid less than in the services to buildings and dwellings industry, such as employment services (an intermediate-use industry) and restaurants (a final-use industry). We can also identify which industries tend to pay janitors better than median wages, such as transportation equipment manufacturing (an intermediate-use industry) and hospitals (a final-use industry).

Using the basic regression from table 2 to estimate the correlation between the industry IFT ratio and wages for janitors yields a slightly negative, but not statistically significant, coefficient on the IFT ratio. I include all goods and services industries in the regression sample. However, the chart shows the individual industries that employ janitors, allowing us to identify the major goods (e.g. chemical manufacturing), services (e.g. restaurants), and FIH services (e.g. employment services) industries that employ janitors. From here, we can parse out possible explanations for the differences in wages between janitors in different industries, and the develop

hypotheses about the potential role of the IFT ratio for individual industries and/or groups of industries.

Figure 1. Janitors' median wages and IFT ratio by industry, weighted by the share of janitors' total employment (2007, 2014)



*The y-axis range includes 50 to 200% of the occupations' median wage.
Notes: Bubble size represents share of janitors' total employment. Bubbles only included for industries employing over 1% of all janitors. Industry IFT ratio is the ratio of intermediate output to total gross output (intermediate + final use output) for an industry.
Source data: Author's analysis of the Bureau of Economic Analysis make and use tables (2007) and the American Community Survey (2014).

The median hourly wage for janitors in 2014 was $11.64, but as the figure makes clear, janitors' wages vary significantly by industry, within both the intermediate-use industries and the final-use industries. As noted above, I do not see a strong negative correlation between median

wages and the IFT ratio; it is weakly negative at best, with a -0.02 estimated coefficient on the IFT ratio (not statistically significant). A closer analysis of the constituent industries reveals several dynamics in play.

I first focus on the intermediate-use industries shown in the right-hand quadrants of the graph. The largest proportion of janitors (24%) is employed by the services to buildings and dwellings industry, which is the main industry providing janitorial services to other companies. This industry is also considered a FIH industry in this analysis, because the services provided by a firm in the services to buildings and dwellings industry (e.g. janitorial services, etc.) could feasibly be carried out by the purchasing firm directly instead, using workers that they would employ directly. At $9.97 an hour, these janitors earn 14% less than the median wage for all janitors. This finding confirms the findings of Dube and Kaplan. However, other intermediate-use industries pay their janitors better wages, and some significantly so. For example, chemical manufacturing and transportation equipment manufacturing are both intermediate-use industries. They employ a significant number of janitors, with median wages of $19.31 and $16.96, respectively.

A number of plausible explanations could account for this difference among intermediate-use industries. For example, the building services industry largely sells only janitorial and similar services, which have low profit margins and where competition is fierce, resulting in significant pressure to cut labor costs. Manufacturing industries, on the other hand, typically sell products that have higher profit margins (generally correlated with higher wages), and janitors are only one of many occupations in those industries. Alternatively, it may be that these two manufacturing industries shown here are more dangerous and/or require a more specialized skill set for their janitors. In addition, segments of both manufacturing industries may

have union density in some occupations, and there might be a spill-over effect for janitors' wages.

I return to these explanations below, but for now the main point is that there is significant variation in janitors' wages within intermediate-use industries, rather than the uniformly low wages that we observe if we consider only the services to buildings and dwellings industry.

I next examine the left-hand quadrants of the graph, populated by final-use industries in which firms are employing janitors. Several final-use industries pay their janitors above median wages. For example, a large proportion of janitors (21%) is employed by government and earns a median of $13.27 per hour. This may be the result of higher labor union density in the public sector and wage spillover effects for non-union, government-employed janitors (Krueger, 1988). The union wage effect may also spill over to private institutions with public sector counterparts such as schools and hospitals, which also pay above-median wages for janitors.

Real estate is another industry that pays janitors above the occupation's median wage. Of particular interest, the real estate industry is one of the largest *customers* of the services to buildings and dwellings industry, accounting for 30% of total output from the services to buildings and dwellings industry. Therefore, the 25% difference in wages between janitors employed in-house by the real estate industry and those working in the building services industry offers suggestive evidence of the kind of outsourcing-related wage penalty identified by Dube and Kaplan, in relation to the IFT ratio.

However, figure 1 also shows significant numbers of final-use industries that pay low wages to their janitors – in some cases as low or lower than the services to buildings and dwellings industry. These are service industries such a retail, restaurants and accommodation,

which typically pay low wages to most of their front-line employees, not just janitors, regardless whether they employ janitors directly or purchase these services from another firm. In these firms, margins are typically quite thin and union representation low; the resulting low wages may mean that there is little incentive to outsource functions like janitorial services as a strategy to reduce labor costs. Or, if firms in these industries do outsource janitorial services they may do so for other reasons.

The other group of final-use industries that pays low wages for janitors includes social assistance and other non-profit firms. In these industries, budgets are often tight and wages for all workers tend to be lower than for many of their private-sector counterparts. I discuss the low-wage service sector in more detail below; the important point here is that the sector's low wages for in-house janitors complicates the analysis of the IFT ratio's connection to wages.

Technology workers

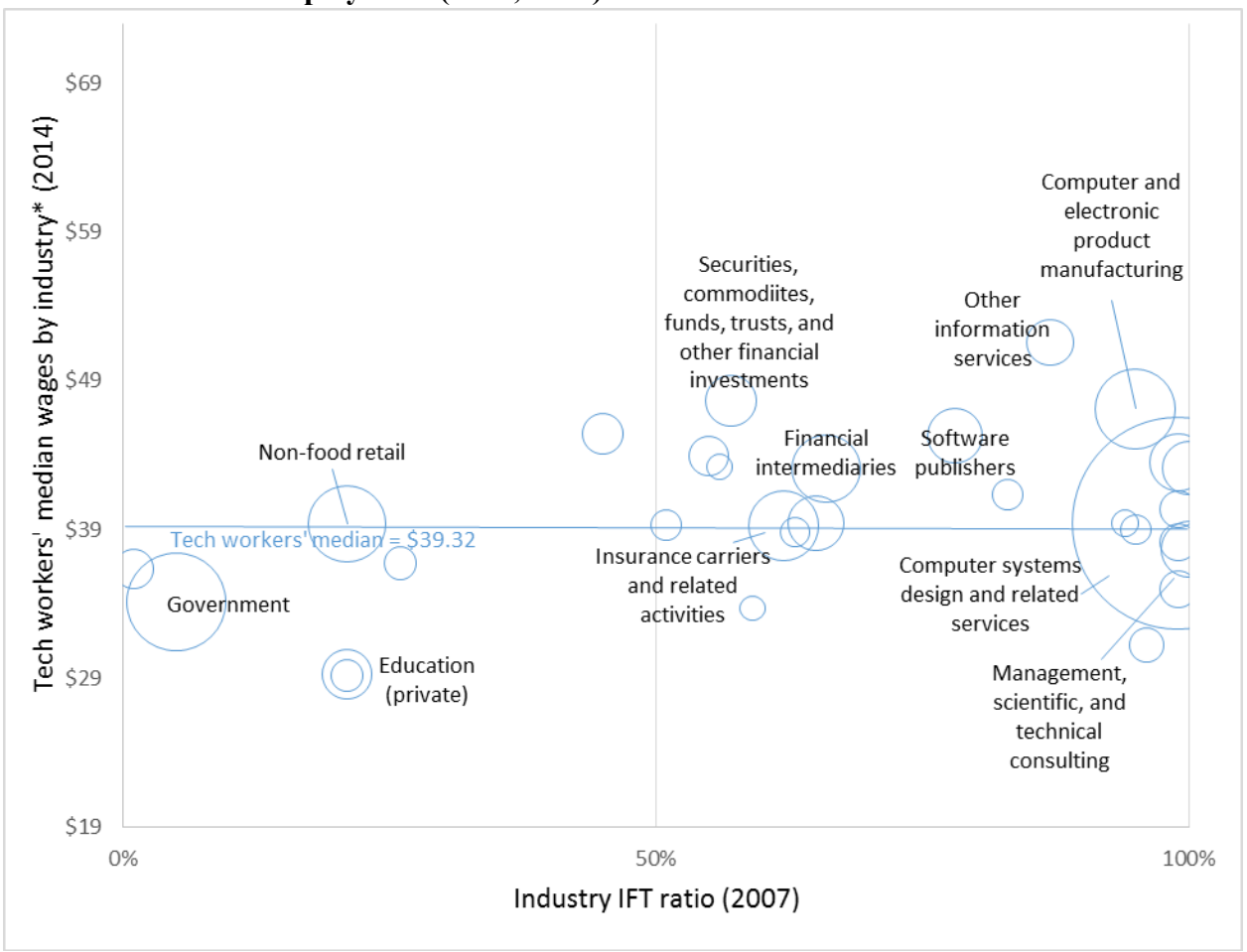
I next analyze the following group of technology workers: software developers, applications and systems software designers, computer programmers, and web developers. Workers in these occupations are typically paid high wages ($39.32 per hour in 2014), and also have more formal education and training – nearly 80% of tech workers had completed a four-year degree or more in 2014.

The computer systems design and related services industry employs the greatest share of tech workers, and it is considered a FIH industry. However, we might not expect to see a negative association for workers' wages in this industry because tech occupations are typically high wage occupations with additional educational requirements. For instance, a firm might outsource computer services because they do not have the technical expertise in house, or

because a computer services firm can offer a more highly-skilled, highly-specialized service than they could provide on their own. On the other hand, tech workers could be outsourced to a separate firm in some cases for very similar reasons as a firm might outsource janitorial services, for instance to reduce labor costs.

Estimating an OLS regression for tech workers reveals a positive correlation between the IFT ratio and wages overall; the estimated coefficient on the IFT ratio is 0.15 (significant). Figure 2 illustrates the relationship between tech workers' wages by industry and each industry's IFT ratio.

Figure 2. Tech workers' median wages and the IFT ratio by industry, weighted by share of tech workers' total employment (2007, 2014)



*The y-axis range includes 50 to 200% of the occupations' median wage.

Notes: Bubble size represents share of tech workers' total employment. Bubbles only included for industries employing over 1% of all tech workers. Industry IFT ratio is the ratio of intermediate output to total gross output (intermediate + final use output) for an industry. Source data: Author's analysis of the Bureau of Economic Analysis make and use tables (2007) and the American Community Survey (2014).

I start my dissection of these findings by analyzing wages in intermediate-use industries, which employ a large majority of tech workers. This finding in itself is important, indicating that tech workers often work for industries engaging in IFT, rather than transactions with final users. Dominating the intermediate-use industries is computer systems design and related services, which is the main employer of these occupations (employing 35% of all tech workers). As such, it largely drives the median wage. Clustered around it are many smaller industries, with significant variation in wages. For example, financial intermediaries pay $43.11 per hour; the securities industry pays $47.67 per hour; and computer and electronic manufacturing pays a median wage of $47.13 per hour. On the other hand, a number of other industries pay below the median wage for all tech workers, including insurance carriers ($39.29 per hour) and management, scientific, and technical consulting services ($37.72 per hour). This spread in wages is striking, especially given that tech occupations are considered highly-skilled and arguably perform critical functions in all of these industries. Closer analysis reveals several dynamics that may be at work.

Among the intermediate-use industries in this graph, technology-related industries tend to pay at or above the median for tech workers (although there is some variation; for example, the data processing and hosting services industry pays just below the median wage). So while tech occupations are likely important in most industries, they are at the core of industries that focus primarily on technology production.

There appears to be a correlation between average industry pay and the pay of tech occupations. In other words, higher-wage industries tend to pay their tech workers higher wages – such as the financial investments industry, utilities, and architectural and engineering services. Higher wages for tech workers in these industries may simply reflect higher profit margins that are distributed throughout the workforce in the form of higher wages, or they may reflect a distinctly specialized set of skills required of tech workers in these industries and their relative importance to these industries' production. Likely it is a combination of these factors.

Conversely, intermediate-use industries that pay below median wages overall (in comparison to the other industries employing tech workers) tend to pay relatively lower wages for tech workers as well, such as non-durable and machinery manufacturing, advertising, publishing, and broadcasting. While it is possible that tech workers in these industries have less highly-specialized or developed skill sets, it is also possible that these industries simply cannot afford to pay them higher wages due to their profit structure and relative position in the production network.

It is not a hard rule that industries paying higher median wages for all occupations also pay higher than median wages for tech workers, however. In a few cases lower-wage industries pay higher wages for tech workers (e.g. banks, transportation equipment and other durable manufacturing). This may reflect an especially specific skill set required of tech workers in these industries.

Looking at the left-hand side of figure 2, we see a familiar group of final-use industries – but again, markedly fewer than in the case of janitors. Tech workers in the non-food retail industry are paid roughly at the median for all tech workers, but those working in government,

education, and health care are paid less. The fact that tech workers in the public and non-profit sectors are paid less than most of their private sector counterparts is unsurprising. Although the public sector tends to pay higher-than-average wages for low-wage occupations, it tends to pay lower-than-average wages for high-wage occupations (Borjas 2002).

Discussion

In the previous section I investigated the relationship between an industry's IFT ratio and workers' wages. This represents a distinct conceptual approach compared to other empirical research on outsourcing, in which researchers have identified a wage penalty for certain types of workers in specific industries. My analysis starts with a very broad question: can we identify a correlation between workers' wages and the extent to which their industry is supplying inputs to other firms? This question was posed as a starting point for exploring the use of an empirical measure of IFT as a tool to further our investigating domestic outsourcing and its wage effects for different industries and groups of industries.

While I did not pose a formal hypothesis about the relationship between IFT and wages, prior research on outsourcing did lead me to have expectations about the kinds of industries and occupations in which I might be most likely to observe a negative association between IFT and wages. Specifically, I expected that I would see lower wages for workers employed in FIH industries, in particular workers in occupations with lower median wages overall.

Across all industries, and within service industries alone, I observed a *positive* correlation between the IFT ratio and wages across all industries. However, I also observed that the FIH industries variable has a negative effect on this relationship, suggesting that there are important distinctions between wages in FIH industries and other intermediate-use service industries.

To further understand these observations, I selected two occupations in which to examine the relationship between the IFT ratio and wages more closely. Two additional occupations, motor vehicle operators and financial clerks, are discussed in Technical Appendix 10. Holding the occupation constant enabled a deeper analysis of the many possible factors affecting wages in each industry – including but not limited to the portion of an industry's output that is intermediate. These occupational case studies allowed me to develop a richer explanation for the observed correlation between the IFT ratio and wages for each occupation, and revealed a more nuanced and complex picture of the dynamics affecting wage-setting in the context of industries' IFT.

By extrapolating from the relationships observed in each of the case studies, I was able to generate several hypotheses about the factors that affect wage setting in intermediate-use and final-use industries. These hypotheses offer an explanation for why a negative association between the IFT ratio and wages does not exist across all industries, even though it does appear for certain occupations employed in FIH industries. Specifically, I explain the prevalence of *low wages among workers employed in final-use industries*, and the prevalence of *high wages in intermediate-use industries*. In both cases, the relationship between the IFT ratio and wages is the opposite of what we would expect to see for occupations and industries in which the literature has identified a wage penalty associated with outsourcing.

1. Prevalence of low wages for workers in final-use industries

Some of the biggest industries in the U.S. in terms of employment, such as retail and restaurants, also pay among the lowest wages. These industries are also producing mostly final-use, consumer-facing services rather than intermediate services for use by other firms or

government. That is to say, the employees of these industries are "in-house" rather than employed by a contractor firm. This is an important reason why the aggregate correlation between an intermediate output and wages is negative: there are many workers employed in industries with low levels of intermediate output (a low IFT ratio) who earn low wages.

The prevalence of low wages in final-use industries shifts attention to the overall wage-setting processes and trends of these industries. It may be that the downward pressure on wages for workers throughout these industries has reduced the incentive for firms to outsource functions like janitorial services, because they already pay competitively low wages for these (and other workers) when they are employed in-house. Or, in some cases they may outsource for other reasons besides reducing labor costs, and pay comparably low wages for outsourced workers. This suggests that other trends affecting wages in these industries – such as low profit margins, financialization, ownership consolidation, deunionization, deregulation, and the declining minimum wage – are potentially more important than outsourcing in terms of wage setting.

There are other types of final-use firms that tend to pay low wages on average, as well. In particular, non-profit and non-governmental social services organizations tend to pay lower than median wages for many occupations. The reasons for this may be distinct from the reasons why for-profit firms pay low wages, such as restricted sources of funding and limited budgets, but the effect on the overall correlation between intermediate output and wages is similar: workers earning low wages in industries with low intermediate output contributes to the positive correlation between intermediate output and wages across industries.

It is also important to keep in mind the question of timeline. It may be the case in some industries that a majority of firms that might have outsourced a particular set of functions have already done so. If so, then higher wage, final-use industries have already outsourced non-core functions to lower-paying contractor firms, leaving behind the low-wage, final-use industries that faced less pressure to outsource because they already paid low wages (or wages were being pushed down for other reasons). Dube and Kaplan's study of security guards and janitors provides some evidence that outsourcing has mainly occurred in industries with higher margins (Dube and Kaplan 2010). This suggests that similarly in-depth studies of additional commonly-outsourced occupations would be useful.

There are two important exceptions to the broad prevalence of low wages for workers in final-use industries. First, among low-wage occupations, government employers tend to pay above-average wages. This is partly due to wage-setting dynamics that are distinct from the private sector (e.g. prevailing wage policies), and partly due to the presence of unions in many public-sector workplaces. Unions are also present in much smaller numbers in certain private sector final-use industries, such as grocery stores. In January 2020, 33.6% of public sector workers were members of a union, compared to only 6.2% of private sector workers (Bureau of Labor Statistics, 2020). For public and private sector workers requiring less formal training, the presence of unions on average raises workers' wages through collective bargaining and/or public policy. There may also be union spillover effects that raise wages for similar groups of non-union workers in industries where unions are strong, although these have weakened significantly over time as union density in the private sector has fallen (Bernstein 2016; Rosenfeld, Denice, and Laird 2016).

2. Prevalence of high wages (and high variation in wages) for workers employed in intermediate-use industries.

Another reason why the aggregate correlation between the IFT ratio and wages is positive is that there is considerable variation in wages among the intermediate-use industries, and some pay higher wages compared to final-use industries. Exploring these relationships in the occupational case studies raised some interesting questions and possible explanations.

One explanation may be that variation in industry-level profit margins drives wage-setting in intermediate-use industries. A high-margin intermediate-use industry, such as finance or tech, may share its margins with its workers, leading to higher wages. This raises the question: why do some firms and some industries share their margins with workers, and others do not? Additionally, workers in high-margin industries that are typically paid lower wages in other industries may be paid more in a firm in a high-margin industry due to a tendency of some firms to avoid extreme wage disparities, known as wage compression (Akerlof & Yellen 1986, 1990). For example, a successful tech company that mostly sells its products or services to other companies may pay higher-than-average wages both to its software engineers as well as to employees in occupations that may typically receive lower wages, such as financial clerks.

Another possibility raised by the occupational analysis is that the level of formal education or training required by an occupation may determine how an industry's intermediate output relates to wages. Occupations that typically require more specifically-defined and formally-recognized training may have greater power in wage-setting than occupations requiring less formal education. This may, in some cases, allow them to benefit more from an arrangement in which they can sell their services to multiple clients (e.g. by working for a specialized type of

intermediate-use firm like a law firm or a consulting firm), compared to working in-house for a single client[18] (Carnoy, Castells, and Benner 1997). We observe this dynamic to some extent in the case of tech workers, which typically have some formal education and tend to be paid more in intermediate-use industries.

In contrast, occupations requiring less formal education may suffer from a diminished ability to affect wage-setting in intermediate-use industries, especially if the occupation is highly concentrated in the industry. This scenario aligns most closely with prior studies of domestic outsourcing, and our expectation that certain occupations may experience a wage penalty when employed in intermediate-use, FIH industries. Janitors offer an example: janitors employed in building services firms are typically paid less than most other janitors. However, there is not a strong negative correlation overall between industry intermediate output and janitors' wages, because of low-wage, final-use industries, and other intermediate-use industries that pay higher wages for janitors.

A second skill-related explanation that emerged from the occupational analysis is that the degree of specialization within an occupation may be an important factor influencing wages by industry. That is, certain workers may be paid more in an industry that requires a highly tailored or specialized application of their skills, and paid less in an industry that requires a more generalized skill set – the case study of financial clerks in Technical Appendix 10 provides an example. On the other hand, for occupations that require more formal training, working for a firm dedicated to the services provided by that occupation may actually be beneficial to workers'

[18] Which, of course, may be in an intermediate or final use industry.

wages. For instance, tech occupations tend to be paid at or above average wages when employed in industries providing tech-specific services.

This points to a third skill-related explanation: occupations that are a *core part of the production process* in their industry may be able to command higher wages. Literature on business strategy suggests that outsourcing is driven in large part by firms increasingly specializing in their core competencies, seeking to gain competitive advantage by shedding lower value-added or non-core tasks to outside entities and retaining the core jobs in-house (Lepak and Snell 1999; Porter 1985; Prahalad and Hamel 1990). This could have the effect of raising wages for the more skilled, specialized occupations that are a critical part of their industry's production process (e.g. tech workers in tech industries), while reducing them for the non-core occupations. This raises the important questions of what defines an occupation as "core," in which industries does being a core occupation increase wage-setting power or not, and how does this relate to a firm's production of intermediate or final-use output?

A final explanation for higher wages in intermediate-use industries is the presence of unions, past or present. Unions give workers greater wage-setting power through collective bargaining over wages, benefits, career ladders, etc. Non-union firms in industries with a strong union presence may try to match these levels to compete for employees (Doeringer & Piore 1971; Jacoby 1985). The effect of unions on workers' wages appears to hold both for final-use and intermediate-use industries in the public or private sector, as we can see for janitors. Even in some industries where union representation has declined significantly, like trucking or manufacturing, there may be a lingering effect of unions on workers' wages.

Conclusion

This analysis shows us that, across broad groupings of industries, we do not observe a negative correlation between the IFT ratio and wages. This holds true for some specific occupations where prior research on domestic outsourcing might have led us to expect a negative correlation across industries. Across all occupations in aggregate, we in fact see a positive correlation between industries' IFT ratio and wages. Of course, these findings do not in any way call into question prior research documenting a lower wages associated with outsourcing for specific industries and occupations. Instead, these findings help improve our understanding of how to define outsourcing, and where to look for outsourcing-related wage penalties.

One motivating factor for this study was to broaden the scope of the narrowly-focused studies of outsourcing in certain occupations and industries, to test the possibility of developing an empirical strategy for estimating the trend and its consequences more widely across the economy. I used data on IFT between industries to aggregate intermediate output across three groupings of industries, according to the typology I developed in (Hammerling 2021): IFT for all industries combined, for services industries only, and for FIH industries.

The latter grouping is the most closely related to prior studies of outsourcing. My analysis revealed that workers in FIH service industries tend to be paid less compared to workers in other service industries, even though the aggregate correlation between IFT and wages for workers in service industries is positive. This suggests that categorical distinction based on the type of intermediate-use service produced may point to important factors for identifying outsourcing-related wage penalties, rather than looking at the volume of IFT alone.

Just as the purpose of this study is not to dispute prior studies, it is not intended to replicate or confirm prior findings either. Rather, the point of this exercise is to expand our understanding of domestic outsourcing and its relationship to IFT in general. What we have learned in this analysis is that the portion of an industry's output that is part of a transaction with another firm is positively correlated with workers' wages, overall. This suggests that the type of IFT associated with a wage penalty in certain occupations and industries represents a distinct subset of IFT.

This finding is a starting point for analysis rather than a conclusion. My results suggest that an aggregated analysis of the correlation between IFT and wages provides incomplete evidence about the complexity of this relationship, and why it looks different under different circumstances. What's needed next is additional layers of analysis to systematically examine where the relationship between the IFT ratio and wages is positive and where it is negative, and then begin to test hypotheses about why.

The occupation case studies represent a first step toward further analysis of domestic outsourcing and wages using the IFT data. These analyses help to explain the aggregate results, and identify important variation in the correlation between the IFT ratio and wages for different cross-sections of occupations and industries. In particular, we observe that certain kinds of occupations in certain kinds of intermediate-use industries tend to be paid less than some other intermediate- or final-use industries.

The occupation case studies explored the relationship between some of the factors related to inter-industry wage differentials and an industry's IFT ratio, revealing several possible explanations about why the aggregate correlation between the IFT ratio and wages is positive.

These analyses also drew attention to other changes in U.S. industrial relations that have hurt wages for many workers in final-use and intermediate industries alike, such as deregulation, union decline, and financialization. It also showed how different occupations may fare differently in different kinds of intermediate-use industries, depending on the level of formal or specialized skills required in an occupation, the typical industry wage structure and margins, whether or not a worker is employed in the public or private sector, and whether an industry has significant union density.

While the case studies help us begin to develop some hypotheses about patterns in the types of IFT in which an outsourcing-related wage penalty appears, specifying these patterns is a topic for a future study. The analysis of FIH services helps move us toward this objective, but the case studies show that even among FIH industries wages for workers may vary considerably, below and above the median wages for an occupation. This variation suggests that we need to specify our definition of domestic outsourcing with great care. What emerges from these occupation-specific analyses is a need to further refine and specify our definition of domestic outsourcing in relation to IFT, especially as we discuss trends in relation to its consequences for workers' wages. This may involve additional analysis using the I-O data or other sources of information on IFT and workers' jobs and wages. It may ultimately propel an analytic focus toward a deeper understanding of the positional location of industries and occupations within production networks.

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Supplemental Technical Appendices

Penalties and premiums:

An investigation of inter-firm transactions and wages across industries in the U.S.

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Contents

Appendix 1. Data sources

BEA Input-Output Accounts Data: The BEA's I-O accounts are a primary component of the U.S. economic accounts. They function as the building blocks for other economic accounts, including the BEA's national income and product accounts (NIPAs), which feature the estimates of gross domestic product (GDP). The I-O accounts also provide a detailed view of the interrelationships between U.S. producers and users and the contribution to production across

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industries. These accounts are used by policymakers and businesses to understand industry interactions, productivity trends, and the changing structure of the U.S. economy. Most of the data in the I-O accounts comes from the Economic Census (Horowitz and Planting 2006). https://www.bea.gov/industry/io_annual.htm

Economic Census: The Economic Census is the U.S. Government's official measure of American business and the economy. U.S. Census Bureau conducts the Economic Census every five years, for years ending in '2' and '7'. Information from the Census covers more than 1,000 industries, 15,000 products, every state, over 3,000 counties, 15,000 cities and towns, and Puerto Rico and other U.S. Island Areas. All but the smallest businesses are sent surveys. https://www.census.gov/programs-surveys/economic-census/about/faq.html

American Community Survey (ACS): The ACS is an annual survey conducted by the U.S. Census Bureau on a sample of the U.S. population. Each year, the Census Bureau contacts over 3.5 million households across the country, inviting them to participate in the ACS. The Bureau selects a random sample of addresses to be included in the ACS – each address has about a 1-in-480 chance of being selected in a month, and no address is selected more than once every 5 years. The survey includes information gathered in the long-form decennial census, such as social, economic, housing, and demographic data. This information is compiled by the Census Bureau and then used by federal, state, and local government, non-governmental organizations, businesses, educators, media, and the public to better understand changes and trends in their communities (U.S. Census 2017). https://www.census.gov/programs-surveys/acs/

Quarterly Census on Earnings and Wages (QCEW): The QCEW is a quarterly count of employment and wages reported by employers covering more than 95% of U.S. jobs, available at

the county, MSA, state and national levels by industry. The primary source for the QCEW is administrative data from state unemployment insurance (UI) programs. https://www.bls.gov/opub/hom/cew/home.htm

Current Employment Survey (CES): The CES survey, also known as the payroll survey, is based on a survey of approximately 149,000 businesses and government agencies representing approximately 651,000 worksites throughout the United States. The primary statistics derived from the survey are monthly estimates of employment, hours, and earnings for the Nation, States, and major metropolitan areas. https://www.bls.gov/ces/

Appendix 2. Note on investment

It is important to note that I consider "investment" use to be an intermediate use and include it in my measure of IFT as such. The I-O accounts treat investment as a final use category, but for my purposes it makes more sense to think of it as intermediate.

Investment is considered a final use in the I-O data. Specifically, GDP equals C + I + G + NX (consumption, investment, government consumption and investment, and net exports). Intermediate inputs, by definition, eventually end up in one of these final use categories, which is why GDP does not include intermediate output (because that would be considered double-counting). A purchased commodity is determined to be either an investment or an intermediate input based on whether it is entirely used up in the production process, or whether it is used repeatedly over time. The classic example would be flour that is consumed in a food production process (intermediate input), versus a machine used repeatedly for manufacturing (investment).

This example seems clear enough, but when you consider investment in services (non-tradeables) the distinction between what counts as an intermediate input and what counts as final use investment becomes murky.

The question of what is a permanent (or even semi-permanent) input into production becomes harder to answer when we look at services. For example, many industries purchase services from the information sector, and often these purchases are recorded as investments, such as purchases from software publishing, motion picture, and cable network firms. Viewed one way, this makes sense – these are effectively intellectual property investments and as such can be viewed as permanent. But viewed from the standpoint of my project, one could argue that programmers employed by a software company selling to other companies should in fact be counted as part of the contract workforce – especially since a given version of software typically has a short half-life, often less than a year. As it stands, in my current data, several business services industries are recorded as having very little intermediate production, with much of their output being recorded under investment. In order to cast a broad net for my definition of IFT and avoid overlooking transactions that may be part of a related dynamic, I include investment as an intermediate output in my analysis. This follows the basic logic of this project, which starts by exploring the breadth of what transactions I consider to be potentially relevant for understanding trends in domestic IFT. Further analysis to refine this approach to investment would be a worthwhile follow-up investigation.

Appendix 3. Constructing the IFT ratio

To measure domestic inter-firm transactions, I transform the make and use tables so that I can construct an industry by industry table, showing each industry's domestic output purchased by domestic users for intermediate or final consumption. With this industry by industry table, I then calculate the portion of each industry's total domestic output that is used for intermediate domestic consumption.

There are 4 basic steps in constructing the estimates:

1. Remove inapplicable categories from the make/use tables
2. Construct a market share matrix based on the modified make table
3. Multiply the market share matrix by the modified use table
4. Calculate the proportion of industry output for intermediate consumption

I walk through each of these steps, beginning with the selection of the source tables, pointing out key concepts and definitions along the way.

Source data:

- Make table: 2007, before redefinitions
- Use table: 2007, before redefinitions, producers' values

Notes:

- **Before redefinitions:** I use the make/use tables before redefinitions, which leaves an industry's secondary output in the same industry category as its primary output, rather than redistributing secondary output into its own primary industry. An example is an in-

house restaurant owned by a hotel, which would be classified as hotel industry output before redefinition, and food service industry output of food services after. For my purposes, I need the before-redefinitions version of the data, because I want to make sure that intermediate production by the food service industry (in this case) is a clean measure of transactions between different firms.

- **Auxiliary establishments**: I investigated the potential problem posed by the NAICS reclassification of auxiliaries; see Appendix 5.
- **Producers' prices vs. purchasers' prices:** I use producers' prices, because purchasers' prices also include the cost of trade margins (transportation, taxes etc.), which I want to separate out into their own industries unless they are provided in-house. I'm assuming that the cost of any in-house transportation – e.g. if Walmart owns its own fleet of trucks – is still captured in producers' prices.
- **Self-employed:** Unincorporated self-employed are treated the same as incorporated self-employed in the data. That is, both types show up as producers and purchasers in the make and use tables.[20]

Step 1. Remove inapplicable categories from the make/use tables

I am estimating domestic production for domestic consumption, so I must remove imports, exports, and related categories from the data. Additionally, I must remove commodities or use categories that do not represent production[21] (e.g. second-hand goods) or consumption. I must

[20] An important caveat to note is that the economic activity of independent contractors is recorded in the I-O Accounts data in the same way as it is for firms. Therefore, the output of independent contractors contributes to both intermediate and final use output. This isn't an issue for the IFT measure per se, but when I merge the ACS data to the measure to analyze the relationship between industry contracting and worker wages, I will be considering them both as an industry and as an employee.

[21] I do not remove scrap production or consumption from the data.

also eliminate the value-added categories of the use table, which are not relevant to the measure construction.

Most of these categories can simply be eliminated by removing rows or columns from one or both of the tables, including:

- Exports (use)
- Used and secondhand goods (make and use)
- Noncomparable imports (make and use)[22]
- Rest of the world adjustment (make and use)[23]
- Change in private inventories (use)[24]
- Value-added rows (use)
- Intermediate, final, and totals (make and use)

In order to remove imports, however, I must estimate the distribution of imports of each commodity across the use table rather than simply eliminating the imports column, because some imports are for intermediate consumption and some are for final consumption. This is explained in greater detail below.

I *do not need* to construct a similar estimate in order to remove exports or change in private inventories from the make table because I only use a percentaged version of the make table (see below), making a proportionally-estimated adjustment to the absolute values unnecessary.

[22] Horowitz & Planting, 2006: 7-10
[23] Horowitz & Planting, 2006: 7-11
[24] This does not represent output that is also consumed (because the output is ending up in private inventories), so I remove it from the table.

Step 1a. Construct a domestic use table by removing imports

In order to measure only domestic consumption, I remove imports from the use table data. BEA publishes an import matrix that shows the use of commodities for intermediate and final consumption; however, this is based on the "after-redefinitions" use table, and I need "before-redefinitions" data to construct my measure. Therefore, I construct an import matrix based on the BEA's methodology,[25] but using the before-redefinitions data.

The steps for constructing the import matrix are:

- Calculate the import to domestic supply. Domestic supply is the total amount of a commodity available for consumption within the U.S; it equals domestic output (the total of each commodity row in the use table), plus the absolute values in the import column, minus exports and change in private inventories for each commodity (which I have already removed in step 1).
- Next, multiply the domestic supply by the commodity output for each row in the use table, after the modifications in step 1. The outcome is a table in the same dimensions as the modified use table that shows the imports of each commodity by intermediate or final consumers.
- Finally, I add the import matrix (the values in which are negative) to the modified use table in order to create the domestic use table.

Note:

[25] Horowitz & Planting, 2006: 12-5

- **Foreign vs. domestic port value:** In addition to using after-redefinitions data, the BEA's import matrices reflect the domestic port value of imports. However, the import column in the use table (which I use to construct a before-redefinitions import matrix) reflects foreign port value. I believe it is more accurate for my methodology to use the foreign port value, which subtracts the values of domestically-produced import support services (e.g. transportation) from the domestic port value of the imported commodity and then redistributes them in their domestic commodity categories.

Assumption:

- The construction of the import matrix makes the assumption that the imported proportion of a given commodity is the same for each consumer (that is, the import to domestic supply). In reality, the proportion of each commodity imported may vary by user.

Step 2. Construct a market share matrix based on the modified make table

A market share matrix shows the proportion of each commodity output that is produced by each industry. I construct this matrix with the make table (after the modifications in step 1) by dividing each cell of a commodity column by total commodity output. The result is a matrix with the same dimensions as the modified make table, showing the portion of each commodity's total output that is produced by each industry.

Step 3. Multiply the market share matrix by the domestic use table

Next, I multiply the market share matrix by the modified domestic use table. The result of this matrix multiplication is a domestic make/use table, which shows each industry's production for intermediate or final use.

Assumption:

- This step assumes that the commodity output profile of each industry on the make table is the same across the purchasing industries in the use table. In reality, industries may differ in the distribution of industries from which they buy a given commodity.

Step 4. Calculate the proportion of industry output for intermediate consumption

The final step is to calculate the proportion of each industry's domestic output that is consumed as intermediate or final use by domestic users. For each industry row, I sum output across the intermediate use columns, plus the investment columns, and divide by the sum of output across all columns (intermediate and final use). I use the same designations as BEA for intermediate or final users, excluding the columns omitted in step 1 and the investment columns that I count as intermediate (see Appendix 2).

Appendix 4. Discussion of methods and technical limitations

My approach to measuring IFT rests on data that capture the total dollar value of each industry's economic output (goods and/or services) that is purchased by different types of users,

including firms in other industries, government, or end-users.[26] The proportion of an industry's total output that is used as an intermediate input into another firm's[27] production process is the portion of the industry that is engaged in IFT. The proportion of an industry's output that is consumed as a final product by end-users is not IFT.

For example, a restaurant's sales to individual consumers is considered output for final use, and therefore *not* an IFT, but a caterers' sales to another company to provide food for meetings or special events is considered output for intermediate use, and therefore it *is* considered an IFT. Both transactions would show up as output of the food services industry, but the former would be captured as "final use" to consumers, and the latter would be counted as "intermediate use" inputs to the industry of the firm purchasing the catering services. To use another example, if a software company employs its own security guards, this is not represented as either intermediate or final output.[28] However, if a software company has a contract with a security company to provide security guard services, the dollar value of the security company's sales to the computer company is captured as output for intermediate use *from* the security services industry and *to* the computer systems design industry.

It is important to emphasize that this approach measures the dollar value of financial transactions between firms; it does not capture any information about the character of the transactions. For instance, it does not include information about whether transactions represent repeated or stand-alone events, whether the goods or services being exchanged are highly specialized or generic, or what the contracting terms are between actors – i.e. is the contract a

[26] Government can be an intermediate- or end-user.
[27] Or organization, or government entity.
[28] It is instead reflected as part of "labor value added" in the software industry, which a separate category from industry total output, and is reflected on the BEA's "Use" table in the bottom rows.

simple receipt for goods or services, or a detailed contract specifying deliverables between parties? Does the client have significant oversight of the contractors' work, or is their relationship arms-length?

My approach to measuring IFT also does not include information about the structure of the production network and the position of transactions within them, nor does it include information about specific firms (such as location, number of employees, etc.), since transactions are recorded at the industry level in the I-O data. Having this type of information would clearly contribute to a more thorough exploration of IFT, especially in relation to domestic outsourcing and other processes. Ultimately, we might decide that these kinds of distinctions are essential to our understanding of how outsourcing relates to workers' wages. First, however, it is important to consider the full breadth of the types of transactions we may wish to consider relevant to an analysis of domestic outsourcing, so that we can understand what trends exist and how broadly they extend throughout the economy.

There are important advantages to the approach I propose. We can measure trends in IFT across the economy and in different industries, creating a big-picture context for estimating trends related to domestic outsourcing. Because my approach measures IFT coming *from* the supplier/producer firm (intermediate *output*), rather than transactions flowing *to* the client/consumer (*input*), it allows us to consider a broader range of industries in which IFT occur, rather than hand-picking industries with well-known examples of outsourcing. For example, other studies on domestic outsourcing have selected industries like administrative support, employment services, cleaning services, or logistics as the outsourcing industries of interest. But what about computer systems design or data processing? Or travel reservation services? Or

drilling oil and gas wells? Should we consider any of the output of these industries – most of which is sold to other firms as inputs – to be outsourcing as well?

My approach begins by including all intermediate output, or IFT, in the analysis. From this broad starting point, we can start to identify basic variations in the forms of IFT based on transactions across different types of industries, and explore their relationship to wages without preconceptions about the industries of interest. This establishes a foundation for further case study and qualitative work on how the character of IFT and the structure of production networks relates to forms of outsourcing, their causes, and their consequences for workers.

Technical limitations

There are a few technical limitations to the BEA I-O data, some of which likely result in under-estimation of the prevalence of IFT. First, there are limitations in the way that the BEA I-O data estimate prices that likely leads to an under-estimation of IFT. As Houseman et al. discuss in a 2011 paper, the I-O data do a poor job of capturing changes in prices over time (Houseman et al. 2011). Specifically, if we expect that outsourced goods and services may be cheaper than in-house equivalents in some circumstances, then the measure likely underestimates the actual quantity of output being purchased at a cheaper price because the BEA I-O data measure intermediate output by volume of sales.

Second, the I-O data do not allow us to identify domestic IFT for consumer-facing services as intermediate production, which means I am not able to include this economic activity in the measure of IFT. One example of this scenario is a hotel that contracts with an independent on-site restaurant. Here, the restaurant is not selling its products and services to the hotel but rather to consumers; these sales are therefore not registered as inputs into the hotel's production

process, unless there is a contract between the restaurant and hotel in which the restaurant pays rent and/or a commission on sales to the hotel. Similarly, the output of franchisees will not be counted as inputs to the franchisor.

Third, a related problem is that consumer-facing services paid via public or private insurance or government vouchers are captured only as consumer expenditures – for health care, subsidized child care, other social assistance, etc. This means that a sizable chunk of the health and human services sector is showing little intermediate production in the I-O data – purchases of services by this sector mainly end up being recorded as final use by consumers, who are paying via health insurance or government vouchers. This quickly raises definitional questions: what do we mean by IFT when it comes to the public sector? The straightforward examples are captured in the data (i.e. hospitals contracting for janitorial services), but some of the less straightforward examples are not. For example, one could argue that the government effectively contracts with nursing homes or home care workers for the provision of care, via Medicaid and Medicare, but BEA I-O data do not capture these purchases as inputs into government services.

Despite these limitations, the BEA I-O data still offer an unmatched opportunity to analyze IFT across a wide range of industries in the U.S. economy, and explore its relationship to workers' wages. Furthermore, most of the data limitations that I was unable to resolve are problems that lead to an *underestimation* of the prevalence of domestic IFT.

Appendix 5. Auxiliary/Enterprise Support Establishment reclassification

Problem: I-O make/use data is recorded at the establishment level. Auxiliary establishments (referred to by the Census as "enterprise support establishments" or ESEs) are establishments that do not produce products or provide services for sale either to other businesses or to final users; rather, these units provide administrative or support services (e.g. legal, accounting, trucking, warehousing) to the primary establishments of the business in which they are located.[29] When the BEA moved to NAICS from SIC industry codes in 1997, it began to assign industry codes to ESEs based on their own products, rather than the products of the parent firm.[30]

This reclassification is potentially problematic for my measure of domestic IFT, because it records transactions between ESEs and parent firms as sales across industries, rather than recording them as internal transactions within the industry of the parent firm (as I would prefer). As a result, the reclassification of ESEs may overstate the amount of intermediate output of industries with a high number of ESEs. However, I was not able to find an empirical study that would allow me to assess the magnitude of the problem.

Solution: I analyzed Census data on ESEs to estimate the impact of ESE reclassification.[31] Specifically, the Census published two tables on ESEs for 2002 and 2007: one with information on the NAICs codes into which the ESEs were reclassified,[32] and one that shows information for ESEs based on the industry that they served.[33] The goal was to examine the size of ESEs (in

[29] Horowitz & Planting, 2006: p. 4.
[30] In addition, a new NAICS industry code for management entities (55 - Management of companies and enterprises) was created, which includes establishments that provide multiple kinds of services. NAICS 55 is discussed in more detail below.
[31] The I-O data does not have any way of identifying ESEs, but the Economic Census captures this information, designating firms as ESEs during the data collection process.
[32] "Geographic Area Series: Enterprise Support Statistics"
[33] "Subject Series – Misc. Subjects: Summary Statistics of Enterprise Support Establishments by Industry Served"

terms of number of establishments and in terms of employment), and to examine the impact of reclassification on the target industries (since my concern is that this reclassification might incorrectly inflate my IFT measure).

Findings: Overall, I found that the impact of ESE reclassification on the industries into which they were reclassified and the industries that they served was minimal. Only two industries are significantly affected by ESE reclassification, which I discuss in more detail in B.

A. **Overall Impact:** ESEs represented only 0.6% of all establishments in the economy in 2007, and only a slightly larger 2.6% of employment (see table A.5.1). Moreover, the majority of the reclassifications is nonconsequential for my analysis because the bulk of ESEs were reclassified into a single NAICS code, Management of Companies and Enterprises (55), which is entirely composed of ESEs or holding companies.[34] Specifically, NAICS 55 represented 76.5% of all auxiliary establishments and 69.4% of employment in ESEs (see table A.5.2). For my purposes, this reclassification is not problematic, because NAICS 55 is by definition a category composed entirely of auxiliary units, either holding companies or ESEs.

Table A.5.1. Overall Impact of ESE Reclassification, 2007

All industries' ESEs	Percent of all establishments	Percent of all employment
Total	0.6	2.6

Source: Author's analysis of the *U.S. Economic Census* Subject Series - Misc Subjects: Summary Statistics of Enterprise Support Establishments by Industry Served for the United States: 2007; compared with EC0700A1: All sectors: Geographic Area Series: Economy-Wide Key Statistics: 2007

Table A.5.2. Portion of ESEs Reclassified into NAICS 55, 2007

Industries into which ESEs are reclassified:	Percent of ESE establishments	Percent of ESE employment
NAICS 55	76.5	69.4
All other industries	23.5	30.6

[34] The only NAICS code within 55 that is considered to include ESEs is 551114 Corporate, subsidiary, and regional managing offices. The others are considered "holding companies" which also serve an auxiliary function.

Source: Author's analysis of the *U.S. Economic Census* Subject Series - Misc Subjects: Summary Statistics of Enterprise Support Establishments by Industry Served for the United States: 2007; compared with EC0700A1: All sectors: Geographic Area Series: Economy-Wide Key Statistics: 2007

B. Impact on industries into which ESEs were reclassified: ESEs were less than 0.5% of the total number of establishments and less than 5% of employment in most of the industries into which they were reclassified (see table A.5.3), excluding NAICS 55. The only industries that were significantly affected by ESE reclassification are Transportation and Warehousing (48-49), primarily driven by Warehousing and Storage (493); and Scientific Research and Development Services (5417). Specifically, in Transportation and Warehousing, ESEs were 3.6% of establishments and 14.2% of industry employment. For Warehousing and Storage, ESEs were 43.5% of establishments and 76.1% of employment.[35] In Scientific Research and Development Services, ESEs were 5.8% of all establishments and 31.3% of all employment.

For these industries I will need to account for the significant presence of ESEs in order to avoid overestimating domestic IFT; I will do so by reweighting the measure of domestic IFT to account for the reclassification of ESEs.

Table A.5.3. Impact of ESEs on the industries into which they were reclassified, 2007*

NAICS code	Industry into which ESEs were reclassified	ESEs as a percent of all industry establishments	ESE employment as a percent of all industry employment
48-49	Transportation and warehousing	3.6	14.2
493	*Warehousing and Storage*	43.5	76.1
51	Information	0.2	1.0
54	Professional, scientific, and technical services	0.3	4.3
5417	*Scientific research and development services*	5.8	31.3

[35] Source: *U.S. Economic Census* EC0748A3: Transportation and Warehousing: Geographic Area Series: Enterprise Support Statistics for the United States: 2007

56	Administrative and support and waste management and remediation services	0.2	0.9
81	Other services (except public administration)	0.2	0.9

*Excluding NAICS 55
Source: Author's analysis of the *U.S. Economic Census* Subject Series – Misc. Subjects: Summary Statistics of Enterprise Support Establishments by Industry Served for the United States: 2007; compared with EC0700A1: All sectors: Geographic Area Series: Economy-Wide Key Statistics: 2007

C. Impact on industries that ESEs served: As shown in table A.5.4, Transportation and Warehousing ESE reclassification had minimal impact on the industries served (i.e. that the ESEs were reclassified out of). The percent of establishments lost in each industry as a result of reclassification was less than 1% of all establishments, and the percent of employees lost in each industry was less than 5%. Data are only available at the 2-digit NAICS code level, so I am not able to replicate this analysis at the detailed industry level (i.e. for Warehousing and Storage).

Table A.5.4. Impact of Transportation and Warehousing ESE reclassification on the industries that they served, 2007

ESE NAICS code	ESE Description	Industry served code	Industry served description	% Industry-served establishments lost in ESE reclassification	% Industry-served employment lost in ESE reclassification
48-49	Transportation and warehousing	31-33	Manufacturing	0.5	0.6
48-49	Transportation and warehousing	42	Wholesale trade	0.4	1.3
48-49	Transportation and warehousing	44-45	Retail trade	0.3	2.7

Source: Author's analysis of the *U.S. Economic Census* Subject Series – Misc. Subjects: Summary Statistics of Enterprise Support Establishments by Industry Served for the United States: 2007; compared with EC0700A1: All sectors: Geographic Area Series: Economy-Wide Key Statistics: 2007

Appendix 6. Detailed industries by sector

The below tables A.6.1-2 list each industry included in the BEA's 2007 detailed I-O data, along with the BEA's industry label and industry code, and the corresponding NAICS code(s). The codes are similar but not identical. For instance, that the BEA's codes for goods capture a much greater degree of detail compared to their codes for services.

These tables are based on the BEA-NAICS code bridge published with the I-O data. Here, I have grouped industries based on their classification as goods (Table A.6.1) or services (Table A.6.2), according to the BLS's classification of NAICS codes (Bureau of Labor Statistics n.d.). Government categories are not included because they do not have corresponding NAICS codes.

Table A.6.1. BEA to NAICS Code Bridge – Goods (2007)

BEA Code and Title				Related 2007 NAICS Codes
11	Agriculture, forestry, fishing, and hunting			
	111CA	Farms		
		1111A0	Oilseed farming	11111-2
		1111B0	Grain farming	11113-6, 11119
		111200	Vegetable and melon farming	1112
		111300	Fruit and tree nut farming	1113
		111400	Greenhouse, nursery, and floriculture production	1114
		111900	Other crop farming	1119
		1121A0	Beef cattle ranching and farming, including feedlots and dual-purpose ranching and farming	11211, 11213
		112120	Dairy cattle and milk production	11212
		112A00	Animal production, except cattle and poultry and eggs	1122, 1124-5, 1129
		112300	Poultry and egg production	1123
	113FF	Forestry, fishing, and related activities		
		113000	Forestry and logging	113
		114000	Fishing, hunting and trapping	114
		115000	Support activities for agriculture and forestry	115
21	Mining			

	211	Oil and gas extraction		
		211000	Oil and gas extraction	211
	212	Mining, except oil and gas		
		212100	Coal mining	2121
		2122A0	Iron, gold, silver, and other metal ore mining	21221, 21222, 21229
		212230	Copper, nickel, lead, and zinc mining	21223
		212310	Stone mining and quarrying	21231
		2123A0	Other nonmetallic mineral mining and quarrying	21232, 21239
	213	Support activities for mining		
		213111	Drilling oil and gas wells	213111
		21311A	Other support activities for mining	213112-5
22	Utilities			
	22	Utilities		
		221100	Electric power generation, transmission, and distribution	2211
		221200	Natural gas distribution	2212
		221300	Water, sewage and other systems	2213
23	Construction			
	23	Construction*		
		230301	Nonresidential maintenance and repair	23
		230302	Residential maintenance and repair	23
		233210	Health care structures	23
		233230	Manufacturing structures	23
		233240	Power and communication structures	23
		233262	Educational and vocational structures	23
		233293	Highways and streets	23
		2332A0	Commercial structures, including farm structures	23
		2332B0	Other nonresidential structures	23
		233411	Single-family residential structures	23
		233412	Multifamily residential structures	23
		2334A0	Other residential structures	23
31 G	Manufacturing			
	321	Wood products		
		321100	Sawmills and wood preservation	3211

	321200	Veneer, plywood, and engineered wood product manufacturing	3212
	321910	Millwork	32191
	3219A0	All other wood product manufacturing	32192, 32199
327	Nonmetallic mineral products		
	327100	Clay product and refractory manufacturing	3271
	327200	Glass and glass product manufacturing	3272
	327310	Cement manufacturing	32731
	327320	Ready-mix concrete manufacturing	32732
	327330	Concrete pipe, brick, and block manufacturing	32733
	327390	Other concrete product manufacturing	32739
	327400	Lime and gypsum product manufacturing	3274
	327910	Abrasive product manufacturing	32791
	327991	Cut stone and stone product manufacturing	327991
	327992	Ground or treated mineral and earth manufacturing	327992
	327993	Mineral wool manufacturing	327993
	327999	Miscellaneous nonmetallic mineral products	327999
331	Primary metals		
	331110	Iron and steel mills and ferroalloy manufacturing	3311
	331200	Steel product manufacturing from purchased steel	3312
	33131A	Alumina refining and primary aluminum production	331311-2
	331314	Secondary smelting and alloying of aluminum	331314
	33131B	Aluminum product manufacturing from purchased aluminum	331315, 331316, 331319
	331411	Primary smelting and refining of copper	331411
	331419	Primary smelting and refining of nonferrous metal (except copper and aluminum)	331419
	331420	Copper rolling, drawing, extruding and alloying	33142
	331490	Nonferrous metal (except copper and aluminum) rolling, drawing, extruding and alloying	33149
	331510	Ferrous metal foundries	33151
	331520	Nonferrous metal foundries	33152
332	Fabricated metal products		
	33211A	All other forging, stamping, and sintering	332111-2, 332117
	332114	Custom roll forming	332114
	33211B	Crown and closure manufacturing and metal stamping	332115-6
	332200	Cutlery and handtool manufacturing	3322
	332310	Plate work and fabricated structural product manufacturing	33231
	332320	Ornamental and architectural metal products manufacturing	33232
	332410	Power boiler and heat exchanger manufacturing	33241
	332420	Metal tank (heavy gauge) manufacturing	33242
	332430	Metal can, box, and other metal container (light gauge) manufacturing	33243
	332500	Hardware manufacturing	3325
	332600	Spring and wire product manufacturing	3326

	332710	Machine shops	33271
	332720	Turned product and screw, nut, and bolt manufacturing	33272
	332800	Coating, engraving, heat treating and allied activities	3328
	33291A	Valve and fittings other than plumbing	332911-2, 332919
	332913	Plumbing fixture fitting and trim manufacturing	332913
	332991	Ball and roller bearing manufacturing	332991
	33299A	Ammunition, arms, ordnance, and accessories manufacturing	332992-5
	332996	Fabricated pipe and pipe fitting manufacturing	332996
	33299B	Other fabricated metal manufacturing	332997-9
333	Machinery		
	333111	Farm machinery and equipment manufacturing	333111
	333112	Lawn and garden equipment manufacturing	333112
	333120	Construction machinery manufacturing	33312
	333130	Mining and oil and gas field machinery manufacturing	33313
	33329A	Other industrial machinery manufacturing	33321, 333291-4, 333298
	333220	Plastics and rubber industry machinery manufacturing	33322
	333295	Semiconductor machinery manufacturing	333295
	33331A	Vending, commercial laundry, and other commercial and service industry machinery manufacturing	333311, 333312, 333319
	333313	Office machinery manufacturing	333313
	333314	Optical instrument and lens manufacturing	333314
	333315	Photographic and photocopying equipment manufacturing	333315
	33341A	Air purification and ventilation equipment manufacturing	333411-2
	333414	Heating equipment (except warm air furnaces) manufacturing	333414
	333415	Air conditioning, refrigeration, and warm air heating equipment manufacturing	333415
	333511	Industrial mold manufacturing	333511
	33351A	Metal cutting and forming machine tool manufacturing	333512-3
	333514	Special tool, die, jig, and fixture manufacturing	333514
	33351B	Cutting and machine tool accessory, rolling mill, and other metalworking machinery manufacturing	333515, 333516, 333518
	333611	Turbine and turbine generator set units manufacturing	333611
	333612	Speed changer, industrial high-speed drive, and gear manufacturing	333612
	333613	Mechanical power transmission equipment manufacturing	333613
	333618	Other engine equipment manufacturing	333618
	33391A	Pump and pumping equipment manufacturing	333911, 333913
	333912	Air and gas compressor manufacturing	333912
	333920	Material handling equipment manufacturing	33392
	333991	Power-driven handtool manufacturing	333991
	33399A	Other general purpose machinery manufacturing	333992, 333997, 333999
	333993	Packaging machinery manufacturing	333993
	333994	Industrial process furnace and oven manufacturing	333994
	33399B	Fluid power process machinery	333995-6
334	Computer and electronic products		

	334111	Electronic computer manufacturing	334111
	334112	Computer storage device manufacturing	334112
	33411A	Computer terminals and other computer peripheral equipment manufacturing	334113, 334119
	334210	Telephone apparatus manufacturing	33421
	334220	Broadcast and wireless communications equipment	33422
	334290	Other communications equipment manufacturing	33429
	334300	Audio and video equipment manufacturing	3343
	33441A	Other electronic component manufacturing	334411, 334412, 334414-7, 334419
	334413	Semiconductor and related device manufacturing	334413
	334418	Printed circuit assembly (electronic assembly) manufacturing	334418
	334510	Electromedical and electrotherapeutic apparatus manufacturing	334510
	334511	Search, detection, and navigation instruments manufacturing	334511
	334512	Automatic environmental control manufacturing	334512
	334513	Industrial process variable instruments manufacturing	334513
	334514	Totalizing fluid meter and counting device manufacturing	334514
	334515	Electricity and signal testing instruments manufacturing	334515
	334516	Analytical laboratory instrument manufacturing	334516
	334517	Irradiation apparatus manufacturing	334517
	33451A	Watch, clock, and other measuring and controlling device manufacturing	334518-9
	334610	Manufacturing and reproducing magnetic and optical media	33461
335	Electrical equipment, appliances, and components		
	335110	Electric lamp bulb and part manufacturing	33511
	335120	Lighting fixture manufacturing	33512
	335210	Small electrical appliance manufacturing	33521
	335221	Household cooking appliance manufacturing	335221
	335222	Household refrigerator and home freezer manufacturing	335222
	335224	Household laundry equipment manufacturing	335224
	335228	Other major household appliance manufacturing	335228
	335311	Power, distribution, and specialty transformer manufacturing	335311
	335312	Motor and generator manufacturing	335312
	335313	Switchgear and switchboard apparatus manufacturing	335313
	335314	Relay and industrial control manufacturing	335314
	335911	Storage battery manufacturing	335911
	335912	Primary battery manufacturing	335912
	335920	Communication and energy wire and cable manufacturing	33592
	335930	Wiring device manufacturing	33593
	335991	Carbon and graphite product manufacturing	335991
	335999	All other miscellaneous electrical equipment and component manufacturing	335999
3361MV	Motor vehicles, bodies and trailers, and parts		

	336111	Automobile manufacturing	336111
	336112	Light truck and utility vehicle manufacturing	336112
	336120	Heavy duty truck manufacturing	33612
	336211	Motor vehicle body manufacturing	336211
	336212	Truck trailer manufacturing	336212
	336213	Motor home manufacturing	336213
	336214	Travel trailer and camper manufacturing	336214
	336310	Motor vehicle gasoline engine and engine parts manufacturing	33631
	336320	Motor vehicle electrical and electronic equipment manufacturing	33632
	3363A0	Motor vehicle steering, suspension component (except spring), and brake systems manufacturing	33633-4
	336350	Motor vehicle transmission and power train parts manufacturing	33635
	336360	Motor vehicle seating and interior trim manufacturing	33636
	336370	Motor vehicle metal stamping	33637
	336390	Other motor vehicle parts manufacturing	33639
3364OT	Other transportation equipment		
	336411	Aircraft manufacturing	336411
	336412	Aircraft engine and engine parts manufacturing	336412
	336413	Other aircraft parts and auxiliary equipment manufacturing	336413
	336414	Guided missile and space vehicle manufacturing	336414
	33641A	Propulsion units and parts for space vehicles and guided missiles	336415, 336419
	336500	Railroad rolling stock manufacturing	3365
	336611	Ship building and repairing	336611
	336612	Boat building	336612
	336991	Motorcycle, bicycle, and parts manufacturing	336991
	336992	Military armored vehicle, tank, and tank component manufacturing	336992
	336999	All other transportation equipment manufacturing	336999
337	Furniture and related products		
	337110	Wood kitchen cabinet and countertop manufacturing	33711
	337121	Upholstered household furniture manufacturing	337121
	337122	Nonupholstered wood household furniture manufacturing	337122
	33712A	Other household nonupholstered furniture	337124, 337125, 337129
	337127	Institutional furniture manufacturing	337127
	33721A	Office furniture and custom architectural woodwork and millwork manufacturing	337211, 337212, 337214
	337215	Showcase, partition, shelving, and locker manufacturing	337215
	337900	Other furniture related product manufacturing	3379
339	Miscellaneous manufacturing		
	339112	Surgical and medical instrument manufacturing	339112
	339113	Surgical appliance and supplies manufacturing	339113

	339114	Dental equipment and supplies manufacturing	339114
	339115	Ophthalmic goods manufacturing	339115
	339116	Dental laboratories	339116
	339910	Jewelry and silverware manufacturing	33991
	339920	Sporting and athletic goods manufacturing	33992
	339930	Doll, toy, and game manufacturing	33993
	339940	Office supplies (except paper) manufacturing	33994
	339950	Sign manufacturing	33995
	339990	All other miscellaneous manufacturing	33999
311FT	Food and beverage and tobacco products		
	311111	Dog and cat food manufacturing	311111
	311119	Other animal food manufacturing	311119
	311210	Flour milling and malt manufacturing	31121
	311221	Wet corn milling	311221
	31122A	Soybean and other oilseed processing	311222-3
	311225	Fats and oils refining and blending	311225
	311230	Breakfast cereal manufacturing	31123
	311300	Sugar and confectionery product manufacturing	3113
	311410	Frozen food manufacturing	31141
	311420	Fruit and vegetable canning, pickling, and drying	31142
	31151A	Fluid milk and butter manufacturing	311511-2
	311513	Cheese manufacturing	311513
	311514	Dry, condensed, and evaporated dairy product manufacturing	311514
	311520	Ice cream and frozen dessert manufacturing	31152
	31161A	Animal (except poultry) slaughtering, rendering, and processing	311611-3
	311615	Poultry processing	311615
	311700	Seafood product preparation and packaging	3117
	311810	Bread and bakery product manufacturing	31181
	3118A0	Cookie, cracker, pasta, and tortilla manufacturing	31182-3
	311910	Snack food manufacturing	31191
	311920	Coffee and tea manufacturing	31192
	311930	Flavoring syrup and concentrate manufacturing	31193
	311940	Seasoning and dressing manufacturing	31194
	311990	All other food manufacturing	31199
	312110	Soft drink and ice manufacturing	31211
	312120	Breweries	31212
	312130	Wineries	31213
	312140	Distilleries	31214
	312200	Tobacco product manufacturing	3122
313TT	Textile mills and textile product mills		
	313100	Fiber, yarn, and thread mills	3131
	313200	Fabric mills	3132
	313300	Textile and fabric finishing and fabric coating mills	3133
	314110	Carpet and rug mills	31411
	314120	Curtain and linen mills	31412

	314900	Other textile product mills	3149
315AL	Apparel and leather and allied products		
	315000	Apparel manufacturing	315
	316000	Leather and allied product manufacturing	316
322	Paper products		
	322110	Pulp mills	32211
	322120	Paper mills	32212
	322130	Paperboard mills	32213
	322210	Paperboard container manufacturing	32221
	322220	Paper bag and coated and treated paper manufacturing	32222
	322230	Stationery product manufacturing	32223
	322291	Sanitary paper product manufacturing	322291
	322299	All other converted paper product manufacturing	322299
323	Printing and related support activities		
	323110	Printing	32311
	323120	Support activities for printing	32312
324	Petroleum and coal products		
	324110	Petroleum refineries	32411
	324121	Asphalt paving mixture and block manufacturing	324121
	324122	Asphalt shingle and coating materials manufacturing	324122
	324190	Other petroleum and coal products manufacturing	32419
325	Chemical products		
	325110	Petrochemical manufacturing	32511
	325120	Industrial gas manufacturing	32512
	325130	Synthetic dye and pigment manufacturing	32513
	325180	Other basic inorganic chemical manufacturing	32518
	325190	Other basic organic chemical manufacturing	32519
	325211	Plastics material and resin manufacturing	325211
	3252A0	Synthetic rubber and artificial and synthetic fibers and filaments manufacturing	325212, 32522
	325310	Fertilizer manufacturing	32531
	325320	Pesticide and other agricultural chemical manufacturing	32532
	325411	Medicinal and botanical manufacturing	325411
	325412	Pharmaceutical preparation manufacturing	325412
	325413	In-vitro diagnostic substance manufacturing	325413
	325414	Biological product (except diagnostic) manufacturing	325414
	325510	Paint and coating manufacturing	32551
	325520	Adhesive manufacturing	32552
	325610	Soap and cleaning compound manufacturing	32561
	325620	Toilet preparation manufacturing	32562

	325910	Printing ink manufacturing	32591
	3259A0	All other chemical product and preparation manufacturing	32592, 32599
326	Plastics and rubber products		
	326110	Plastics packaging materials and unlaminated film and sheet manufacturing	32611
	326120	Plastics pipe, pipe fitting, and unlaminated profile shape manufacturing	32612
	326130	Laminated plastics plate, sheet (except packaging), and shape manufacturing	32613
	326140	Polystyrene foam product manufacturing	32614
	326150	Urethane and other foam product (except polystyrene) manufacturing	32615
	326160	Plastics bottle manufacturing	32616
	326190	Other plastics product manufacturing	32619
	326210	Tire manufacturing	32621
	326220	Rubber and plastics hoses and belting manufacturing	32622
	326290	Other rubber product manufacturing	32629

*Construction data published by BEA at the detail level do not align with 2007 NAICS industries. In NAICS, industries are classified based on their production processes, whereas BEA construction is classified by type of structure. For example, activity by the 2007 NAICS Roofing contractors industry would be split among many BEA construction categories because roofs are built on many types of structures.

Table A.6.2. BEA-NAICS Code Bridge – Services (2007)

BEA Code and Title				Related 2007 NAICS Codes
42	Wholesale trade			
	42	Wholesale trade *		
		420000	Wholesale trade	42
44RT	Retail trade			
	441	Motor vehicle and parts dealers		
		441000	Motor vehicle and parts dealers	441
	445	Food and beverage stores		
		445000	Food and beverage stores	445
	452	General merchandise stores		
		452000	General merchandise stores	452
	4A0	Other retail *		

		4A0000	Other retail	442-4, 446-8, 451, 453-4
48TW	Transportation and warehousing			
	481	Air transportation		
		481000	Air transportation	481
	482	Rail transportation		
		482000	Rail transportation	482
	483	Water transportation		
		483000	Water transportation	483
	484	Truck transportation		
		484000	Truck transportation	484
	485	Transit and ground passenger transportation		
		485000	Transit and ground passenger transportation	485
	486	Pipeline transportation		
		486000	Pipeline transportation	486
	487OS	Other transportation and support activities		
		48A000	Scenic and sightseeing transportation and support activities for transportation	487, 488
		492000	Couriers and messengers	492
	493	Warehousing and storage		
		493000	Warehousing and storage	493
51	Information			
	511	Publishing industries, except internet (includes software)		
		511110	Newspaper publishers	51111
		511120	Periodical Publishers	51112
		511130	Book publishers	51113
		5111A0	Directory, mailing list, and other publishers	51114, 51119
		511200	Software publishers	51121
	512	Motion picture and sound recording industries		

		512100	Motion picture and video industries	5121
		512200	Sound recording industries	5122
	513	Broadcasting and telecommunications		
		515100	Radio and television broadcasting	5151
		515200	Cable and other subscription programming	5152
		517110	Wired telecommunications carriers	5171
		517210	Wireless telecommunications carriers (except satellite)	5172
		517A00	Satellite, telecommunications resellers, and all other telecommunications	5174, 5719
	514	Data processing, internet publishing, and other information services		
		518200	Data processing, hosting, and related services	5182
		5191A0	News syndicates, libraries, archives and all other information services	51911-2, 51919
		519130	Internet publishing and broadcasting and Web search portals	51913
FIRE	Finance, insurance, real estate, rental, and leasing			
	521CI	Federal Reserve banks, credit intermediation, and related activities		
		52A000	Monetary authorities and depository credit intermediation	521, 5221
		522A00	Nondepository credit intermediation and related activities	5222-3
	523	Securities, commodity contracts, and investments		
		523A00	Securities and commodity contracts intermediation and brokerage	5231-2
		523900	Other financial investment activities	5239
	524	Insurance carriers and related activities		
		524100	Insurance carriers	5241
		524200	Insurance agencies, brokerages, and related activities	5242
	525	Funds, trusts, and other financial vehicles		
		525000	Funds, trusts, and other financial vehicles	525
	531	Real estate		
		5310HS	Housing	531
		531OR E	Other real estate	531
	532RL	Rental and leasing services and lessors of intangible assets		
		532100	Automotive equipment rental and leasing	5321

		532A00	Consumer goods and general rental centers	5322-3
		532400	Commercial and industrial machinery and equipment rental and leasing	5324
		533000	Lessors of nonfinancial intangible assets	533
PROF	Professional and business services			
	5411	Legal services		
		541100	Legal services	5411
	5415	Computer systems design and related services		
		541511	Custom computer programming services	541511
		541512	Computer systems design services	541512
		54151A	Other computer related services, including facilities management	541513, 541519
	5412OP	Miscellaneous professional, scientific, and technical services		
		541200	Accounting, tax preparation, bookkeeping, and payroll services	5412
		541300	Architectural, engineering, and related services	5413
		541400	Specialized design services	5414
		541610	Management consulting services	54161
		5416A0	Environmental and other technical consulting services	54162, 54169
		541700	Scientific research and development services	5417
		541800	Advertising, public relations, and related services	5418
		5419A0	Marketing research and all other miscellaneous professional, scientific, and technical services	54191, 54193, 54199
		541920	Photographic services	54192
		541940	Veterinary services	54194
	55	Management of companies and enterprises		
		550000	Management of companies and enterprises	55
	561	Administrative and support services		
		561100	Office administrative services	5611
		561200	Facilities support services	5612
		561300	Employment services	5613
		561400	Business support services	5614
		561500	Travel arrangement and reservation services	5615
		561600	Investigation and security services	5616
		561700	Services to buildings and dwellings	5617
		561900	Other support services	5619
	562	Waste management and remediation services		

		562000	Waste management and remediation services	562
6	Educational services, health care, and social assistance			
	61	Educational services		
		611100	Elementary and secondary schools	6111
		611A00	Junior colleges, colleges, universities, and professional schools	6112-3
		611B00	Other educational services	6114-7
	621	Ambulatory health care services		
		621100	Offices of physicians	6211
		621200	Offices of dentists	6212
		621300	Offices of other health practitioners	6213
		621400	Outpatient care centers	6214
		621500	Medical and diagnostic laboratories	6215
		621600	Home health care services	6216
		621900	Other ambulatory health care services	6219
	622	Hospitals		
		622000	Hospitals	622
	623	Nursing and residential care facilities		
		623A00	Nursing and community care facilities	6231, 6233
		623B00	Residential mental retardation, mental health, substance abuse and other facilities	6232, 6239
	624	Social assistance		
		624100	Individual and family services	6241
		624A00	Community food, housing, and other relief services, including rehabilitation services	6242-3
		624400	Child day care services	6244
7	Arts, entertainment, recreation, accommodation, and food services			
	711AS	Performing arts, spectator sports, museums, and related activities		
		711100	Performing arts companies	7111
		711200	Spectator sports	7112
		711A00	Promoters of performing arts and sports and agents for public figures	7113-4
		711500	Independent artists, writers, and performers	7115
		712000	Museums, historical sites, zoos, and parks	712
	713	Amusements, gambling, and recreation industries		

		713100	Amusement parks and arcades	7131
		713200	Gambling industries (except casino hotels)	7132
		713900	Other amusement and recreation industries	7139
	721	Accommodation		
		721000	Accommodation	721
	722	Food services and drinking places		
		722110	Full-service restaurants	7221
		722211	Limited-service restaurants	7222
		722A00	All other food and drinking places	7223-4
81	Other services, except government			
	81	Other services, except government		
		811100	Automotive repair and maintenance	8111
		811200	Electronic and precision equipment repair and maintenance	8112
		811300	Commercial and industrial machinery and equipment repair and maintenance	8113
		811400	Personal and household goods repair and maintenance	8114
		812100	Personal care services	8121
		812200	Death care services	8122
		812300	Dry-cleaning and laundry services	8123
		812900	Other personal services	8129
		813100	Religious organizations	8131
		813A00	Grantmaking, giving, and social advocacy organizations	8132, 8133
		813B00	Civic, social, professional, and similar organizations	8134, 8139
		814000	Private households	814

* Additional detail for the electric power generation, transmission, and distribution; wholesale trade; and other retail industries is available on an annual basis as part of the detailed gross output statistics.

Appendix 7. Feasibly in-house industries

The third grouping of domestic IFT that I assess includes only services that could feasibly have been produced in-house by the client. I identified these industries by hand, and they are listed below in table A.7.1. Table A.7.2 the list of services industries that I did not identify as feasibly in-house. That is, they are part of group 2 but not group 3.

An important pre-qualifying condition for the list of feasibly in-house industries is that over half of the industry's output must be an intermediate input into other firms or the government. That is, industries producing services primarily for final use consumption are not considered feasibly in-house. From this list of services, to identify which services I would consider to be "feasibly in-house" I considered historical patterns of ownership and supply chain structure as precedent. Specifically, for each industry classified as a service producing more intermediate than final use output, I assessed whether it is a common or frequent practice for an industry purchasing those services to instead produce those services in-house. In some cases I there are well-known examples of this (e.g. Walmart owns and operates some of its own warehousing and transportation services), and in other cases I looked to the BEA's use table to determine which industries are the main purchasing industries for particular services, and I then searched online for examples of in-house production to get a sense of the typical supply chain structure.

It is essential to recognize that this was an imperfect process. The decisions in many cases were difficult to make, and there may be examples in some cases that contradict my selections. This highlights the challenges of group 3 compared to group 2, and the limitations of using a conceptually narrow scope of IFT for an empirical analysis of trends.

Industry group 3 is an attempt to more closely match the approach taken in other literature on "domestic outsourcing," (e.g. Berlignieri 2014, Dorn et al. 2018) most of which hand-picks specific industries known to be common suppliers of outsourced services – that is, services that were, are, or could feasibly be provided in-house instead. My approach expands beyond the common examples like food services, cleaning, and logistics, to services industries that aren't necessarily typical examples of outsourcing but also may be involved in the same kind

of process. For instance, we might not typically think of public relations services, repair and maintenance services, or computer systems design as "outsourcing industries" but they all represent services that are in some cases provided in house and in other cases supplied by a separate firm.

While my approach, like other work on outsourcing, also involves an imprecise hand-selection of industries, my starting point for doing the hand-selection is the empirical test of which industries produce more output for intermediate versus final use, casting a broader net for which industries we might want to consider as contractor industries. In this way, I am able to estimate trends in domestic IFT using a more comprehensive approach than prior studies, even in my narrowest grouping of industries.

Table A.7.1. Feasibly In-House Services (2007)

BEA Title	Related NAICS Codes
Accounting, tax preparation, bookkeeping, and payroll services	5412
Advertising, public relations, and related services	5418
All other food and drinking places	722514, 722515, 7224, 7223
Architectural, engineering, and related services	5413
Automotive repair and maintenance	8111
Business support services	5614
Commercial and industrial machinery and equipment repair and maintenance	8113
Computer systems design services	541512
Couriers and messengers	492
Custom computer programming services	541511
Data processing, hosting, and related services	518
Dry-cleaning and laundry services	8123
Electronic and precision equipment repair and maintenance	8112
Employment services	5613
Environmental and other technical consulting services	54162, 54169
Facilities support services	5612
Full-service restaurants	722511
Independent artists, writers, and performers	7115
Investigation and security services	5616

Legal services	5411
Limited-service restaurants	722513
Management consulting services	54161
Marketing research and all other miscellaneous professional, scientific, and technical services	54191, 54193, 54199
Medical and diagnostic laboratories	6215
Office administrative services	5611
Other ambulatory health care services	6219
Other computer related services, including facilities management	541513, 541519
Other educational services	6114, 6115, 6116, 6117
Other support services	5619
Personal and household goods repair and maintenance	8114
Photographic services	54192
Promoters of performing arts and sports and agents for public figures	7113, 7114
Scenic and sightseeing transportation and support activities for transportation	487
Scientific research and development services	5417
Services to buildings and dwellings	5617
Software publishers	5112
Specialized design services	5414
Transit and ground passenger transportation	485
Travel arrangement and reservation services	5615
Truck transportation	484
Warehousing and storage	493

Table A.7.2. Other Services (2007)

BEA Title	Related NAICS Codes
Accommodation	721
Air transportation	481
Amusement parks and arcades	7131
Automotive equipment rental and leasing	5321
Book publishers	51113
Cable and other subscription programming	5152
Child day care services	6244
Civic, social, professional, and similar organizations	8134, 8139
Commercial and industrial machinery and equipment rental and leasing	5324
Community food, housing, and other relief services, including rehabilitation services	6242, 6243
Consumer goods and general rental centers	5323, 5322
Death care services	8122
Directory, mailing list, and other publishers	51114, 5112
Electric power generation, transmission, and distribution	2211

Elementary and secondary schools	6111
Food and beverage stores	445
Funds, trusts, and other financial vehicles	525
Gambling industries (except casino hotels)	7132
General merchandise stores	452
Grantmaking, giving, and social advocacy organizations	8132, 8133
Home health care services	6216
Hospitals	622
Individual and family services	6241
Insurance agencies, brokerages, and related activities	5242
Insurance carriers	5241
Internet publishing and broadcasting and Web search portals	51913, 51919
Junior colleges, colleges, universities, and professional schools	6112, 6113
Lessors of nonfinancial intangible assets	533
Management of companies and enterprises	55
Monetary authorities and depository credit intermediation	521, 522
Motion picture and video industries	5121
Motor vehicle and parts dealers	441
Museums, historical sites, zoos, and parks	712
Natural gas distribution	2212
News syndicates, libraries, archives and all other information services	51911, 51912
Newspaper publishers	51111
Nursing and community care facilities	6231
Offices of dentists	6212
Offices of other health practitioners	6213
Offices of physicians	6211
Other amusement and recreation industries	7139
Other personal services	8129
Other retail	442, 443, 444, 446, 447, 448, 451, 453, 454
Outpatient care centers	6214
Performing arts companies	7111
Periodical Publishers	51112
Personal care services	8121
Pipeline transportation	486
Postal service	491
Private households	8141
Radio and television broadcasting	5151
Rail transportation	482
Real estate	531
Religious organizations	8131

Residential mental retardation, mental health, substance abuse and other facilities	6232, 6233, 6239
Satellite, telecommunications resellers, and all other telecommunications	5174, 51791
Securities and commodity contracts intermediation and brokerage	523
Sound recording industries	5122
Spectator sports	7112
Veterinary services	54194
Waste management and remediation services	562
Water transportation	483
Water, sewage and other systems	2213
Wholesale trade	42
Wired telecommunications carriers	5171
Wireless telecommunications carriers (except satellite)	5172

Appendix 8. Summary data on industries and IFT

Figure A.8.1 shows the intermediate output for summary industry groups, as a percentage of gross output for those industry groups (the IFT ratio). More than half of gross industry output for manufacturing industries, construction,[36] and several types of services[37] is intermediate output – that is, these industries are producing more intermediate than final use output. Among services industries, several produce less than half of all output as intermediate, including retail; food services, accommodations, entertainment, and arts; and education, health care, and social assistance.

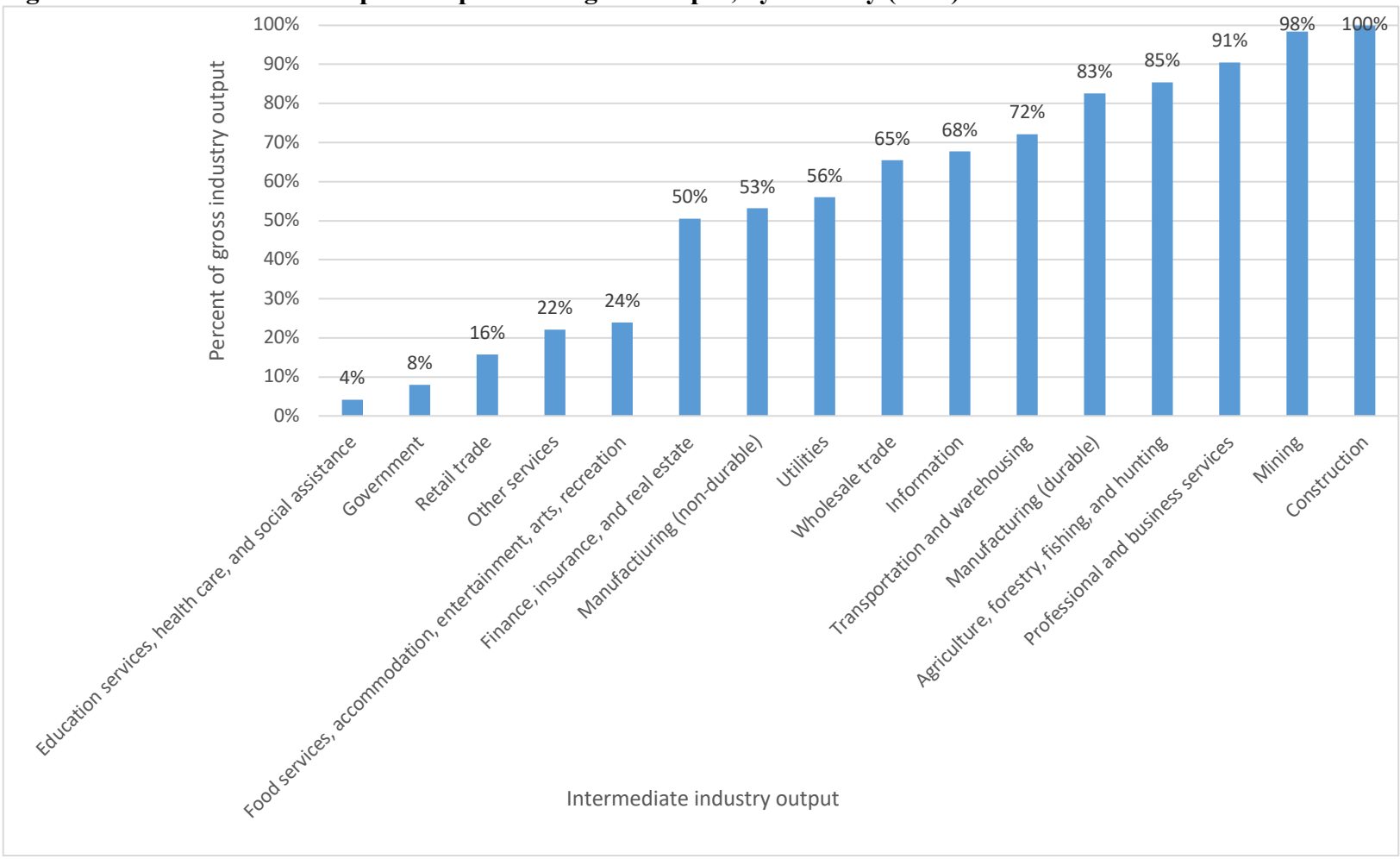
Figure A.8.2 shows each industry group's intermediate and final use output as a portion of all economic output across the economy. Here, we can see that durable manufacturing and

[36] I consider output that is classified as a purchaser's investment to be an intermediate rather than a final use (see Appendix 2). This explains, for example, why the construction industry's output is essentially 100% intermediate: because construction expenditures from private, individuals are considered investment, just as a firm's construction expenditures.

[37] It is important to remember that industry categories, like the broad sectoral categories, are imperfect. Even in the detailed I-O data, some industry categories represent a more alike group of firms than others. One major limitation of the I-O data is that is has significantly more detail on manufacturing industries compared to services industries. Additionally, there is insufficient detail in the categorization for some newer industries, such as those related to technology.

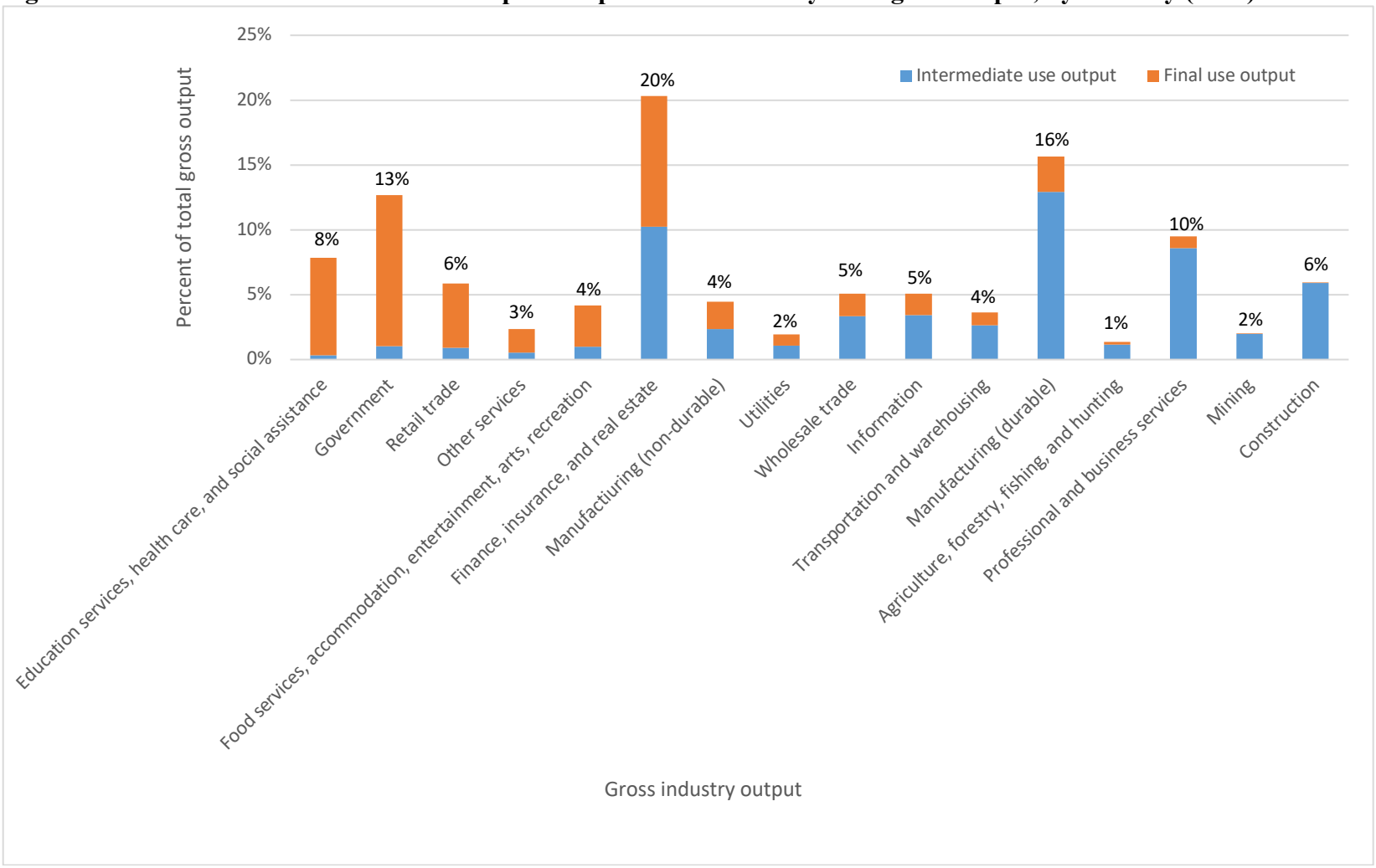
PBS represent a large share of total gross output, and that most of that output is intermediate use. Government and education services (etc.) are also a large portion of total output, but most of their output is final use. FIRE represents the largest share of total output of all industry groups, and about half of its output is intermediate use and half is final use.

Figure A.8.1. Intermediate output as a percent of gross output, by industry (2007)



Source data: Author's analysis of the Bureau of Economic Analysis make and use tables, 2007

Figure A.8.2. Intermediate and final use output as a percent of economy-wide gross output, by industry (2007)



Source data: Author's analysis of the Bureau of Economic Analysis make and use tables, 2007

Appendix 9. Variables and regressions by industry grouping

This appendix includes the complete regression results and variable names for the estimated correlation between industry percent intermediate output and workers' wages. I estimate six distinct regressions: one simple model selecting each subset of industries based on the three groupings of industries, and one model for each industry group including demographic control variables. I cluster standard errors by industry for each regression.

As a reminder, these regressions should be understood as simple descriptive tools to aggregate the correlative relationship between wages and industries' intermediate output. I tested many different approaches to representing this correlation and found that the simple ordinary least squares (OLS) model, with and without basic demographic controls, offered the clearest starting point for beginning to explore the possibility of a connection between industry intermediate output and workers' wages.

Table A.9.1 Estimated relationship between the industry IFT ratio and wages – Ordinary Least Squares (OLS) regression model

Simple linear regression	$ln(w) = \beta_1 X_{i1} + \varepsilon_i$
Linear regression with demographic controls	$ln(w) = \beta_1 X_{i1} + \beta_2 X_{i2} + \beta_3 X_{i3} + \beta_4 X_{i4} + \beta_5 X_{i5} + \beta_6 X_{i6} + \beta_7 X_{i7} + \varepsilon_i$
Dependent variable	w = hourly wage
Independent variable	X_{i1} = industry IFT ratio
Demographic control variables	X_{i2} = race (categorical) X_{i3} = U.S. citizen (y/n) X_{i4} = age X_{i5} = region (categorical) X_{i6} = level of educational attainment X_{i7} = sex (m/f)
Unit of analysis	i = worker

Regression results:

Table A.9.2 Regression result for each industry grouping, simple OLS (2014)

	Industry group 1 - all goods and services		Industry group 2 – services only		Industry group 3 – feasibly in-house services	
Industry IFT ratio	0.297 *	(0.13)	0.475 *	(0.17)	0.713 **	(0.16)
FIHŧ	-		-		-0.343 **	(0.11)
Constant	2.720	(0.11)	2.616	(0.11)	2.64	(0.01)
R-Squared	0.02		0.05		0.08	
Adjusted R-squared	0.02		0.05		-	
Number of observations	1,134,174		739,993		739,993	

*Significant at 0.05
**Significant at 0.005
ŧ A dummy variable indicating whether or not an industry is feasibly in-house
(Standard errors in parentheses)

Source data: Author's analysis of the Bureau of Economic Analysis make and use tables (2007) and the American Community Survey (2014).

Table A.9.3 Regression result for each industry grouping, OLS with demographic controls (2014)

	Industry group 1 - all goods and services		Industry group 2 – services only		Industry group 3 – feasibly in-house services	
Industry IFT ratio	0.262 **	(0.06)	0.305 **	(0.09)	0.424 **	(0.09)
FIHŧ	-		-		-0.170	(0.05)
Race - other	-0.068 **	(0.01)	-0.069 **	(0.01)	-0.067 **	(0.01)
Race – Black (non-Hispanic)	-0.108 **	(0.02)	-0.117 **	(0.01)	-0.115 **	(0.01)
Race - Hispanic	-0.089 **	(0.01)	-0.086 **	(0.01)	-0.085 **	(0.01)
Race – Asian (non-Hispanic)	0.016	(0.02)	0.018	(0.03)	0.019	(0.03)
Citizen – yes (1) or no (0)	0.114 **	(0.01)	0.095 **	(0.02)	0.080 **	(0.02)
Age (18-64)	0.017 **	(0.)	0.017 **	(0.)	0.016 **	(0.00)
Region – New England	0.003	(0.01)	0.016	(0.01)	0.014	(0.01)
Region – Middle Atlantic	-0.014	(0.01)	-0.021	(0.01)	-0.023	(0.01)
Region – East North Central	-0.122 **	(0.01)	-0.127 **	(0.01)	-0.127 **	(0.01)
Region – West North Central	-0.141 **	(0.01)	-0.135 **	(0.01)	-0.139 **	(0.01)
Region – South Atlantic	-0.098 **	(0.01)	-0.091 **	(0.01)	-0.089 **	(0.01)

Region – East South Central	-0.185	**	(0.01)	-0.175	**	(0.01)	-0.176	**	(0.01)
Region – West South Central	-0.099	**	(0.02)	-0.093	**	(0.01)	-0.096	**	(0.01)
Region - Mountain	-0.099	**	(0.01)	-0.090	**	(0.01)	-0.092	**	(0.01)
Region - Pacific	0.000	**		0.000	**		0.000	**	0.00
Education – less than high school	-0.199	**	(0.01)	-0.187	**	(0.01)	-0.168	**	(0.02)
Education – high school graduate	0.000	**		0.000	**		0.000	**	0.00
Education – some college	0.173	**	(0.02)	0.174	**	(0.03)	0.167	**	(0.03)
Education – college graduate	0.628	**	(0.02)	0.632	**	(0.04)	0.615	**	(0.04)
Sex – female (1) or male (0)	-0.167	**	(0.02)	-0.139	**	(0.02)	-0.142	**	(0.02)
constant	2.071		(0.07)	2.004		(0.07)	2.068		(0.04)
R-Squared	0.31			0.31			0.32		
Adjusted R-squared	0.61			0.31			-		
Number of observations	1,134,174			739,993			739,993		
**Significant at 0.005									
ɬ A dummy variable indicating whether or not an industry is feasibly in-house									
(Standard errors in parentheses)									

Source data: Author's analysis of the Bureau of Economic Analysis make and use tables (2007) and the American Community Survey (2014).

Appendix 10. Additional occupation case studies

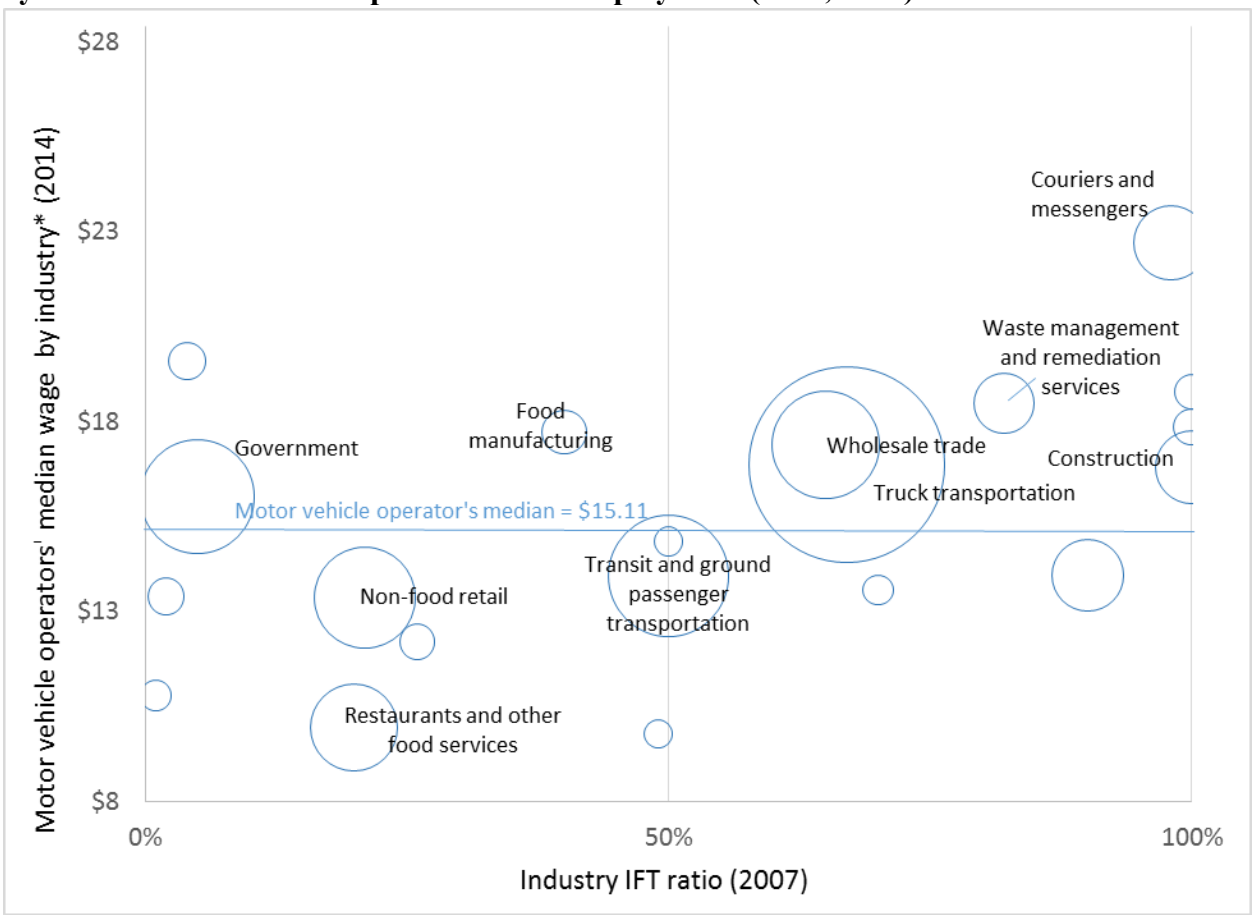
Motor vehicle operators

Major occupations that fall under the category of motor vehicle operators are bus drivers, truck drivers, delivery drivers (including UPS and FedEx drivers), taxi/chauffeurs, and ambulance drivers. As in the case of janitors, prior research leads us to expect a negative correlation between the IFT ratio and wages for these workers in certain industries like truck transportation, based on the well-documented trend of firms increasingly outsourcing trucking to

other firms and/or independent contractors[38] (Marshak and Hubbard 2003) and subsequent wage declines for many workers in these occupations (Habermalz and Monaco 2007).

However, the overall correlation between the IFT ratio and wages for motor vehicle operators is positive, as figure A.10.1 illustrates. The median hourly wage for motor vehicle operators was $15.11 in 2014, but varies considerably across industries. The correlation between industry IFT ratio and wages is even more clearly positive than in the case of janitors: the estimated OLS coefficient (without controls) is 0.35 (significant).

Figure A.10.1. Motor vehicle operators' median wages and IFT ratio by industry, weighted by share of motor vehicle operators' total employment (2007, 2014)



*The y-axis range includes 50 to 200% of the occupations' median wage.

[38] Independent contractors are not included in the analysis of wages, however.

Notes: Bubble size represents share of motor vehicle operators' total employment. Bubbles only included for industries employing over 1% of all motor vehicle operators. Industry IFT ratio is the ratio of intermediate output to total gross output (intermediate + final use output) for an industry.
Source data: Author's analysis of the Bureau of Economic Analysis make and use tables (2007) and the American Community Survey (2014).

To make sense of this finding, I take a closer look at motor vehicle operators' wages, starting with intermediate-use industries. The largest concentrations of motor vehicle operators are employed in the intermediate-use truck transportation industry (27%) and in transit and ground passenger transportation (10%), which is a mixed intermediate and final-use industry that includes bus drivers, taxi drivers, etc. The truck transportation industry pays a bit over the median wage for motor vehicle operators ($16.43 per hour) and the transit and ground transportation industry pays just under the median ($13.49 per hour).

Truck transportation, like building services for janitors, is a feasibly in-house service, because it mainly produces an intermediate-use service that could feasibly be produced in-house, even though many firms choose to outsource this function. A wide array of industries purchase truck transportation services; the primary purchasers of these services include the construction industry, retail, animal slaughtering and processing, wholesale trade, and government. The truck transportation industry is one of the major purchasers of truck transportation services as well, which is an indicator of IFT occurring within the industry itself, between different trucking firms and between firms and independent contractors.[39]

Working as a motor vehicle operator in the truck transportation industry is a notoriously difficult, dangerous, and under-paid job (Murphy, 2017). However, the wages these workers

[39] Independent contractors are included in the original I-O data, for example they are included as purchases of trucking services by the trucking industry, along with purchases of services from other trucking firms.

receive – while not high, especially given the working conditions – are a bit higher than the median for all motor vehicle operators. It is important to note that this analysis only applies to employees; were independent contractors included in this analysis, the median wage for this group of workers would likely be considerably lower. The slightly higher wages for (non-independent contractor) truck drivers in the trucking industry may reflect a residual effect of the better wages and working conditions that previously characterized the industry. The truck transportation industry is currently only about 10% unionized, but unionization rates (and therefore wages) were much higher prior to deregulation of the trucking industry in the late 1970s (Hirsch 1988). Additionally, there may be other factors that have hurt motor vehicle operators' wages even more in other industries.

Another intermediate-use industry with significant numbers of motor vehicle operators is the couriers and messengers industry. This industry – which includes FedEx and UPS – employs 4% of all motor vehicle operators and pays them a median wage of $22.25 per hour, significantly higher than the median wage for all motor vehicle operators. This industry is also considered a feasibly in-house industry. The likely explanation for motor vehicle operators' wages in the couriers industry is high union density, raising wages and preventing wage erosion for both union and non-union workers (Mishel 2012). Unions represent about 30% of all workers in the couriers and messengers industry, and 64% of all postal service transportation workers (Milkman and Luce 2015). The union effect also likely contributes to higher median wages for motor vehicle operators working for waste management and remediation workers, which includes municipal waste collectors and hazardous materials workers. About 3% of all motor vehicle operators work in this industry, and they earn a median wage of $18.04 per hour.

I next turn to the left-hand quadrants of figure A.10.1, showing final-use industries that employ motor vehicle operators. Among these, the largest employer is government, which employs 9% of all motor vehicle workers. As we would expect, these workers are paid above the median wage for all motor vehicle workers (although not by much). Unions may have an effect here; similarly for food and beverage stores and food manufacturing, both of which have some (although limited) union presence (Food Chain Workers Alliance, Solidarity Research Cooperative 2016).

Other final-use industries pay motor vehicle operators much less, however, including non-food retail (7% of operators) and restaurants and other food services (5% of operators). These industries employ motor vehicle operators as direct employees, but also purchase services from the truck transportation industry, as they do with janitors in the services to buildings and dwellings industry. However, while janitors in the building services industry make similarly low wages to janitors in the restaurant and retail industries, motor vehicle operators employed in the truck transportation industry tend make *higher* wages than their counterparts in the restaurants and retail industry, likely as a result of the legacy of unions in the trucking industry, and/or other factors driving down wages for workers in retail and restaurants.

Financial clerks

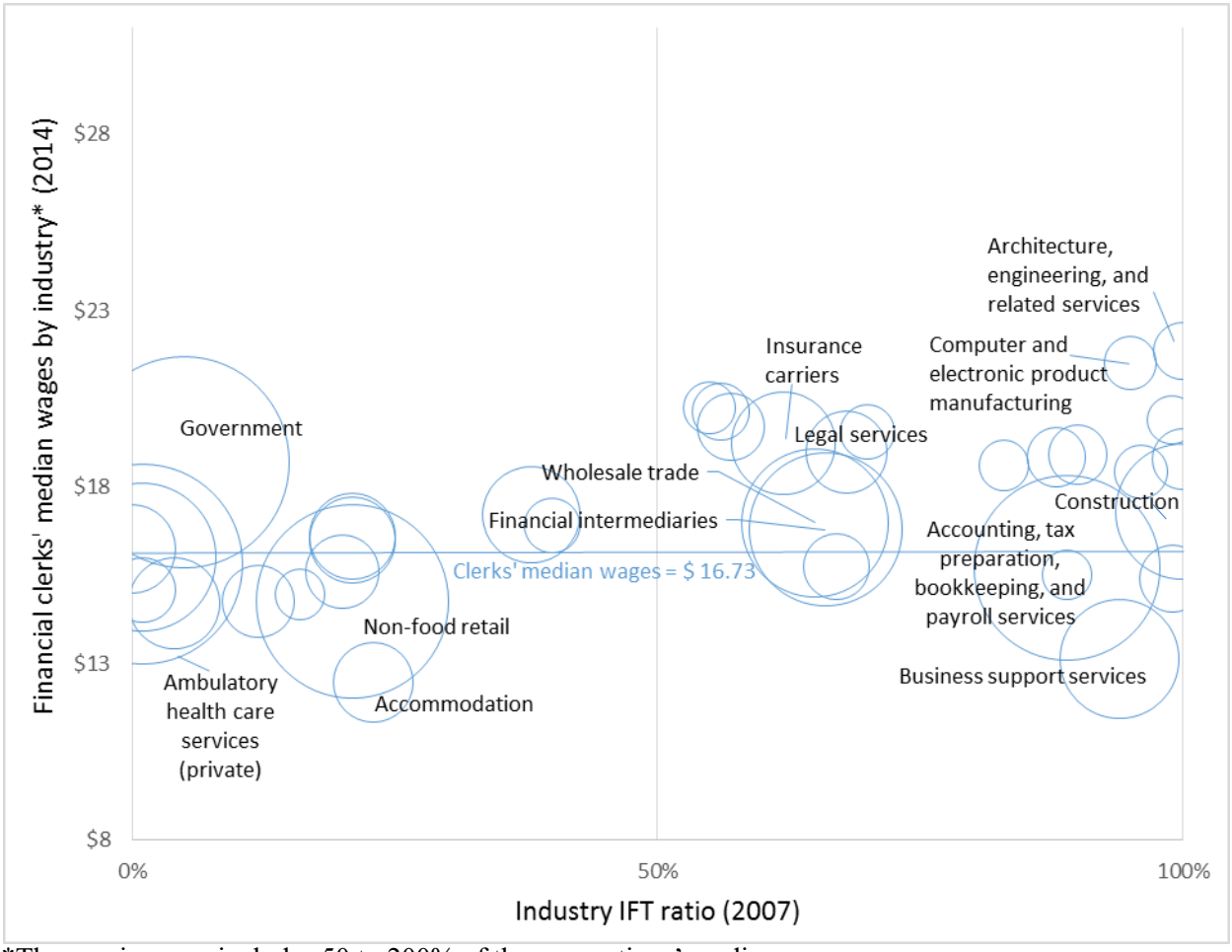
Financial clerks work in a wide range of industries, keeping records, executing financial transactions, and providing customer service.[40] Typical entry-level workers in these jobs have had some college education, but no degree ("Bookkeeping, Accounting, and Auditing Clerks,"

[40] The financial clerks occupational category includes bookkeeping, accounting, and auditing clerks; bill and account collectors; billing and posting clerks; gaming cage workers; payroll and timekeeping clerks; and procurement clerks.

2015). Based on our initial expectations about wages in feasibly in-house industries, we might expect to see a wage penalty for clerks employed in industries like accounting and bookkeeping services, and business support services. While wages for clerks in these industries are lower than clerks' overall median wage ($16.73 per hour), the overall correlation between the IFT ratio and wages is positive.

Wages for clerks vary by industry, within both the intermediate-use and final-use industries. Estimating OLS regressions for the financial clerks occupation showed a mildly positive correlation between the IFT ratio and clerks' wages – the estimated slope on the IFT ratio is 0.06, and significant. To better understand why this is, I examine the main industries employing clerks (figure A.10.2).

Figure A.10.2. Financial clerks' median wages and the IFT ratio by industry, weighted by share of clerks' total employment (2007, 2014)



*The y-axis range includes 50 to 200% of the occupations' median wage.

Notes: Bubble size represents share of clerks' total employment. Bubbles only included for industries employing over 1% of all clerks. Industry IFT ratio is the ratio of intermediate output to total gross output (intermediate + final use output) for an industry.
Source data: Author's analysis of the Bureau of Economic Analysis make and use tables (2007) and the American Community Survey (2014).

I start by examining intermediate-use industries on the right-hand side of the graph. In contrast to janitors employed in building services, financial clerks are not as highly concentrated in one main contractor industry – there is not one industry that is the main industry selling financial clerk services to other companies or the government. Instead, employment in this occupation is spread across many different intermediate-use industries, and some final-use industries.

Among the intermediate-use industries, accounting, tax preparation, bookkeeping, and payroll services employs the most clerks (8%). This industry pays slightly below the median wage for clerks, at $15.72 per hour. Business support services, which employs 3% of clerks, pays significantly below the median, at $13.13 an hour. For these two industries, both of which are considered feasibly in-house services, we do observe a wage penalty for clerks.

However, many other intermediate-use industries employing clerks pay above the median wage. Within this group the largest employers are the financial intermediaries industry and wholesale trade, both of which employ 5% of all financial clerks and pay them slightly over the median wage ($16.80 and $16.99 per hour, respectively). Several industries that employ smaller numbers of clerks pay their clerks significantly more, including legal services ($18.99) and insurance carriers ($19.25). Note that several of these industries also are feasibly in-house services, yet they pay higher than typical wages for clerks.

There are several possible explanations for the wide range in wages among financial clerks in intermediate-use industries. Similar to other occupations analyzed here, we may be observing the difference between industries that produce high-margin goods and services (such as legal services, financial investments, and computer system design), and those that produce lower-margin goods and services (such as services to buildings and dwellings and business support services). We can also observe, for instance, that the industries paying higher wages for clerks have higher median wages for workers across all occupations.

Another possibility (which is not mutually exclusive) is that some of these high-wage, intermediate-use industries require a more specialized skill set from their financial clerks in order to carry out work that is highly technical, such as architecture, engineering, or financial

investments. This specialization may result in higher compensation compared to financial clerks at an accounting services or business support services firm, which may require a more general skill set in order to meet the needs of a wide range of clients.

It may also be the case that within these high-wage, intermediate-use industries, some firms have begun contracting financial clerks services to another firm, e.g. in the accounting services industry, which typically pay clerks less per hour. The largest purchasers of accounting services include insurance carriers, wholesale trade, and architectural and engineering services, among others. This is appears to be an example of a high-wage, intermediate-use industry purchasing services from another intermediate-use but lower-wage industry, potentially as a way to reduce their labor costs.

I next turn to the left-hand side of figure A.10.2. which shows final-use industries that employ clerks. These industries almost uniformly pay below the overall median wage for the occupation. For example, the ambulatory health care services industry employs 9% of clerks and pays them a median wage of $15.82 per hour. Non-food retail employs 8% of all financial clerks and pays even lower, at $14.76 per hour. The lowest-paid financial clerks work in the accommodations industry and earn $12.48 per hour. As I've discussed previously, many of these industries pay low wages to front-line workers across the board and operate in a competitive, low-margin business environment.

Government is one of the few final-use employers of financial clerks that pays above-median wages –well above the median, at $18.70 per hour. Ten percent of all clerks are employed by government entities. However, government is also a significant consumer of the accounting services industry (about 8% of clerks services are purchased by government), which

again suggests that some government entities are purchasing clerks' services from a firms in an intermediate-use industry in order to reduce labor costs.

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