How do Firms in Different Sectors Organize their Supply Chains? Evidence from Transaction-Level Import Data

By SEBASTIAN HEISE AND JUSTIN R. PIERCE AND GEORG SCHAUR AND PETER K. SCHOTT*

In recent years, tariffs and the threat of future trade wars have forced firms to reconsider how they source goods from abroad. The academic and public discourse has often focused on how these risks might affect where multinational firms locate their foreign affiliates, with "nearshoring," "friendshoring," and "reshoring" suggested as possibilities. In earlier work (Heise et al., 2021), we highlight the importance of another element of firms' international sourcing affected by the risk of trade wars: firms' organization of supply chains, and specifically their choice of procurement system.[1]

By procurement system, we mean the order frequency, order size, price paid, and inspection regime that buyer firms use when purchasing goods from a seller. A seminal paper on the choice of such procurement systems is Taylor and Wiggins (1997), which shows that a buyer can ensure that suppliers provide high-quality goods either through spot-market purchases with costly inspections—which Taylor and Wiggins (1997) call the "American" system—or by paying an incentive premium as part of a long-term buyer-seller relationship, which they call the "Japanese" system. The model predicts that the "American" system involves large and infrequent orders at low prices, while "Japanese" procurement is associated with small and frequent purchases at higher prices due to the incentive premium. Heise et al. (2021) extend the Taylor and Wiggins (1997) framework to international procurement and show that a higher likelihood of trade wars is associated with less "Japanese" sourcing. They also show how to test the model's implications empirically and use transaction-level U.S. import data to provide the first evidence consistent with the mechanisms in Taylor and Wiggins (1997).

Heise et al. (2021) introduce a model-based empirical measure that can be used to classify firms' procurement systems: the ratio of the number of sellers to the number of shipments (*SPS*). The measure leverages the model's prediction that firms purchasing under the "American" system will source goods from many foreign sellers, while those engaged in long-term relationships will purchase from fewer or even a single seller. Heise et al. (2021) show that after using *SPS* to classify firms' imports by procurement system, their order patterns are consistent with other key implications of the model. In particular, those procuring goods from relatively fewer suppliers place smaller shipments at higher frequency and pay higher unit values, consistent with the "Japanese" system.

This paper complements the findings in our earlier work by providing a detailed analysis of the choice of procurement system by firms' major sector of activity. Recently, there has been growing interest in using empirical measures such as *SPS* to examine and characterize relationships between buyer and seller firms. Much of this literature has focused on applications to specific goods or sectors. For example, Cajal-Grossi, Macchiavello and Noguera (2023) use the *SPS* measure developed by Heise et al. (2021) to examine "relational" buyer-seller relationships in the Bangladeshi garment industry. Cajal-Grossi, Del Prete and Macchiavello (2023) then use the *SPS* measure to examine the effect of Covid-related supply chain disruptions on procurement strategies in the garment sector for six developing countries.

* Heise: Federal Reserve Bank of New York, sebastian.heise@ny.frb.org. Pierce: Board of Governors of the Federal Reserve System, justin.r.pierce@frb.gov. Schaur: University of Tennessee, gschaur@utk.edu. Schott: Yale School of Management CEPR NBER; peter.schott@yale.edu. The views and opinions expressed in this work do not necessarily represent the views of the Federal Reserve Bank of New York, the Census Bureau, the Board of Governors of the Federal Reserve System, or its research staff. The Census Bureau has reviewed this data product to ensure appropriate access, use, and disclosure avoidance protection of the confidential source data used to produce this product. This research was performed at a Federal Statistical Research Data Center under FSRDC Project Number 1883 (CBDRB-FY21-P1883-R9019, CBDRB-FY22-P1883-R9643).

[1] A more recent version of that paper is Heise et al. (2024).

In this paper, we use confidential data for U.S. import transactions to provide descriptive statistics on the use of procurement systems for a broad range of sectors. We classify importers' procurement systems using *SPS* and show that the finding of more-frequent, smaller, and higher-priced imports within long-term buyer-seller relationships predicted by the model in Heise et al. (2021) is remarkably stable across different sectors.

I. Which Sectors Use "Japanese" Sourcing?

As in Heise et al. (2021), we characterize procurement systems using confidential transaction-level data from the the US Census Bureau's (Census) Longitudinal Foreign Trade Transaction Database (LFTTD). Our dataset covers the years 1992 to 2016, and we restrict imports to those that are "arm's length," or between unrelated firms.[2] When examining import behavior, our unit of observation is an importer m sourcing a good h from country c via mode of transportation z, which we refer to as a "quadruple." This level of aggregation helps isolate obvious sources of variation in observed price and quantity.

Following our earlier work, we classify buyer quadruples' procurement systems using the ratio of the number of sellers used to the number of shipments received:

$$SPS_{mhcz} = \frac{Sellers_{mhcz}}{Shipments_{mhcz}}. \tag{1}$$

Heise et al. (2021) provides some statistics on the distribution of SPS_{mhcz} across quadruples, and here we focus on heterogeneity across sectors. The first two columns of Table 1 provide measures of the mean *SPS* by major sector of the importing firm m, for two periods, 1995-2000 and 2002-2007.[3]

There is substantial variation in procurement systems across sectors. Transportation and Warehousing, the sector with the highest ratio of sellers per shipment, has an *SPS* in both periods that is nearly twice as large as that for the sector with the lowest value of *SPS*, manufacturing. This finding suggests that manufacturers are substantially more engaged in longer-term relationships than transport and warehouse firms, with the latter engaged more in spot-market sourcing.

While our *SPS* measure allows us to delineate which relationships appear more "Japanese" than others, it does not define a formal threshold. To provide some guidance for the importance of "Japanese" sourcing, Heise et al. (2021) define a quadruple as being engaged in "Japanese" sourcing ($J^{cz}_{mhcz} = 1$) if SPS_{mhcz} falls in the first quartile of the distribution of SPS_{mhcz} within a country-mode bin in the 1995-2000 period.

The third and fourth columns of Table 1 report the share of the value of U.S. imports accounted for by quadruples with $J^{cz}_{mhcz} = 1$. Going forward, we refer to "Japanese" sourcing as J and to "American" sourcing as A. As shown in the table, J quadruples account for a disproportionately large share of import value in all sectors. But again, there is substantial variation across sectors, with the share of J trade for manufacturers in 2002-2007 over 25 percentage points higher than that for transportation and warehousing.

Examining changes over time, the prevalence of J procurement has increased in most sectors, as evidenced both by declining *SPS* in columns 1 and 2 and an increasing share of import value associated with J quadruples in columns 3 and 4. Two exceptions to this upward trend are the high-wage services sectors of "Professional Services" and "Finance and Insurance," which likely do not use imported goods intensively in their production functions. The largest shift toward longer-term buyer-seller relationships between the 1995-2000 and 2002-2007 periods occurs in the retail sector, which saw a 15 percentage point increase in the share of import value occurring under J procurement.

II. Shipping Patterns Within Procurement System, by Sector

Heise et al. (2021) examine whether quadruples—once categorized by *SPS*—engage in shipping patterns consistent with their model. Pooling observations across all sectors, they show that, indeed, quadruples with lower values of *SPS* receive more frequent and smaller

[2] Census considers firms to be related if either party owns a 6 percent or greater share of the other.

[3] The major sector of the firm is based on employment across sectors.

TABLE 1—"JAPANESE" RELATIONSHIPS BY MAIN INDUSTRY OF THE IMPORTER

	Mean *SPS*		$J^{cz}_{mhcz} = 1$ Share of Import Value	
	(1)	(2)	(3)	(4)
Industry code (NAICS)	1995-2000	2002-2007	1995-2000	2002-2007
Manufacturing (31-33)	0.119	0.113	0.739	0.778
Agriculture (11)	0.123	0.106	0.584	0.630
Wholesale (42-43)	0.158	0.128	0.623	0.729
Other services	*0.160*	*0.130*	*0.655*	*0.713*
Professional services (54-55)	0.177	0.220	0.586	0.415
Mining, utilities and construction (21-23)	0.182	0.131	0.561	0.684
Finance and insurance (52-53)	0.187	0.213	0.516	0.514
Retail (44-45)	0.208	0.157	0.532	0.688
Information (51)	0.211	0.182	0.553	0.566
Admin support & waste mgmt (56)	0.213	0.195	0.312	0.423
Transportation and Warehousing (48-49)	0.216	0.210	0.487	0.511

Notes: Sources are LFTTD and authors' calculations. Columns 1 and 2 report the weighted average sellers per shipment (SPS_{mhcz}) across buyer quadruples with at least five transactions by main 6-digit NAICS industry-period. To obtain the main NAICS, we find in each year the industry with the importer's largest share of employment, and then take the modal main industry across the years in which the quadruple is active. We aggregate SPS_{mhcz} across quadruples using import values as weights. Columns 3 and 4 report the share of the value of US imports accounted for by quadruples with SPS_{mhcz} in the first quartile of the distribution of SPS_{mhcz} within country-mode in the first period. Rows of the table are sorted by the column (1).

shipments at lower prices, consistent with the *J* system. They therefore argue that *SPS*, reproduced in equation 1, provides a model-based continuous measure of the extent of *J* or *A* sourcing for a given quadruple.

In this paper, given the recent interest in sector-level empirical applications of the *SPS* measure, we perform a similar analysis examining how shipping patterns vary by *SPS*, separately, by major sector of U.S. importing firms. To do so, we estimate the following equation from Heise et al. (2021):

(2)
$$\ln(\overline{Y}_{mhcz}) = \beta_1 \ln(SPS_{mhcz}) + \beta_2 \ln(QPW_{mhcz}) + \beta_3 beg_{mhcz} + \beta_4 end_{mhcz} + \lambda_{hcz} + \varepsilon_{mhcz}.$$

The dependent variable consists of a set of shipping characteristics that the model in Heise et al. (2021) predicts will change based on the choice of procurement system. These shipping characteristics include average quantity per shipment (QPS_{mhcz}), weeks between shipments (WBS_{mhcz}), average unit value (UV_{mhcz}), and average length of the buyer(m)-seller(x) relationships within *mhcz* buyer quadruples. The key independent variable is SPS_{mhcz}, the model-based measure of a quadruple's procurement system. Other controls include the quantity per week imported by the quadruple (as called for by the Heise et al. (2021) model), controls for the beginning and end period of a quadruple's trading activity (to capture effects of trading in a given time period), and product by country by mode of transportation fixed effects (λ_{hcz}). We estimate equation 2 separately for firms in three sectors that are intensively engaged in international trade: Manufacturing, Wholesale, and Retail. Results are presented in Tables 2 - 4.

Beginning with Manufacturing (Table 2), we find that shipping characteristics are related to *SPS* in ways predicted by the model and are consistent with the results for the pooled sample in Heise et al. (2021). In particular, a higher *SPS*, which indicates a greater reliance on the spot market—and hence more *A* sourcing—is associated with larger shipment sizes, more time between shipments, a lower unit value, and shorter relationship lengths in the manufacturing sector.

Examining results for the Wholesale and Retail sectors in Tables 3 and 4, respectively, indi-

TABLE 2—SPS_{mhcz} AND PROCUREMENT ATTRIBUTES - MANUFACTURING

	(1)	(2)	(3)	(4)
Dep. var.	$\ln(QPS_{mhcz})$	$\ln(WBS_{mhcz})$	$\ln(UV_{mhcz})$	$\ln(length_{mhcz})$
$\ln(SPS_{mhcz})$	0.500^{***}	0.538^{***}	-0.181^{***}	-0.540^{***}
	0.014	0.014	0.022	0.012
$\log(QPW_{mhcz})$	0.769^{***}	-0.238^{***}	-0.367^{***}	-0.131^{***}
	0.018	0.018	0.022	0.008
Observations	560,000	560,000	560,000	560,000
Fixed effects	*hcz*	*hcz*	*hcz*	*hcz*
R-squared	0.950	0.712	0.816	0.434
Controls	beg, end	beg, end	beg, end	beg, end

Notes: Sources are LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport (*mhcz*) bins on bins' sellers per shipment (SPS_{mhcz}) and total quantity shipped per week (QPW_{mhcz}). Industries are assigned using the main 6-digit NAICS industry of the importer based on total employment. QPS_{mhcz}, WBS_{mhcz}, UV_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value, and average relationship length. All regressions include product by country by mode of transport (*hcz*) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (*c*) and product (*h*) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

cates similar relationships between *SPS* and all four shipping characteristics, as indicated by the identical sign and significance of coefficients on the *SPS* variable and their highly similar magnitudes across sectors. In other words, while firms differ substantially across sectors in their choice of procurement system, the effect of changing procurement systems on shipping characteristics is remarkably robust across sectors. These results also illustrate that the results in Heise et al. (2021) are not driven by relationships for a single sector or group of sectors.

III. Conclusion

This paper builds on Heise et al. (2021) by providing new analysis on U.S. firms' choice of procurement systems by major sector. We provide descriptive statistics on the extent of long-term "Japanese" type procurement, showing substantial variation across sectors, with manufacturers most likely to use such systems. We also show—after classifying trade by procurement system—that buyers' shipment characteristics align with those predicted by the model in Heise et al. (2021). This finding is robust across all sectors examined. Our results complement the findings in our earlier paper and the subsequent analysis by Cajal-Grossi, Macchiavello and Noguera (2023) applying our *SPS* measure to the garment industry.

References

Cajal-Grossi, Julia, Davide Del Prete, and Rocco Macchiavello. 2023. "Supply chain disruptions and sourcing strategies." *International Journal of Industrial Organization*, 90: 103004. The 49th Annual Conference of the European Association for Research in Industrial Economics, Vienna, 2022.

Cajal-Grossi, Julia, Rocco Macchiavello, and Guillermo Noguera. 2023. "Buyers' sourcing strategies and suppliers' markups in bangladeshi garments." *The Quarterly Journal of Economics*, 138(4): 2391–2450.

Heise, Sebastian, Justin R. Pierce, Georg Schaur, and Peter K. Schott. 2021. "Tariff Rate Uncertainty and the Structure of Supply Chains." Cowles International Trade Conference.

Heise, Sebastian, Justin R Pierce, Georg Schaur, and Peter K Schott. 2024. "Tariff rate uncertainty and the structure of supply chains." NBER Working Paper No. 32138.

Taylor, Curtis R., and Steven N. Wiggins. 1997. "Competition or Compensation: Supplier Incentives under the American and

TABLE 3—SPS_{mhcz} AND PROCUREMENT ATTRIBUTES - WHOLESALE

	(1)	(2)	(3)	(4)
Dep. var.	$\ln(QPS_{mhcz})$	$\ln(WBS_{mhcz})$	$\ln(UV_{mhcz})$	$\ln(length_{mhcz})$
$\ln(SPS_{mhcz})$	0.443^{***}	0.475^{***}	-0.181^{***}	-0.571^{***}
	0.015	0.015	0.013	0.020
$\log(QPW_{mhcz})$	0.682^{***}	-0.328^{***}	-0.281^{***}	-0.167^{***}
	0.012	0.012	0.017	0.007
Observations	1,215,000	1,215,000	1,215,000	1,215,000
Fixed effects	*hcz*	*hcz*	*hcz*	*hcz*
R-squared	0.945	0.708	0.856	0.469
Controls	beg, end	beg, end	beg, end	beg, end

Notes: Sources are LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport (*mhcz*) bins on bins' sellers per shipment (SPS_{mhcz}) and total quantity shipped per week (QPW_{mhcz}). Industries are assigned using the main 6-digit NAICS industry of the importer based on total employment. QPS_{mhcz}, WBS_{mhcz}, UV_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value, and average relationship length. All regressions include product by country by mode of transport (*hcz*) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (*c*) and product (*h*) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

TABLE 4—SPS_{mhcz} AND PROCUREMENT ATTRIBUTES - RETAIL

	(1)	(2)	(3)	(4)
Dep. var.	$\ln(QPS_{mhcz})$	$\ln(WBS_{mhcz})$	$\ln(UV_{mhcz})$	$\ln(length_{mhcz})$
$\ln(SPS_{mhcz})$	0.424^{***}	0.458^{***}	-0.120^{***}	-0.556^{***}
	0.030	0.031	0.023	0.022
$\log(QPW_{mhcz})$	0.643^{***}	-0.366^{***}	-0.195^{***}	-0.115^{***}
	0.007	0.007	0.012	0.008
Observations	525,000	525,000	525,000	525,000
Fixed effects	*hcz*	*hcz*	*hcz*	*hcz*
R-squared	0.945	0.708	0.856	0.955
Controls	beg, end	beg, end	beg, end	beg, end

Notes: Sources are LFTTD and authors' calculations. Table reports the results of regressing noted attribute of importer by product by country by mode of transport (*mhcz*) bins on bins' sellers per shipment (SPS_{mhcz}) and total quantity shipped per week (QPW_{mhcz}). Industries are assigned using the main 6-digit NAICS industry of the importer based on total employment. QPS_{mhcz}, WBS_{mhcz}, UV_{mhcz}, and $length_{mhcz}$ are average quantity per shipment, average weeks between shipment, average unit value, and average relationship length. All regressions include product by country by mode of transport (*hcz*) fixed effects, control for the beginning and end week of the quadruple, and exclude quadruples with less than five shipments. Standard errors, adjusted for clustering by country (*c*) and product (*h*) are reported below coefficient estimates. ***, **, and * represent statistical significance at the 1, 5 and 10 percent levels.

Japanese Subcontracting Systems." *American Economic Review*, 87(4): 598–618.