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Published in:
Journal of Operations Management

DOI (link to publication from Publisher):
10.1002/joom.1254

Publication date:
2023

Document Version
Publisher's PDF, also known as Version of record

Received: 6 October 2021 | Revised: 21 March 2023 | Accepted: 3 April 2023

DOI: 10.1002/joom.1254

RESEARCH ARTICLE

WILEY

The signaling effect of supplier's customer network instability on service price: Insights from the container shipping charter market

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Handling Editor: Andy Yeung

Abstract

In a service exchange setting, the supply management literature generally assumes, with notable exceptions, the availability of complete information regarding supplier reliability. Highlighting the information asymmetry in supplier evaluation and using signaling theory, we argue that for a focal buyer, a supplier's downstream ego-network instability, that is, other buyers' turnover in a supplier's network from one period to the next, acts as a *signal* of supplier unreliability, thereby reducing the price that the buyer pays to the supplier in a service exchange. Furthermore, we suggest that focal buyer–supplier relationship strength and structural equivalence weaken the negative effect of instability because the buyer has a more direct and positive experience with the supplier. Using a dataset of 3263 unique dyads formed by 260 buyers (shipoperators) and 493 suppliers (shipowners) during the 2000–2018 period in the container shipping charter market, we find support for our hypotheses, except for the contingent effect of structural equivalence. Our study contributes to signaling literature and network research by developing a supplier's downstream ego-network instability as a salient heuristic for a focal buyer's pricing decisions. These findings equip buyer managers who may not accurately foresee supplier service quality in the charter market with a new supplier evaluation tool: a supplier's downstream ego-network instability.

KEYWORDS

buyer–supplier structural equivalence, network signals, relationship strength, service price, supplier downstream ego-network instability, supplier evaluation

Highlights

- For shipoperator buyer managers making pricing decisions in the container shipping charter market, turnover (instability) in the supplier's network of direct buyer relations acts as a relevant supplier evaluation tool.

- A shipowner supplier whose downstream network exhibits instability may signal unreliability of service quality, and in this regard switching buyers can backfire for suppliers in terms of potential buyers' evaluations and pricing decisions.
- The relational embeddedness of buyer-supplier relationships helps mitigate the effects of negative external signals about supplier reliability originating elsewhere in the supplier network, suggesting the relevance for shipowner supplier managers of nurturing and strengthening one-to-one existing relationships with buyers.

1 | INTRODUCTION

Buyer firms increasingly rely on suppliers to avail themselves of timely, superior quality services (Narayanan et al., 2015; Wynstra et al., 2015). Nevertheless, they face information asymmetries in assessing the reliability of supplier service quality ex ante, prior to any purchase, begging the question of how buyers aptly price service exchange with suppliers (Li, 2013; Riedl et al., 2013). Especially in the container shipping charter market (CSCM) setting, information asymmetry arises from intangible aspects of service exchange (e.g., crew competence and ship management), enhancing adverse selection risks for buyers (Balci et al., 2019; Kaya & Özer, 2009). For example, in 2021, Evergreen Marine, the shipoperator buyer, faced reputation and litigation risks when Ever Given—the ship it chartered from Shoei Kisen Kaisha, the shipowner supplier responsible for the service of the ship—became stranded in the Suez Canal, adding more than 3 months of voyage delay and affecting billions of dollars' worth of trade. In fact, in a more general study, one of five buyers considered supplier failure to be the primary cause of reputation damage, customer trust loss, insurance premium increase, and regulatory fines (Mitchell, 2017). To avoid such undesirable costs, buyers aspire to partner with reliable suppliers, offering higher prices to them (Beer et al., 2018; Keppler et al., 2021).

When reliability remains difficult to observe,[1] buyers look for *signals* to assess supplier collaborative behavior (Spence, 1974). Though a variety of supplier-related signals may affect a buyer's consideration set (see Riley, 2001), prior work has specifically recognized interfirm network relations as a relevant signal source, shaping prices (Uzzi & Lancaster, 2004). Although network research provides rich insights into supplier evaluation (Yan et al., 2017), most studies have focused on signals based on network *structure* (Riedl et al., 2013; Yan et al., 2020), paying limited attention to network *dynamics*. Social network theory indicates that in addition to a network's structure, its dynamics need to be considered to obtain a complete picture of buyer–seller exchanges (Ahuja et al., 2012; Dhanorkar et al., 2019). Network dynamics refer to the evolution of networks through "the addition or subtraction of [partners]" (Ahuja et al., 2012, p. 435), reflecting the *instability* or change in network composition over time. A sole focus on network structure implicitly assumes the existing underlying connections to be "manna from heaven" (Vissa & Bhagavatula, 2012, p. 273) and "denies much of the dynamic nature of social relations," wherein networks serve as "a context for action" (Burt, 2004, p. 354; Moody et al., 2005, p. 1208).

To unpack this issue, particularly in the CSCM context where buyer–supplier relationship information is readily observable, we introduce the notion of using *supplier downstream ego-network instability*—instability in the network of a potential supplier and its directly connected buyers—as a signal. Other kinds of supplier network instability, such as that arising from the supplier's relations with other stakeholders (e.g., its suppliers), are also worthy of study. Yet we consider suppliers' downstream instability because extant relational dynamics between a supplier and its buyers provide a more direct cue about the supplier's imminent collaborative conduct from a prospective buyer's viewpoint.

More specifically, supplier downstream ego-network instability refers to the *downstream buyer turnover* in the supplier's ego-network from one period to the next, that is, the proportion of buyers in the supplier's network of direct relations that changed from one period to another. Research on the instability effect, though scant, has mostly focused on the focal firm's own performance (e.g., Burt & Merluzzi, 2016; Kumar & Zaheer, 2019). However, what is not understood is the signaling value of a supplier's downstream ego-network instability to a third evaluating buyer. Furthermore, preexisting dyadic relational and structural factors between a buyer and a supplier—relationship strength and structural equivalence—constitute two crucial contingent elements

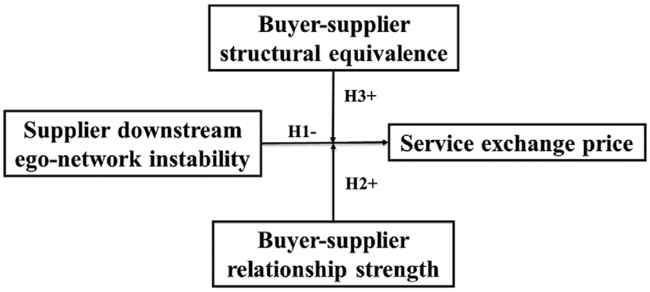

FIGURE 1 Conceptual framework.

because direct experiences as well as common partners help alleviate information asymmetry (Chae et al., 2020; Krause et al., 2007), influencing the degree to which buyers use instability as a cue for pricing decisions. With information asymmetry entailing extra costs for buyers, we tackle the following questions of both theoretical and managerial importance in the CSCM context: *How does a supplier's downstream ego-network instability influence the price a buyer pays in a service exchange with the supplier? What, if any, is the contingent effect of buyer–supplier relationship strength and structural equivalence on the link between instability and price?*

Our basic premise is that a focal buyer pays a higher transaction price per unit to a potential supplier to the extent that it views the supplier as reliable because the buyer subsequently saves the extra costs of adverse selection (see Beer et al., 2018). Because it is usually unfeasible to directly observe supplier reliability, applying signaling theory, we develop hypotheses about network dynamics-based signals as proxies by which to infer the difficult-to-observe unreliability. Specifically, we posit that a buyer's exchanges with a supplier that has a high degree of instability in its downstream ego network corresponds with a decreased per unit exchange price because instability signals inconsistent collaborative behavior and, in turn, inconsistent service quality. Moreover, we suggest that the negative effect of this instability on a buyer's pricing decision is attenuated by the buyer–supplier relational strength because of the accumulation of direct, first-hand positive experience and enhanced access to private information that would otherwise be unavailable to the buyer. Furthermore, we argue that structural equivalence reduces the negative effect of instability because of information provided to the buyer by its direct partners' positive associations with the supplier. We demonstrate the theoretical framework for this study in Figure 1.

To test our postulations, we use a novel empirical context—the chartering market of container shipping—where shipowner suppliers provide vessels to shipoperator buyers for transportation services. In our theory building, we draw from quotes by top management of firms in the container shipping industry. Our sampling frame comprises 3263 dyads formed by 260 buyers and 493 suppliers during the 2000–2018 period, resulting in 5257 unique buyer–supplier dyad-year observations. Our results support the proposed hypotheses but for the insignificant contingent effect of structural equivalence. Our interviews further validate that, in contrast to instability, the stability of a supplier's network signals reliability in providing service of the desired quality or greater. An executive of one of the largest buyers in the container shipping charter market said, "There is definitely some influence of stability of supplier's portfolio on the negotiated rates." Similarly, a top manager of a leading buyer in the market stated, "There is a value of stability of relations."[2]

Our work contributes to operations management research in several ways. First, we explicitly theorize about and empirically test, in the container shipping charter market context, the signaling effect of supplier downstream ego-network instability on price of buyer–supplier service exchange. Support for our hypothesis validates the relevance of signaling theory for supplier evaluation and pricing even under the *network dynamics* considerations, thereby complementing the network studies' dominant focus on *network structure* with an emphasis on *network composition* over time. Second, we offer new insights into the contingent effect of buyer–supplier relationship strength and structural equivalence on pricing outcomes, suggesting their role as a "buffer" that alleviates the negative effect of instability. Third, our findings add to the *sociological relationship-based* understanding of prices (Baker, 1984), in which a potential supplier's downstream ego-network instability provides relevant information for the service exchange price that is otherwise not obtainable via market means.

2 | THEORETICAL UNDERPINNINGS

2.1 | Signaling theory as a theoretical hook

Signaling theory addresses how decision-makers utilize *signals* to mitigate selection-related information asymmetries (Connelly et al., 2011; Spence, 1974). This theory is particularly appropriate in the CSCM contexts in which a shipowner supplier (signaler) possesses full insider information (e.g., details about vessel condition, such as its fuel consumption, and ship-related certificate), whereas a shipoperator buyer (receiver) lacks, but would like to have, the necessary information about a supplier's service quality reliability for decision-making. Reliability, a crucial factor in supplier selection practices, refers to the ability to handle a service task accurately and dependably in a consistent manner (Choi & Hartley, 1996; Plomaritou, 2008; Rao et al., 2014). Lack of full information on reliability increases the likelihood of adverse supplier selection (Stiglitz, 2002), resulting in operation disruptions and poor performance.[3] In reality, even a commoditized service industry, such as CSCM, has intangible dimensions—in particular, the kind of service "environment" a supplier has to offer, referring to the process aspects of how the service is provided (Kersten & Koch, 2010). To mitigate this information asymmetry, signals become relevant when buyers make pricing decisions for the supplier-specific service exchange (Beer et al., 2018).

Signals refer to *observable* characteristics or activities of signalers that, by chance or design, convey information to receivers about unobservable characteristics (Spence, 1974), such as reliability or consistent customer service (Roth & Van Der Velde, 1991). It is not necessary for signalers to be agentic (i.e., to intentionally communicate signals to a receiver). As long as signals are observable to the receiver, they can alter receiver preferences. Thus, a potential supplier's network may act as a source of signals (Yan et al., 2020), and the signals in turn help buyers bridge the divide between the information they have about a supplier and the information they desire to have in order to price the exchange (Podolny, 2001; Zhao et al., 2014).

2.2 | Supplier network as signals

To mitigate information asymmetry, "both scholars and practitioners have begun considering the importance of evaluating suppliers' values in a *network context*" (Yan et al., 2015, p. 53, italics added; Narasimhan & Narayanan, 2013). In this vein, a buyer's prior relational ties with the potential supplier itself serve as an important channel for information gathering about the supplier (Keppler et al., 2021; Krause et al., 2007). Relatedly, scholars have exhorted that buyers need to pay more attention to a supplier's network position and underscored the influence of supply network structure on buyer performance (Bellamy et al., 2014; Kim et al., 2011; Yan et al., 2015). In fact, Chae et al. (2020) argue that buyer–supplier structural equivalence (shared common partners) can provide a buyer with information benefits. At the interfirm level, Uzzi (1999) shows that prior relationships and network structure between firms enable access to nonmarket information. While these studies show the role of a supplier's network ties in serving as conduits of private information, affecting buyer outcomes, this research has mostly focused on the effect of supplier relationships on partners that *already have ties* with the supplier rather than the effect on those *others* who are not yet part of the supplier network.

More recently, scholars have started to argue that a supplier's network relationships with partners *other* than an evaluating buyer serve as *signals* of the supplier's potential as a future partner to the evaluating buyer (e.g., Yan et al., 2017; Yan et al., 2020). Yan et al. (2017) argue that a supplier's upstream and downstream network structure can indicate supplier innovation value to an external buyer. At the interfirm level, studies show that a firm's relationships with venture capitalists occupying superior structural positions in syndicate networks provide signals to external stakeholders (Gulati & Higgins, 2003; Ozmel et al., 2013). However, network studies of supplier evaluation, though extremely insightful and relevant to this paper, mainly focus on network *structure* as a signal while the role of network dynamics, that is, network instability, remains under-examined.

Social network theory suggests that a more complete understanding of network-based signals requires consideration of network dynamics as well (e.g., Ahuja et al., 2012). Network instability is theoretically distinct from other network structure-based constructs (such as network density, size, and centrality) in its focus on network composition over time, and even in cases when the network structure stays the same over time, the composition of the network may change, reflecting underlying dynamics. Regarding network instability, supplier downstream ego-network instability represents a salient signal because compared to the supplier's relationships with other stakeholders, the supplier's network of relations with *other buyers* and the associated supplier–buyer collaborative dynamics provide a more *direct* representation of a supplier's future conduct vis-à-vis a focal buyer. In addition, our interviews made it clear that practitioner managers in buyer firms consider supplier downstream ego-network instability as signals to assess supplier reliability.

In summary, it remains to be established whether a supplier's downstream ego-network instability provides signals to buyers trying to make pricing decisions. Additionally, to the extent that existing relational and structural factors—namely, buyer–supplier relationship duration and structural equivalence—help alleviate buyer–supplier information asymmetry, the signaling effect of supplier downstream ego-network instability may be mitigated. Thus, we develop and empirically validate the hypotheses pertaining to the effects of supplier downstream ego-network instability and its interplay with the extant relational and structural factors. We describe these relationships in greater detail below in the CSCM context.

3 | HYPOTHESES DEVELOPMENT

3.1 | Supplier downstream ego-network instability and buyer–supplier exchange price

A supplier firm's downstream ego-network instability refers to the *alteration in its ego-network composition* or the *aggregate change in its direct buyer relationships* from one period to another, reflecting turnover from the exit and entry of buyers (see Burt & Merluzzi, 2016; Kumar & Zaheer, 2019). Essentially, this aggregation of dyadic relationship instability (Lai et al., 2005) at the supplier ego-network level gives a potential buyer the gist of the supplier's overall collaborative conduct vis-à-vis existing buyers based on the relational dynamics in the supplier's portfolio, ranging from stability (with all buyers remaining unchanged) to absolute instability. For example, buyers form *consistency* perceptions about a supplier's conduct based on its collaborative continuity within its larger ego-network of buyer relationships (see Vinhas et al., 2012), given that network dynamics play out differently if supplier collaborations "become more stable over time or, alternatively, if they become less stable over time" (Greve et al., 2010, p. 303). Thus, the downstream ego-network instability constitutes a relevant supplier evaluation heuristic.

We argue that a supplier's ego-network instability in buyer relations acts as a signal of unreliability, particularly in regard to supplier service quality and collaborative competence (see Lai et al., 2005; Mishra & Shah, 2009). More specifically, in the CSCM setting, the shipoperator buyer faces asymmetries in observation because the intangible aspects of service, such as vessel readiness and crew quality, are not directly observable ex ante (Plomaritou, 2008; Yeung, 2008).[4] But ceteris paribus, a supplier's ego-network instability presents the focal buyer with an observable filtering criterion in that charter fixture announcements are published regularly in different maritime news publications, such as *FreightWaves* and *American Shipper*, allowing the buyer to watch the supplier's networking actions over time.

A senior director of an industry player viewed instability or downstream buyer turnover as a negative attention-directing signal, reflecting unreliability: "Charterers [buyers] will surely look at all possible information at any given time [e.g., follow the published charter fixtures].[5] In terms of reliability of counterparts [suppliers], a turnover in customer portfolio is an issue. It is not only this but also small things like [ensuing] rumors in the market that can make people shy away from a particular shipowner [supplier]…If the tonnage provider [shipowner/supplier] is not reliable, then you run the risk of the vessel being arrested by port state [authorities] for poor management or [seized by other] service providers for lack of payment. Hence, you would risk your operational stability towards your [own] clients, and [add] the cost of same" (text in square brackets added for clarity).[6]

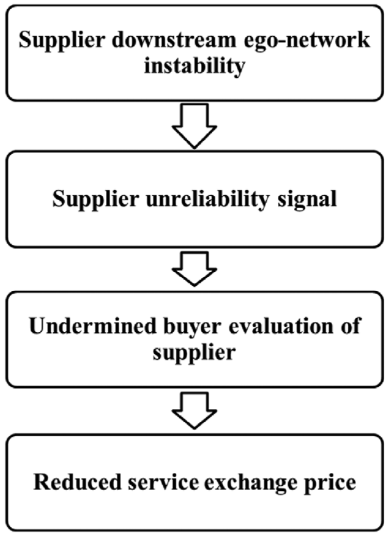

FIGURE 2 Logic roadmap for supplier instability-price linkage.

Echoing similar sentiments, a global account manager of an industry player stated, "[Charter fixture information] cannot remain secret. It will be known to the market" and further added, "I would say you always go for the stable counterparts [suppliers with low churn in portfolio], unless you can get a better rate and are willing to take the risk… Imagine when the market is moving fast, things can turn sour quick[ly], we want a strong counterparty" (text in square brackets added for clarity). Given the awareness that the supplier may falter on its obligations in a potential exchange relationship and thus add to the costs involved, the buyer pays the supplier with network instability a lower per unit price in service exchange (see Figure 2 for a logic roadmap).

When a supplier keeps changing its buyers, the focal buyer perceives it as a signal of inconsistent or incoherent collaborative behavior that may negatively influence the reliability of future service quality. "The frequent rewiring of attachments" makes it difficult "not to damage future prospects for affiliation" (Powell et al., 2005, p. 1187). Both deletions and additions of buyer ties act as "shocks" to a supplier that shake up its existing collaborative competencies, pushing it to reshape its current collaborative procedures or learn new ones (Day et al., 2013; Gulati & Singh, 1998), the costs of which may spill over to a potential buyer. When buyers come and go, instability and the inherent routine disruption it creates send the signal to the buyer that the supplier, due to potential lack of collaborative competence, may not be able to maintain uninterrupted, high-quality service. Even when greater instability may arise merely due to buyer additions, it aggravates the concerns that the supplier pays insufficient attention to the focal buyer's service needs because of the challenges of sustaining an increasing network of buyer relationships (Burt, 1992; Uzzi, 1996). Additionally, it raises concerns that the focal buyer is replaceable because new buyers provide alternative exchange choices for the supplier.

In contrast, supplier ego-network stability arising from relational stability in supplier–buyer dyads indicates the collaboration and coordination benefits needed to ensure the effectiveness of buyer–supplier interactions and the quality-of-service experience. Buyer–supplier relationship stability plays an essential role in improving the reliability of service quality because suppliers, in service-based logistics and maritime settings, need to make buyer-specific investments primarily in collaborative intangible assets, such as the "time and effort in developing procedures and routines for supplying a particular product or service" (Lai et al., 2005, pp. 401–402). When a supplier's downstream ego network exhibits low instability, it reflects reliability by illustrating that the potential supplier will exert effort to maintain the relationship and provide a buyer with the desired level of service quality or greater (Monczka et al., 1998).

In sum, in contrast to the case of a supplier with low downstream ego-network instability, the focal buyer will pay a lower price when dealing with a supplier that demonstrates high instability, accounting for the expected poor reliability performance. For example, shipoperator buyers in CSCM contexts may face financial loss due to damage of high-priced cargoes, owing to questionable service quality—and to compensate for the expected poor performance, they may pay a supplier with high instability less. The additional expected adverse supplier selection costs arising from the unreliable service quality make it "cheaper" to pay a higher freight cost to a reliable shipowner supplier (Plomaritou et al., 2011). Overall, by placing a premium on reliable partners, a buyer may pay "high instability suppliers" less. More formally stated,

> **HYPOTHESIS 1.** *The service exchange price (per unit) between a buyer and a supplier will decrease as the supplier's downstream ego-network instability increases.*

3.2 | The effect of supplier downstream ego-network instability on buyer–supplier exchange price under diverse relational and structural conditions

Thus far, we have argued that a buyer uses a supplier's downstream ego-network instability as a signal of unreliability due to the information asymmetry that arises when supplier reliability is difficult to observe directly. However, to the extent that more direct alternative information sources, relatively speaking, expose the buyer to information that supports a positive evaluation of a supplier, the influence of supplier downstream ego-network instability as an unreliability signal may become less prominent, suggesting a possible substitution effect. Based on prior work (e.g., Chae et al., 2020; Chae et al., 2022), two alternative information sources—namely, buyer–supplier relational strength and buyer–supplier structural equivalence—stand out as relevant for alleviating information asymmetry. In this vein, we next examine how the effect of supplier downstream ego-network instability differs based on relational strength and structural equivalence, respectively between the buyer and the supplier.

Regarding relational conditions, we expect that the negative effect of instability becomes stronger when buyer–supplier relational strength is low but weaker when relational strength is high. As supplier downstream ego-network instability stems *entirely* from *external* input "unrelated" to the focal buyer, its negative influence on pricing decisions may be mitigated by strong buyer–supplier relations, which are derived from long-term *direct* ties and provide a more personal history of supplier behavior based on actual partner-specific experience (Chae et al., 2020; Gulati, 1995; Podolny & Morton, 1999). In essence, relationship strength as reflected in the duration of buyer–supplier relations captures the social closeness between them (Capaldo, 2007; Gao et al., 2015; Granovetter, 1985; Krause et al., 2007), serving as a more exact determinant of future supplier conduct. When a strong buyer–supplier tie already exists and acquires embedded characteristics, the assessment criteria switches from external *proxy* to internal *experiences*. A buyer's own past interactions and experiences with the supplier help generate trust rooted in good will along with positive performance outcome expectations (Carey et al., 2011; Dyer & Singh, 1998; Gulati et al., 2009; McCutcheon & Stuart, 2000; Sako, 1992). We argue that the value of supplier information relayed by positive first-hand experience via relational strength increases when the external proxy conveys negative information about the supplier, that is, when the supplier ego-network instability is high. Strong, embedded ties are long-lasting, and prior exchange history plays a buffering role, suggesting that greater buyer–supplier relational strength may mitigate the negative influence of the supplier's downstream ego-network instability signals. In contrast, when the relationship strength is low, the lack of trust between new partners further aggravates the unreliability effect of supplier downstream ego-network instability. Therefore, we hypothesize that:

> **HYPOTHESIS 2.** *'Buyer–supplier relationship strength weakens the negative relationship between service exchange price (per unit) and the supplier's downstream ego-network instability.*

Following similar logic, regarding structural conditions, we expect that the negative influence of instability could become weaker when buyer–supplier structural equivalence is high but prevail when structural equivalence is lacking. A supplier's downstream ego-network instability is *more externally driven*—completely externally determined by the supplier's other downstream relations—than buyer–supplier structural equivalence, which stems from shared common partners (Lorrain & White, 1971) and, hence, uses *direct second-hand inputs*. We argue that the information leading to a positive evaluation reflected in a supplier's ties with a buyer's direct partners may outweigh the negative unreliability signal from totally external sources. When buyer–supplier structural equivalence is high, the supplier's relationships with the buyer's direct partners signal its collaborative orientation or competence and the two actors are more inclined to form a cohesive relationship due to shared common ties and network resource overlap (Burt, 1978, 1987; Rindfleisch & Moorman, 2001). The focal buyer's partners, who have worked together before with the supplier, help it learn about the supplier and better understand the expected positive benefits of future service exchanges (Chae et al., 2020; Rowley, 1997), thus mitigating the negative effect of instability. Sharing common partners also aids in aligning incentives and motivations between buyers and suppliers (Yan & Kull, 2015), increasing the relevance of a potential supplier relationship. In contrast, when buyer–supplier structural equivalence is lacking, a lack of common partners could make it difficult for the focal buyer to evaluate the supplier correctly. Under such circumstances, it is likely that the focal buyer will rely more on the unreliability signal inherent in supplier downstream ego-network instability for pricing the exchange. Therefore, we offer:

> **HYPOTHESIS 3.** *Buyer–supplier structural equivalence weakens the negative relationship between service exchange price (per unit) and the supplier's downstream ego-network instability.*

4 | EMPIRICAL CONTEXT

We test our hypotheses in the novel context of CSCM, which we describe in greater detail below. We next discuss our data collection, measures, and estimation method.

4.1 | Container shipping charter market

Container shipping has been referred to as "the lifeline of almost any global supply chain," representing more than three-fifths of global sea-based trade by value (Fransoo & Lee, 2013, p. 253; Stopford, 2009). The increasingly pivotal role of container shipping is effectuated by the offshoring or outsourcing of previously in-house production to distant facilities, necessitating attention to ensuring reliable physical distribution (Notteboom & Rodrigue, 2008). In this paper, we focus on the container shipping charter market (CSCM)—the "vertical factor market" in which a service exchange is initiated via a charter fixture (contract) where a shipowner supplier provides vessels to the shipoperator buyer demanding transportation services (Lun et al., 2010), allowing us to model buyer–supplier relationships. The service exchange is usually based on a time charter, which serves as our main focus, where the supplier concedes the commercial use of its vessel to the buyer for a stipulated time period while remaining in charge of running the vessel, including handling crewing, insurance, repair and maintenance, and supplies and stores (Reinhardt et al., 2012).

The container shipping chartering context is perfectly suited to testing our theory regarding a supplier's downstream ego-network instability as a signal. Signals become relevant because "the shipping industry practice of separating ship ownership from operations, which is at the basis of the charter market" creates "diverging operational goals and *information asymmetries*" between the shipowner supplier and the shipoperator buyer (charterer) (Dirzka & Acciaro, 2021, p. 2). On one hand, maritime and transportation studies have emphasized supplier reliability in terms of logistic service quality in which "knowledge and courtesy of…personnel," "prompt response to problems and complaint," and "on-time pick-up and delivery" matter (Jang et al., 2013, p. 496; Lin et al., 2017, p. 23; Lobo, 2010). On the other hand, obtaining accurate information about the reliability of the service quality proves difficult because the chartering service consumption and production are inseparable (Plomaritou et al., 2011). It is also difficult because the *experience* other buyers have vis-à-vis the supplier is acquired *privately* via direct day-to-day interactions (e.g., those between the charterer buyer and the crew personnel of the shipowner supplier) and therefore is not readily available to a potential buyer.

At the same time, the chartering information is disclosed on a regular basis by leading maritime intelligence agencies such as *Alphaliner* or *Clarksons*, thereby ensuring that actors within the market "see" who allies with whom and rendering our theorizing on ego-network instability as an *observable* signal empirically tractable. Given the enabling role of logistics in linking production sources with consumers, the CSCM context becomes "the center of network-based strategies" (Kleindorfer & Visvikis, 2009, p. 3). As one of the top analysts at BIMCO (Baltic and International Maritime Council) mentioned during our interview, "Relations are an elephant in the room in the industry." Similarly, transportation scholars view relationship quality as an antecedent to logistics service quality (Jang et al., 2013), implicitly alluding to the role of signals based on network relations. Lastly, each charter fixture contains the charter rate per day that the buyer has agreed to pay to the supplier for a service exchange, allowing us to obtain our outcome measure.

4.2 | Data collection

We hand-collected a buyer–supplier dyadic dataset using the following steps (see Table 1 for a summary of the data collection process). Utilizing the *Container Intelligence Monthly* reports from *Clarksons Research* as a reference point, we compiled a list of 7174 notifications of time charter fixtures (contracts) from 1999 through 2018.[7] This step provided information about the name of the chartered vessel and the shipoperator buyer (charterer), among other things, but not the shipowner supplier name.[8] Next, using vessel-related information from the prior step,[9] we searched ship registers, ship tracking systems, and firm webpages (such as *Clarksons Shipping Intelligence Network's* annual publication of the containership register, *DynaLiners Trades Review*, *Ship-DB* database, *Equasis*, Shipspotting.com, Balticshipping.com, Marinetraffic.com, Vesselfinder.com, and Vesseltracking.net) to obtain further fine-grained information about the shipowner supplier as well as fixture history. Specifically, our keyword-based search employed different combinations of vessel name, each ship's International Maritime Organization (IMO) number (unique ship identifier number), and year of build. In so doing, in addition to obtaining supplier names,

TABLE 1 Data collection steps.

	Data development steps	Number of buyer–supplier charter fixtures added (removed)	Number of buyer–supplier charter fixtures/dyads	Database used (wherever applicable)
1	Started with all charter fixture reports from 1999 through 2018	7174	7174	Container Intelligence Monthly reports from Clarksons Research
2	Triangulated and complemented the original list, based on vessel-related information from the prior step and searching ship registers, ship tracking systems, and firm webpages	199	7373	Clarksons Shipping Intelligence Network's annual publication of the containership register, DynaLiners Trades Review, Ship-DB database, Equasis, Shipspotting.com, Balticshipping.com, Marinetraffic.com, vesselfinder.com, and vesseltracking.net
3	Uniquely identified shipoperator buyers and shipowner suppliers and removed charter fixtures with unidentifiable firms	(139)	7234	Equasis, IHS Markit, DynaLiners Trades Review (information about who owns who), and Alphaliners Top 100
4	Removed fixtures with same buyer and supplier identification numbers	(6)	7228	Not applicable
5	Removed charter fixtures with non-operating suppliers and buyers to account for bankruptcies	(162)	7066	Lloyds List, TradeWinds, American Shipper, Dynaliners Trades Review, and ISL SEABASE Online Catalog
6	Collapsed multiple occurrences of the same dyad for each year	(1101)	5965	Not applicable
7	Removed missing values for any of the variables in a year	(708)	5257	Not applicable

we revalidated and complemented the original list, adding 199 new charter fixtures involving these vessels, which resulted in a total of 7373 fixtures.

Next, for the same buyer or supplier, the fixture reports may contain different and even shortened names (e.g., Maersk-Sealand, Maersk Line, or Maersk). To uniquely identify shipoperator buyers and shipowner suppliers, we then used these names and searched the corresponding company IMO numbers (unique registered owner identification numbers) in the *Equasis* and *IHS Markit* databases. We assigned the same company IMO number as a parent firm to all its subsidiaries, wherein the subsidiaries were identified using the company websites and publications such as *DynaLiners Trades Review* (information about who owns whom) and the *Alphaliner Top 100*. For firms that did not have an IMO number but could be easily identified (through company websites or secondary sources that verified their identity in some fashion, such as by using a liner schedule, to confirm their presence in the container shipping industry), we assigned our own unique identification numbers. At this stage, we dropped 139 fixtures because either a buyer or a supplier was unidentifiable, meaning its (shortened) name disclosed in a fixture report did not prove sufficient to allow us to independently verify its existence outside of the specific report. Furthermore, we dropped six fixtures in which the buyer and supplier identification numbers were the same, which left us with 7228 fixtures. Finally, using sources such as *Lloyds List*, *TradeWinds*, *American Shipper*, *DynaLiners Trades Review*, and *ISL SEABASE Online Catalog*, we dropped 162 observations relating to non-operating suppliers and buyers to factor in bankruptcies, resulting in 7066 fixtures or buyer–supplier dyads.

For each buyer–supplier dyad-year, we then collapsed multiple occurrences of the same dyad to make the data compatible for panel-data estimation, resulting in 5965 observations.[10] Our sample size decreased even further by 708 observations due to missing values for any of the variables in any given year (e.g., country of registration, charter rate, and Hofstede country dimensions), including the lagged independent variable.[11] Our final sampling frame includes an unbalanced panel of 5257 buyer–supplier dyad-year observations, involving 260 buyers from 58 countries and 493 suppliers from 59 countries connected via 3263 unique dyads during the 2000–2018 period.

4.3 | Variable operationalization

4.3.1 | Dependent variable

For each shipoperator buyer and shipowner supplier dyad in a given year, we measured service exchange price by obtaining average one-year time *charter rates* in US dollars per day in two steps. First, each time charter stipulates a daily rate, in US dollars per day, that a buyer is obligated to pay to a supplier for the hire of a container ship. We collected information about these daily "hire" rates for all time charters pertaining to a specific dyad in a given year. Second, for each dyad-year, we computed the average rate of time charters between the shipoperator buyer and the shipowner supplier in US dollars per day.[12]

Our approach to calculating the mean rate across charters at the buyer–supplier dyad-year level is appropriate for two main reasons. First, it aligns with the shipping industry practice of computing time charter average on a yearly basis in US dollars per day to determine broader charter-rate indices, such as the Harper Petersen Charter Rates Index (HARPEX) (Plomaritou & Papadopoulos, 2018, p. 79; see "average one-year time charter rates" in Drewry Maritime Research's *Shipping Insight*, 2016). Similarly, Dirzka and Acciaro (2021, p. 10) compute average time charter rate using the overall charter fixture list from the World Fleet Register. Even the performance assessment in the shipping industry is made in terms of "time charter equivalent" or the mean *daily* revenue performance. Second, and perhaps more to the point, in the inter-firm relationship context, Uzzi and Lancaster (2004, p. 329) examine the pricing of legal services using a similar approach. Since legal service pricing is done in U.S. dollars per hour, the authors averaged the hourly rate to generate a firm-level yearly dependent variable, with dyad, focal firm, partner, and market-level as independent variables and controls.

4.3.2 | Independent variable

We employed the following formula to compute a *supplier's downstream ego-network instability*:

$$\frac{\textit{Direct downstream buyer ties}_{added} + \textit{Direct downstream buyer ties}_{lost}}{\textit{Supplier's total number of unique direct downstream buyer ties during period}_{t}}$$

We calculated a supplier's downstream ego-network instability in three stages. First, for each year, we prepared a list of all downstream buyers directly connected to a focal supplier using our charter-fixture database. Second, for year *t*, we computed (a) the number of *new* downstream buyers that the focal supplier directly connected to, compared to the connections it already had in the previous year (i.e., direct buyer ties *added*), (b) the number of the focal supplier's old downstream buyer connections that existed in the previous year but dissolved in year *t* (i.e., direct buyer ties *lost*), and (c) the number of unique downstream buyers that the focal supplier was connected to during that period (*buyer base*). Third, we captured a supplier's downstream ego-network instability as the ratio of the focal supplier's directly linked downstream buyers that differed (were *added or lost*) from one time period to the next (see for similar reasoning Kumar & Zaheer, 2019; Sasovova et al., 2010) to the number of unique downstream buyers directly linked to the focal supplier during the period (see Burt & Merluzzi, 2016). For the year in which a focal supplier enters our sampling frame for the first time, we assigned an instability value of zero; put differently, we assumed that the supplier experienced zero buyer turnover in its year of entry into our sample. Our independent variable is a time-varying, supplier-year-level measure.

A concern may arise about the suitability of weighting both downstream buyer deletions and additions equally in our conceptualization and operationalization of a supplier's downstream ego-network instability. However, both deletions and additions cause disruptions in a supplier's downstream ego-network architecture, such as changes in network range and size, influencing the day-to-day functioning of the network (see Ahuja et al., 2012; Cannella Jr & McFadyen, 2016; Koka et al., 2006). From a prospective buyer viewpoint, additions of other buyer ties by the supplier may raise questions about the supplier's flexibility toward the potential buyer, signaling reliability concerns. Our incorporation and weighting of buyer additions is aligned with similar approaches used elsewhere in the strategic management and entrepreneurship literature (Burt & Merluzzi, 2016; Vissa & Bhagavatula, 2012).

4.3.3 | Moderator variable

We measured our contingency variable, *buyer–supplier relationship strength*, as the summed-up duration in months of all charter fixtures closed by a given buyer–supplier dyad to date. Our operationalization of relational strength as the duration of the buyer–supplier relationship aligns with the measure used by extant work (Capaldo, 2007; Chae et al., 2020; Krause et al., 2007). Given the large spread of this variable, we logged it in our analysis. We captured another contingency variable of interest, *buyer–supplier structural equivalence*, as a dyadic, yearly varying measure of the number of common partners between a shipoperator buyer and a shipowner supplier (Chae et al., 2020). We employed the *network → dyadic measures → alters in common* algorithm in UCINET 6 version 6.734 to compute the number of partners each dyadic pair has in common (Borgatti et al., 2002).

4.3.4 | Control variables

We implemented a range of controls to account for alternate sources of signals that may affect how much a buyer pays to a potential supplier for a service exchange. Though we emphasize network instability (a change in a supplier's downstream ego-network composition over time), *structural* aspects of the buyer–supplier network may also determine charter rates. We accounted for the structural characteristics in two key ways. First, we computed a dyad-level network-structural variable, *relative structural holes*, as the absolute value of the difference between the structural hole positions of a supplier and a buyer, where we captured structural holes spanned as *1—ego-network constraint* (Burt, 1992; Zaheer & Bell, 2005). By connecting otherwise unconnected partners, spanning structural holes in its ego-network grants a firm greater information access and control over its network partners (Burt, 1992; Lan et al., 2020). Thus, our measure captures differences in constraints faced in terms of control and information benefits, reflecting buyer–supplier power imbalance (see Casciaro & Piskorski, 2005). The direction in which this control variable exerts its effect is inconsequential for our main theorization about the hypothesized signaling role of instability and hence, the use of the absolute value of the difference (Casciaro & Piskorski, 2005).

Second, we calculated another relevant network-structural feature, *relative centrality*, as the absolute value of the difference between the degree centralities of a supplier and a buyer (Chatterjee et al., 2017; Cui et al., 2018). With the centrality differences equating to the differences in network size, the associated network resource inequalities translate into *social power* imbalances (see Ofem et al., 2018). The highlighting of these differences also shows how easy it may be for one party, compared to the other, to find an alternative partner. Thus, the measure reflects buyer–supplier power imbalance. These two controls also account for the fact that the charter rate may not be solely determined by a buyer but may also involve

TABLE 2 Descriptive statistics and correlations.

Variable	Mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) Charter rate	10,449.88	6453.68	1.000																		
(2) Supplier's ego network instability	0.076	0.220	−0.027*	1.000																	
(3) Buyer–supplier relationship strength	33.26	54.019	0.182***	−0.029**	1.000																
(4) Structural equivalence	0.007	0.084	0.027**	−0.020	0.054***	1.000															
(5) Relative structural holes	0.333	0.318	−0.097***	−0.009	−0.134***	−0.051***	1.000														
(6) Relative centrality	7.614	8.675	−0.046***	−0.052***	0.134***	−0.009	0.293***	1.000													
(7) Firm size difference	200,500.70	413,083.50	−0.029**	−0.070***	0.124***	−0.005	0.161***	0.820***	1.000												
(8) Buyer dependence	26.982	30.330	−0.027*	0.044***	−0.094***	−0.017	0.104***	−0.410***	−0.478***	1.000											
(9) Supplier capability geared	0.608	0.657	−0.039***	0.040***	0.133***	0.006	−0.040***	0.128***	0.090***	−0.038***	1.000										
(10) Supplier capability gearless	0.576	0.676	0.113***	−0.047***	0.150***	−0.007	−0.026*	−0.031**	−0.001	0.040***	−0.703***	1.000									
(11) Vessel size	30,019.57	33,549.02	0.378***	−0.032***	0.356***	0.004	−0.110***	0.093***	0.128***	−0.026*	0.034**	0.434***	1.000								
(12) Supplier competitor	0.050	0.219	0.038***	−0.011	−0.057***	0.013	−0.004	−0.038***	0.015	0.031**	−0.082***	0.053***	−0.017	1.000							
(13) Supplier financial distress	0.290	0.522	0.004	−0.004	0.115***	−0.001	−0.036**	0.047***	0.036***	−0.024*	0.115***	0.052***	0.090***	−0.025*	1.000						
(14) Dyadic instability	1.063	2.117	−0.026*	−0.069***	0.204***	0.058***	−0.097***	0.075***	0.095***	−0.136***	−0.001	0.037***	0.101***	−0.043***	0.003	1.000					
(15) Power distance difference	22.982	15.859	0.001	−0.019	0.006	0.000	−0.052***	0.051***	0.003	−0.072***	−0.047***	0.060***	0.032**	−0.044***	0.004	0.051***	1.000				
(16) Long-term orientation difference	27.657	28.399	−0.022	−0.012	−0.075***	−0.001	−0.078***	−0.170***	−0.170***	−0.044***	−0.155***	0.130***	−0.001	0.011	0.014	0.020	0.487***	1.000			
(17) Uncertainty avoidance difference	29.446	20.461	−0.010	0.014	−0.064***	−0.024*	0.066***	0.031***	−0.001	−0.061***	−0.047***	0.027*	−0.024*	−0.024*	0.010	−0.033**	0.326***	0.192***	1.000		
(18) Masculinity difference	18.888	17.059	−0.027***	0.029***	0.001	−0.019	0.081***	0.161***	0.097***	−0.014	0.056***	−0.040***	−0.062***	−0.034**	0.022	−0.021	−0.017	−0.212***	0.063***	1.000	
(19) Individualism difference	25.725	20.392	0.008	0.003	−0.091***	−0.007	−0.063***	−0.219***	−0.219***	0.035**	−0.105***	0.055***	−0.006	−0.078***	0.010	0.017	0.617***	0.530***	0.256***	−0.052***	1.000
(20) Market volatility	1721.77	1276.29	0.405***	0.046***	0.032**	0.015	0.032**	−0.079***	−0.087***	0.038***	−0.002	0.009	−0.048***	0.039***	−0.005	−0.106***	−0.049***	−0.058***	−0.019	0.061***	−0.058***

Note: $N = 5257$; Buyer–supplier relationship strength in months and dyadic instability in years before taking the log. Buyer dependence is in percentage.
***$p < .01$; **$p < .05$; $p < .1$.

bargaining by suppliers. Another relevant structural characteristic of a supplier's ego network pertains to whom the supplier works with, that is, whether its other downstream buyers are competitors to a potential buyer (Yan et al., 2020). In our chartering context, since all buyers compete with one another as vessel operators in the container shipping industry, the value of this control remains the same for all observations and drops out in the regression.

To further control for the bargaining power of both parties, we computed *firm size difference* as the difference between a buyer and a supplier in terms of the total dead weight tonnage (DWT) realized in a given time period. Next, we accounted for a buyer's switching cost in its relationship with a supplier using *buyer dependence* (Krause et al., 2007). We measured the DWT that the specific supplier delivered to the buyer in a given time period as a percentage of the total DWT the same buyer used in the same time period. Furthermore, the exchange price may be influenced by an on-again, off-again dyadic relationship between a buyer and a supplier instead of a continuous one. We captured this buyer–supplier *dyadic instability* using the number of years elapsed since the last service exchange, logging this variable.[13]

We also included supplier-level controls in our analysis. For signals of a supplier's capability, vessel type and vessel size are relevant drivers of the charter rate. The focal buyer may have specific criteria regarding the vessel needed, and a potential supplier's vessel may fit the buyer's benchmark. As for capability by vessel type, *geared* refers to a count of geared vessels used to fulfill charter fixtures. Similarly, *gearless* captures the count of gearless vessels used in charter fixtures. Both variables, *geared* and *gearless*, are highly correlated (−0.703; Table 2). Since the variance inflation factors (VIFs) did not indicate multicollinearity to be a problem, we retained both variables as controls. The results remained robust when we dropped one of the variables. We note that our measure also proxies for suppliers' geographic specialization in that east–west trade routes involve, on average, larger gearless vessels,[14] whereas north–south trade lanes mainly include feeder vessels. For a supplier's capabilities related to the economies of scale, we operationalized our variable, *vessel size*, as the total DWT of vessels employed in a buyer–supplier charter fixture (Goulielmos, 2017).

To capture the extent of potential competition between a supplier and a buyer, we created a dummy variable, *supplier competitor*, which assumes a value of one when a vessel owner-supplier, apart from offering vessels for hire, also engages as a buyer by hiring such vessels. The measure assumes a value of zero otherwise. Controlling for a supplier's financial condition is also important because its financial health may provide relevant cues about its ability to fulfill a potential buyer's requirements. To proxy for a *supplier's financial distress*, we counted the number of a supplier's vessel-sale transactions (sale of ships) reported in the purchase and sales market of the container shipping industry each year using the *Clarkson* and *Eggar Forrester* databases.

Differences between the buyer's and supplier's approach toward charter rates may also arise because container shipping is one of the most globalized industries (Lun et al., 2010), with buyers and suppliers being located in different countries. For instance, the degree to which actors avoid uncertainty or are part of a society with hierarchical relations, when uncontrolled for, may bias our results because these factors may affect negotiations and the charter rate. Accordingly, we computed five additional controls to account for cultural differences (Hofstede, 1984). For a buyer–supplier dyad, we computed *power distance difference, long-term orientation difference, uncertainty avoidance difference, masculinity difference, and individualism difference* based on Hofstede's (2016) values (Skowronski et al., 2022; Wacker & Sprague, 1998). We constructed these variables as an absolute difference between country-level scores assigned to a supplier and a buyer for their respective countries. We note that in contrast to other time-varying controls used in this study, these five variables are time-invariant, consistent with the literature (e.g., Lee et al., 2018; Skowronski et al., 2022). Additionally, country-level time-invariant characteristics, such as historical importance of the shipping sector or legal and political systems, could induce more heterogeneity among suppliers from different countries than among those from the same countries, affecting the outcomes of charter fixtures. The same applies to buyers. Thus, to control for these factors, we incorporated both buyer and supplier country-specific dummies.[15]

Last but not least, we controlled for the prevailing market conditions (Özer & Zheng, 2016). To capture industry vulnerability to global demand fluctuations, we constructed *market volatility* as the standard deviation of the mean fixture charter rate in a given period. Such swings may make it difficult for firms to react to supply–demand gaps in a timely fashion and predict the future demand, influencing charter rates in general (Jeon, 2022).

4.4 | Estimation method

4.4.1 | Random effects regression

As noted earlier, our sampling frame derives information from buyer–supplier charter fixtures signed between 2000 and 2018. Although, we use the buyer–supplier dyad as our unit of analysis, our independent and control variables comprise a mix of firm- and dyad-level variables. As such, an ordinary least squares (OLS) regression may not be suitable for modeling the data structure. When selecting between random- and fixed-effects estimators, we chose a generalized least squares (GLS) random effects model because our data show an unbalanced panel structure—only a subset of buyer–supplier dyads is repeatedly sampled. Additionally, some controls related to differences in cultural dimensions are time-constant but important given the globalized nature of container shipping chartering. This approach is consistent with that of Uzzi and Lancaster (2004), who utilized a similar dependent variable—price per hour—and network structural explanations.

Further, to compare random effects versus fixed effects, we implemented a robust *F*-statistic version of the Hausman test appropriate for an unbalanced panel, as explained in equation 10.79 of Wooldridge (2002, p. 290) (see also Arellano, 1993). The robust Hausman test essentially involved time-demeaned and quasi-demeaned data and yielded a *p*-value greater than .05 ($p = .337$), suggesting that not enough evidence exists to reject the null hypothesis of random effects being the preferred model. Further, we in part control for the unobserved heterogeneity correlated with the regressors by incorporating dummy variables for groups—namely, buyer countries and supplier countries, which contain repeated observations (Wooldridge, 2002).[16] Our employment of a random-effects estimator efficiently controls for any "leftover" serial-correlation arising from unobserved time-invariant factors (Wooldridge, 2002). Additionally, to alleviate concerns regarding heteroskedasticity and non-independence of observations, we employed cluster-robust standard errors at the dyad level. Overall, we report results for our main analyses in Table 3 using the random-effects model.

That being said, as robustness checks for our main findings, we also employed the series of fixed effects shown in Table B3. As additional checks, we used dynamic models (Table B3), which included a lagged dependent variable used as a control in the random-effects model as well as a generalized method of moments (GMM) dynamic panel estimator. To account for endogeneity due to sample selection and omitted variables, we used Heckman's two-step correction (Heckman, 1979) and two-stage least squares (2SLS) estimation in Table B4.

4.5 | Analysis and findings

In Table 2, we show the variable mean, standard deviation, and correlations. All variance inflation factors were under 10, making it less likely that multicollinearity is a concern (Peng & Lai, 2012). We next present our regression results in Table 3. Model 1 contains only controls. In Model 2 of Table 3, we include our main variable of interest, supplier's downstream ego-network instability. In Models 3 and 4, we add the moderator variables—namely, buyer–supplier relationship strength and structural equivalence, respectively. Model 5 includes the main variable of interest with full controls, including the moderators. Model 6 tests the interaction between a supplier's downstream ego-network instability and buyer–supplier relationship strength, and Model 7 tests the interaction between instability and structural equivalence. Model 8 represents the full model with both interactions. Our first hypothesis postulated that a supplier's downstream ego-network instability would have a negative effect on the charter fixture rate. As can be seen in Model 2 and in Models 5–8, the coefficient of supplier downstream ego-network instability remains negative and significant (Model 5: $b = -1548.641$, $SE = 257.036$, $p = .000$, CI: -2052.422 to -1044.86; Model 8: $b = -3041.5$, $SE = 699.784$, $p = .000$, CI: -4413.051 to -1669.948), suggesting a lower charter rate for suppliers with high instability, supporting H1. For a one-unit increase in instability, the charter rate is expected to decrease, on an average, by \$1272.906 (Table 8: $dy/dx_{\text{instability}} = -1272.906$, $SE = 302.592$, $p = .000$, CI: -1865.975 to -679.837), after accounting for all other predictors.

Hypothesis 2 considered the buffering effect of buyer–supplier relationship strength. In Models 6 and 8, the coefficient of interaction between a supplier's downstream ego-network instability and buyer–supplier relationship strength is positive and significant (Model 6: $b = 588.737$, $SE = 277.901$, $p = .034$, CI: 44.061 to 1133.412; Model 8: $b = 574.188$, $SE = 277.696$, $p = .039$, CI: 29.915 to 1118.462), suggesting that relationship strength weakens the negative influence of instability on transaction price per unit and validating H2. To better understand the interaction, in Figure 3, we plotted the predictive margins (predicted values) of charter fixture rates across an observed range of a supplier's downstream ego-network instability under conditions of (a) low buyer–supplier relationship strength (logged duration) (= *0*) and (b) high strength (= *6*). As can be seen in the margins plot, in general, the predicted charter rates are higher when the buyer–supplier relationship strength is high, and a dyad with high supplier ego-network instability displays lower values of the predicted charter rate when relationship strength is low than when relationship strength is high.

For example, for a supplier with buyer–supplier relationship strength held constant at 1 month (i.e., logged value of zero), the price paid by a buyer is expected to

TABLE 3 Results of the random-effects GLS regression.

Dependent variable Model Modeling framework	Fixture rate M1 GLS random effects	Fixture rate M2 GLS random effects	Fixture rate M3 GLS random effects	Fixture rate M4 GLS random effects	Fixture rate M5 GLS random effects	Fixture rate M6 GLS random effects	Fixture rate M7 GLS random effects	Fixture rate M8 GLS random effects
Controls								
Relative structural holes	−1087.4***	−1078.2***	−914.1***	−1079.2***	−903.4***	−902.3***	−898.2***	−897.1***
	(.000)	(.000)	(.001)	(.000)	(.001)	(.001)	(.001)	(.001)
Relative centrality	−2.546	−4.970	−5.864	−2.614	−7.714	−8.517	−7.846	−8.630
	(.891)	(.790)	(.751)	(.888)	(.676)	(.645)	(.671)	(.641)
Firm size difference	−0.000870**	−0.000897**	−0.000813**	−0.000862**	−0.000836**	−0.000814**	−0.000836**	−0.000814**
	(.025)	(.021)	(.030)	(.026)	(.026)	(.030)	(.026)	(.030)
Buyer dependence	−5.834*	−5.271	−5.717*	−5.867*	−5.248	−4.994	−5.057	−4.812
	(.083)	(.117)	(.077)	(.081)	(.104)	(.122)	(.117)	(.136)
Supplier capability geared	−2583.5***	−2554.8***	−3074.3***	−2584.2***	−3043.6***	−3060.9***	−3042.3***	−3059.1***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Supplier capability gearless	−2854.4***	−2848.1***	−3320.2***	−2853.1***	−3309.0***	−3323.4***	−3307.1***	−3321.1***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Vessel size	0.0971***	0.0964***	0.0925***	0.0971***	0.0921***	0.0923***	0.0921***	0.0923***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Supplier competitor	1535.1***	1559.7***	1547.1***	1528.5***	1560.9***	1534.2***	1563.9***	1537.9***
	(.002)	(.001)	(.001)	(.002)	(.001)	(.001)	(.001)	(.001)
Suppliers' financial distress	63.17	61.52	84.10	64.27	83.21	74.66	85.23	76.87
	(.677)	(.687)	(.559)	(.672)	(.566)	(.603)	(.557)	(.594)
Dyadic instability	−101.8***	−106.6***	−294.1***	−104.4***	−298.2***	−297.5***	−298.1***	−297.4***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Power distance difference	7.269	6.647	4.951	7.387	4.534	4.638	4.107	4.214
	(.470)	(.509)	(.609)	(.463)	(.639)	(.631)	(.671)	(.663)
Long-term orientation difference	1.669	2.154	0.586	1.560	0.930	0.951	1.018	1.037
	(.782)	(.722)	(.920)	(.796)	(.873)	(.870)	(.862)	(.859)
Uncertainty avoidance difference	−4.493	−3.994	−1.786	−4.496	−1.376	−1.377	−1.513	−1.512
	(.368)	(.423)	(.713)	(.368)	(.776)	(.776)	(.755)	(.755)
Masculinity difference	−1.601	−1.567	2.257	−1.471	2.367	2.241	2.998	2.867
	(.794)	(.800)	(.700)	(.811)	(.688)	(.704)	(.614)	(.629)

(Continues)

TABLE 3 (Continued)

Dependent variable **Model** **Modeling framework**	**Fixture rate** **M1** **GLS random effects**	**Fixture rate** **M2** **GLS random effects**	**Fixture rate** **M3** **GLS random effects**	**Fixture rate** **M4** **GLS random effects**	**Fixture rate** **M5** **GLS random effects**	**Fixture rate** **M6** **GLS random effects**	**Fixture rate** **M7** **GLS random effects**	**Fixture rate** **M8** **GLS random effects**
Individualism difference	7.175	8.028	7.808	7.184	8.573	8.655	8.788	8.866
	(.282)	(.228)	(.223)	(.281)	(.180)	(.176)	(.170)	(.166)
Market volatility	2.105***	2.110***	1.938***	2.103***	1.944***	1.947***	1.943***	1.946***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Independent variables								
Supplier's ego-network instability		−1744.7***			−1548.6***	−3058.6***	−1568.9***	−3041.5***
		(.000)			(.000)	(.000)	(.000)	(.000)
Buyer–supplier relationship strength			1276.2***		1264.1***	1223.0***	1262.8***	1222.7***
			(.000)		(.000)	(.000)	(.000)	(.000)
Structural equivalence				1149.9	1000.3	1026.7	402.3	436.9
				(.244)	(.308)	(.295)	(.657)	(.630)
Supplier's ego-network instability × Buyer–supplier relationships strength						588.7**		574.2**
						(.034)		(.039)
Supplier's ego-network instability × Structural equivalence							29,280.4	28,841.5
							(.123)	(.129)
Intercept	9077.8***	9324.0***	6589.9***	9059.5***	6810.2***	6927.3***	6781.9***	6896.6***
	(.000)	(.000)	(.002)	(.000)	(.001)	(.001)	(.001)	(.001)
Supplier country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Buyer country dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	5257	5257	5257	5257	5257	5257	5257	5257

Note: *p*-values in parentheses; Errors are clustered at the dyad level.
$^{*}p < .10$; $^{**}p < .05$; $^{***}p < .01$.

drop by $2849.479 for a unit change in instability, from zero (completely stable) to one (completely unstable) (Table 8: $dy/dx_{instability} = -2849.479$, SE = 708.698, $p = .000$, CI: − 4238.502 to − 1460.456). As relationship strength increases, so does the instability slope. Eventually, the instability penalty becomes insignificant, meaning high instability does not negatively influence rates anymore, when the buyer–supplier relationship strength is high (Table 8: $dy/dx_{instability} = 595.651$, SE = 1053.812, $p = .572$, CI: − 1469.783 to 2661.085).[17]

Hypothesis 3 considered the contingent effect of buyer–supplier structural equivalence. In Models 7 and 8, the coefficient of interaction between a supplier's downstream ego-network instability and buyer–supplier structural equivalence, despite having a positive sign, is not significant, thereby not supporting H3 (Model 7: $b = 29{,}280.4$, SE = 18,989.84, $p = .123$, CI: −7939.005 to 66,499.8; Model 8: $b = 28{,}841.46$, SE = 18,984.78, $p = .129$, CI: −8368.025 to 66,050.94). We note, though, that the hypothesized effect is positive and marginally significant based on a one-sided test. The lack of significance for the interaction effect in two-sided tests could stem from the rarity of having common partners in the CSCM context (less than 1% of shipoperator buyers and shipowner suppliers share common partners).

4.6 | Robustness tests

We further assessed the robustness of our findings in several other tests, summarizing these results in Table 4 and elaborating on the details in Appendix B. Broadly speaking, the findings remained similar to our main results in Table 3 when we took into account alternate operationalizations of dependent and independent variables, respectively (Tables B1 and B2), alternate modeling frameworks (Table B3), sample selection, and omitted variable biases (Table B4).

Further, we conducted two extra robustness checks in Appendix C. First, we acknowledge that one could argue that the duration of a relationship may not adequately capture the strength of the relationship, in that a buyer could maintain a long-term relationship with a supplier without the two parties engaging in high-volume exchanges. In Model 32, we therefore captured relational strength as the buyer–supplier cumulative volume until time *t* and found consistent results. Second, acknowledging that buyers may differ in their choice of number of suppliers to engage, we added an additional control, *buyer with multiple buyers*, as a count of suppliers (Model 33) and a dummy with a value of one for a buyer with multiple suppliers and zero otherwise (Model 34). Our results generally remained robust to these checks.

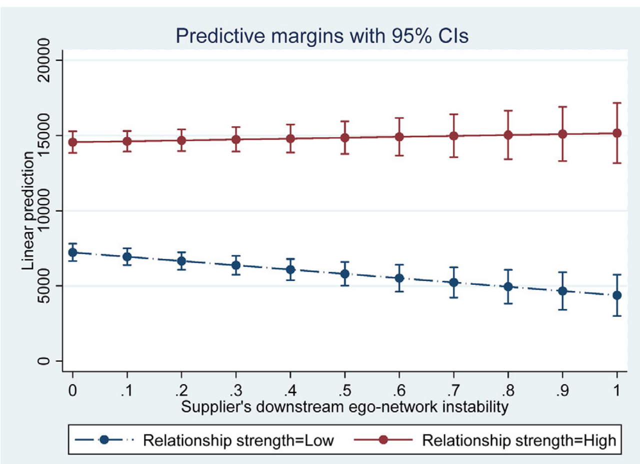

FIGURE 3 Interaction plot.

5 | DISCUSSION AND CONCLUSIONS

5.1 | Theoretical contributions

This study examines how the price of a service exchange between a shipoperator buyer and a shipowner supplier is affected by pre-existing dynamics in the supplier's ego-network of direct buyer relations (i.e., supplier downstream ego-network instability). Further, it explores how this effect depends on the relational and structural conditions already present in the focal buyer–supplier dyad. Our findings reveal that *instability* in a shipowner supplier's downstream ego network reduces the price a shipoperator buyer pays to the supplier for a service, and that buyer–supplier relationship tenure mitigates the negative effects of instability. We did not find support for the positive contingent effect of structural equivalence. In the CSCM context, the intangibility and inseparability of service production from consumption make it difficult to accurately assess supplier service reliability beforehand (Plomaritou et al., 2011). Put differently, the quality of the transportation service becomes apparent to the focal shipoperator buyer only after it has experienced the exchange (say, e.g., after the direct interaction between the buyer and the supplier's crew). Furthermore, assessing the reliability of service quality proves complicated because the *experience other* buyers have in regard to the supplier is acquired *privately* via direct day-to-day buyer–supplier interactions, and the other buyers' perceptions of supplier service quality are therefore not readily available to a potential buyer. At the same time, the supplier's downstream ego network over time is observable to the

TABLE 4 Summary of other robustness checks.

Rationale	Analyses	Results
Different operationalizations of supplier value		
Do the results regarding the *charter rate* extend to the *market premium* paid by the buyer above the HARPEX index?	Regression of *market premium* on instability	Largely consistent (marginally significant H1 and significant H2); also, significant H3 (Table B1, M9)
Charter rate may not completely capture the 'value' buyer places on its service exchange with the supplier. The buyer may instead increase future volume.	Regression of (a) a *supplier's share* of a buyer's business and (b) a *buyer's share* of a supplier's business on instability	Consistent for (a); largely consistent for (b) (marginally significant H1 and significant H2) (Table B1, M10–11)
A buyer may increase future transaction frequency instead of raising charter rates.	Regression of (a) *multiple tie dummy* and (b) *multiple ties* on instability	Consistent for (a); nonsignificant results for (b) (Table B1, M12–13)
Alternative operationalizations of supplier downstream ego-network instability		
We used a year-over-year measure of instability, possibly making it susceptible to idiosyncratic, short-term events. Do the results change if the same measure is calculated using different time spans?	Regression of charter rate on instability measures for a rolling (a) *two-year* and (b) *three-year* window	Consistent for (a) and (b); also, significant H3 for (b) (Table B2, M14–15)
The original measure comprises both buyers added and buyers removed. Do the results hold separately?	Regression of charter rate on instability measures for (a) *buyers lost*, (b) *buyers added*	For (a), nonsignificant H2 but marginally significant H1 and significant H3; consistent for (b) (Table B2, M16–17)
If the buyer does pay attention to network dynamics, then besides how much a supplier's downstream network changes, how instability changes may also provide relevant signals to a buyer.	Regression of charter rate on instability measures capturing (a) the overall *reduction* and (b) *increase* in instability from one period to the other; (c) *shrinkage* when lost buyers exceed added ones and (d) *expansion* when added exceed lost ones	Nonsignificant results for (a); consistent for (b); nonsignificant H1 and H2 but significant H3 for (c); consistent for (d) (Table B2, M18–21)
Alternative estimation methods		
Are the results robust to fixed-effects estimation?	Fixed-effect regressions	Largely consistent (H2 marginally significant in two models); significant H3 in M25 (Table B3, M22–25)
Do the effects hold in the case of dynamic models?	(a) RE model with lagged dependent variable as a control and (b) GMM dynamic panel estimator	Largely consistent for (a) (H2 marginally significant); consistent for (b); also, marginally significant H3 for (b) (Table B3, M26–27)
Endogeneity tests		
Sample selection may confound the results.	Heckman's two-step correction	Consistent (Table B4, M28–29)
Omitted variables may influence both instability and charter rate.	2SLS estimation	Consistent (Table B4, M30–31)
Extra tests		
Duration may not reflect adequately reflect relational intensity.	Cumulative volume as a measure of relational strength	Consistent (Table C1, M32)
Buyers with multiple suppliers differ from buyers with a single supplier.	Control (a) supplier count and (b) multiple supplier dummy	Consistent for (a) and (b) (Table C1, M33–34)

buyer, allowing us to theorize about and test the effects of instability.

Ceteris paribus, our results underscore a novel supplier evaluation tool—a supplier's *downstream ego-network instability* as a *signal* of unreliability of supplier service quality, or its obverse: downstream stability as a reliability signal for pricing decisions. In so doing, our findings connect to maritime logistics services research that has highlighted the positive influence of relational stability at the buyer–supplier *dyad* level on operational logistics service quality and underscored dyadic relational performance as a crucial indicator of reliable service quality (Jang et al., 2013; Lai et al., 2005). We demonstrate that an *external* buyer, unconnected to the supplier, takes a broader look at the relational continuity that the supplier exhibits in its overall *portfolio* of dyadic relationships with other downstream buyers to form judgments about the supplier's future service reliability. Additionally, our results in this vein build on supply network studies that have examined the role of supplier network ties as signals (Yan et al., 2020), yet they also shift scholarly attention toward network *dynamics* (instability) after controlling for network *structure*, a dominant theme in prior work (e.g., Chae et al., 2020; Lan et al., 2020). Our results provide evidence that a focus on dynamics may help create a more complete picture of network effects.

Furthermore, our results expand upon prior work on relationship strength by identifying buyer–supplier relationship tenure as a contingency for reducing the negative effect of a supplier's downstream ego-network instability on service exchange price paid by the shipoperator buyer. The moderating influence of buyer–supplier relationship strength on the effects of other network relational aspects in and of itself may not be novel (Fynes & Voss, 2002). Our findings add incremental nuance to this work by suggesting that in the CSCM context, due to positive past and current direct experiences of buyers with suppliers and their superior informational value, relationship strength acts as a "*buffer*" against the negative influence of information from an external secondary source—namely, supplier downstream ego-network stability. Regarding price formation (Uzzi, 1999), an information-dependent outcome, our results demonstrate the worth of relationship strength during times of *conflicting* information—the positive information provided by relationship strength dilutes negative unreliability effects due to ego-network instability, with buyers putting more weight on the information obtained via direct experience.

Moreover, continuing the line of work that focuses on dyadic structural positions (e.g., Chae et al., 2020), we test the role of buyer–supplier structural equivalence as a plausible boundary condition that influences the relationship between supplier downstream ego-network instability and service exchange price. It could well be that in the presence of information asymmetry about supplier reliability, the shipoperator buyer puts more weight on the positive information provided by the relationships its direct partners have with the supplier than on the negative signals emanating from a completely external third source. However, we do not find support for this relationship in a two-sided test. We note, though, that the hypothesized effect is positive and marginally significant based on a one-sided test. The insignificant finding in two-sided tests could result from the rarity of having common partners in the CSCM context. It could also be that buyers do differentiate between a *direct secondary* structural information source (i.e., buyer–supplier structural equivalence) and an *external secondary* source (i.e., supplier downstream ego-network instability), but not much. This is an area worthy of future research.

Our findings also build on those of past studies on price formation by highlighting a network-based viewpoint (e.g., Uzzi & Lancaster, 2004). In the CSCM context, pricing decisions are not made in a vacuum, based solely on market forces, but against the backdrop of network relations in which prior and continuing exchanges *external* to a focal service exchange influence pricing behavior within the focal exchange. Prior work that views markets as structures of relationships has mostly analyzed price formation from the perspective of either actual partners who are directly connected to each other via network ties or external actors who form price judgments based on the network structural positions of potential partners (Baker, 1984; Benjamin & Podolny, 1999; Uzzi, 1999; Zuckerman, 1999). Complementing this general focus on network structure, our results show the influence of network dynamics, specifically instability, in making pricing decisions, thereby having implications for how networks affect market efficiency. Anticipation of negative experiences based on the relational dynamics in a supplier's network of downstream relations may result in a lower charter price for the shipowner supplier by causing the shipoperator buyer to factor in the future additional costs of unreliable service that it may incur.

5.2 | Managerial implications

For shipoperator buyer managers making pricing decisions in the CSCM context, our results point to a new supplier evaluation tool: a supplier's downstream ego-network instability. Given that buyer managers may not accurately foresee supplier service quality ex ante, thereby incurring adverse selection costs, they must pay attention to relational continuity in the supplier's overall portfolio of other direct buyer relations. More specifically, a shipowner supplier whose ego network of downstream buyer relations exhibits instability may signal unreliability of service quality, as evidenced by our interviews and results.

Accordingly, shipowner supplier managers must be cautious about engendering turnover in their network of downstream buyer relations. Our results indicate that high supplier ego-network instability provides negative signals to potential buyers, who assess the supplier's buyer turnover as they consider a potential partnership. For this reason, switching buyers can backfire for suppliers in terms of other potential buyers' evaluations in the commoditized service context of CSCM, where it is widely accepted that "selecting the key logistics service providers and establishing long-term relationships with customers" is crucial (Jang et al., 2013, p. 494). Under such circumstances, the buyers may bargain hard for price reduction in their negotiations with the supplier in question (Schurr & Ozanne, 1985), leading to lower prices in an exchange.

For shipowner supplier managers, our results also suggest that relationally embedded dyadic buyer–supplier ties may be resilient to negative external signals about supplier reliability originating elsewhere in the supplier downstream ego network. Shipowner suppliers may stand to gain by nurturing and strengthening *existing* relationships with buyers. This is because these relational factors more directly validate supplier collaborative conduct and its espousal of a long-term relationship orientation, regarding preparedness to forgo short-term benefits in favor of long-term advantages that relationships offer, thereby reducing supplier reliability risk (Cheng et al., 2012; Lai et al., 2005; Lee et al., 2009).

5.3 | Limitations and future directions

In light of certain limitations, our results must be interpreted with caution, which illuminates pathways for future research. First, this paper examines how dynamics in a supplier's ego-network of relations may signal its ability to provide reliable high-quality service without disruptions, influencing the price the supplier gets for its services in a commoditized setting. A question about generalizability arises regarding whether the relationships recognized in our estimation sample can be generalized beyond the CSCM context. Our interviews with players outside of the CSCM context also point to the instability-price linkages identified in this study. An industry consultant in dry bulk chartering stated, "a lot of fixtures [contracts] are done with the same partners. All things equal, for a new partner with an unstable portfolio, they [buyers] will pay less in comparison to a new one with a stable portfolio [of relationships]." Likewise, according to a supplier manager in a related industry, "the churn [in a supplier's buyer portfolio] would be more penalized, still not a deal breaker, for a new customer as compared to an old one," suggesting the validity of relationship strength as a contingency. Accordingly, we believe that our findings are likely to hold in other commoditized logistics services contexts as well. However, we have not focused on how a supplier's network dynamics may signal its value in a knowledge-intensive setting for innovation-related performance outcomes. A follow-up question then arises regarding whether our results would hold in a knowledge-intensive supplier selection context where a buyer evaluates a supplier for its innovation value and where information asymmetry is higher than in commoditized settings.

Second, a buyer's use of an indirect method of supplier assessment—employing a supplier's downstream ego-network instability as a signal—is influenced by the availability of other direct or indirect sources of information about the supplier. In this study, aside from using buyer–supplier relational strength and structural equivalence as contingencies, we simply controlled for the other direct and indirect information sources, such as country, size, and structural holes. In this regard, investigating how these other sources of information may interact with a supplier's downstream ego-network instability provides a relevant future direction for research. Furthermore, buyers may collect pertinent information regarding potential suppliers in conferences or industry trade associations after meeting other buyers (Macaulay, 1963). Future work may identify the other boundary conditions that influence the instability-price relationships.

Third, we considered a supplier's network ties with direct (first-tier) downstream buyers. However, the negative signal value of the related ego-network instability could also be influenced by broader second-tier relationships (Choi & Hartley, 1996), an area worthy of investigation in future research. Fourth, while our unit of analysis was the dyad in a network, we did not consider valued exponential random graph models (ERGMs) and stochastic actor-oriented models (SAOMs) typically used to examine tie formation, thus providing a fertile avenue for future research. Lastly, though we used interviews in conjunction with theorizing and analyses, we did not directly observe how buyers make actual decisions regarding prices to be paid to the supplier, and as such, research would benefit from a processual stance in terms of gaining a more comprehensive understanding of how a supplier's downstream ego-network instability affects performance.

6 | CONCLUSION

Given that suppliers differ in reliability and buyers face information asymmetries in supplier selection, *how, then, does a buyer price its service exchange with a supplier*? We tackle this non-trivial question using signaling theory and develop the construct of supplier downstream ego-network instability as a supplier evaluation tool that signals unreliability of supplier service quality. Our findings show that supplier downstream ego-network instability reduces the price that a buyer pays to the supplier for a service exchange, particularly when the buyer–supplier relationship strength is lacking. It may well be that, as the American writer Suzy Kassem observes, "A relationship that is truly genuine does not keep changing its colors. Real gold never rusts." By theorizing about and empirically testing supplier downstream ego-network instability effects and their interplay with existing buyer–supplier relationship strength and structural equivalence, respectively, our study provides insights into a buyer's pricing decisions in a commoditized service context.

ACKNOWLEDGMENTS

An earlier version of the paper won the best supply chain paper award, sponsored by the Institute for Supply Management (ISM), at the 2021 Academy of Management Conference. We thank Tom Derry, the CEO of ISM, Stephanie Eckerd, Wendy Tate, Rachna Shah, and the audiences of the Operations and Supply Chain Management Division of the Academy of Management for providing valuable feedback on prior version of the manuscript. We would also like to thank Robert Smith for data merging assistance and the seminar participants at Aalborg University for valuable suggestions. We remain most grateful to the co-Editor-in-Chief Tyson Browning and the Department Editor Andy Yeung for their excellent guidance and the anonymous Associate Editor and two reviewers whose insightful feedback helped further enhance the paper. All errors remain ours.

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ENDNOTES

[1] In the CSCM context, reliability of transportation service quality becomes clear to a shipoperator buyer only during the course of the collaboration, depending on, say, the adherence of the shipowner supplier's crew to the buyer's navigational and commercial instructions. Moreover, the supplier-specific experience that *other* buyers have is acquired *privately* via direct day-to-day interactions, thus rendering it not easily accessible for a future buyer.

[2] In Appendix A Table A1, we describe the background of the interviewees and provide a summary of the key results from eight semi-structured interviews with top managers and experts in both container shipping and non-container shipping (dry bulk and tanker) charter market to provide insights about the role of supplier downstream ego-network instability in supplier selection.

[3] For example, the shipoperator buyer, Tossa Marine, suffered a loss in 2001 due to an unexpected delay, when the vessel it chartered was detained in Portugal, because unbeknownst to the buyer, the shipowner supplier, Alfred Toepfer, did not have an ITF "blue card," a certificate showing that the crew was paid according to ITF rules.

[4] For example, in 2001, despite the fuel consumption warranty of *Losinjska Povidka*, a shipowner supplier, for the charter, *Valfracht Maritime*, the shipoperator buyer, only found later on during the voyage that the chartered vessel consumed an excessive amount of fuel oil, affecting buyer costs.

[5] Charter fixtures refer to the charterparty contract signed between shipoperator buyers and shipowner suppliers.

[6] See Tables A1 and A2, respectively, for triangulation via interviews and an academic and practitioner literature search in the maritime context.

[7] Even though our final estimation sample starts in 2000, we gathered data from 1999 to minimize information loss due to the lagged independent variable.

[8] This step also provided information about charter duration, charter rate (US dollars per day), and the chartered vessel's technical specifications (e.g., DWT tons, geared, or gearless equipment), which are relevant for variable creation.

[9] As vessels may change names several times, we also retrieved their unique vessel identifier number (IMO ship identification number).

[10] On a related note, to create any variable at the dyad-year level that uses fixture-specific information, we averaged the values of all fixtures associated with the dyad concerned for that year.

[11] To alleviate reverse causality, our independent variable, a supplier's downstream ego-network instability, was lagged by 1 year (see Kim & Zhu, 2018).

[12] Given the magnitude of this variable, some regression coefficients, such as those of a supplier's instability, are large.

[13] Our results remained robust to two alternate measures of dyadic instability: a dummy assuming a value of one for "gaps" in relationships and zero otherwise, and a dummy assuming a value of one for multiple occurrences of dyads and zero for one-off relationships.

[14] Medium-sized vessels with more than 3000 TEU are usually employed in North–South and non-core East–West trade. Larger ships up to 8000 TEU are trading on Transpacific, Far East–Europe and North–South trade routes (mostly with South and Latin America). Large Container Vessels (LCVs) with 8–14,000 TEUs can cross the Panama Canal, due to its expansion, while the largest category of very large container vessels (VLCVs) can still pass the Suez Canal and so are almost exclusively deployed on Far East—Europe trade lanes.

[15] Our charter fixture database included country of registration and operations as well as ownership changes. We used the buyer's and supplier's country of operations as input for country-related variables. While the country of registration and operations mostly coincide, this approach allows us to capture the effects of country of operations and "filter out" symbolic presence driven by financial benefits in locations such as the Cayman Islands and Monaco in cases of firms registered in such locations.

[16] As Wooldridge (2002, p. 288) points out, "For example, if we have panel data on a group of working people, we might include city dummy variables in a wage equation. Alternatively, if we have panel data at the student level, we might include school dummy variables. Including dummy variables for groups controls for a certain amount of heterogeneity that might be correlated with the (time-constant) elements of $\mathbf{x}_{it}$."

[17] The relationship-strength threshold at which instability slope becomes insignificant is 3.75 (42.521 months or 3.543 years).

[18] Plomaritou et al. (2011) found that *only* supplier-based characteristics influence buyer behavior—for example, "provision of high-quality transport services, compliance of a shipping company with international regulations of safety management, reputation and image of the ship-owner in the market, low-cost sea transport operations, satisfactory cooperation with personnel and crew, and information system for shippers" (pp. 77–78)."

[19] https://www.harperpetersen.com/harpex.

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How to cite this article: Kumar, P., Nowinska, A., & Schramm, H.-J. (2023). The signaling effect of supplier's customer network instability on service price: Insights from the container shipping charter market. *Journal of Operations Management*, *69*(8), 1282–1319. https://doi.org/10.1002/joom.1254

APPENDIX A

A2: MORE ON ASSUMPTIONS FOR H1.

Implicit in our explanations for H1 is the assumption that supplier ego-network instability is readily observable, that is, a potential buyer has full information about a supplier's relationships with other downstream buyers, both current and past. Our interviews reveal that buyers in this industry proactively collect information about charter fixtures, which contain information about buyer–supplier relationships. Charter fixture announcements are published regularly in different maritime news publications such as *FreightWaves* and *American Shipper*. Furthermore, our fieldwork revealed that buyers either maintain their own databases or subscribe to at least one database such as *Clarkson SIN*, *IHS Markit*, *Alphaliner*, *Vessels Value*, or *Dynaliners* to keep track of buyer–supplier relationships. Moreover, analysts, brokers, and agencies promoting maritime safety, such as *Bancero Costa*, *Braemar Seascope*, and *Equasis*, follow the charter fixtures and post them online for free. Additionally, some of the databases about vessels are accessible free of charge—namely, *Equasis* and *Ship DB*. Given the public availability of data, it is safe to assume that within the service-based context of container shipping, buyers have sufficient information to delineate a supplier's downstream ego-network.

In addition, our argumentation presupposes that the buyers use supplier downstream ego-network instability (or the obverse dynamic, ego-network stability) as a signal. Our interviews quoted in the paper ("turnover in customer portfolio is an issue") and reported in the introduction section ("definitely some influence of stability of supplier's portfolio on the negotiated rates") confirm that practitioners use instability as a signal of unreliability. Aside from these buyer interviews, the positive influence of stability is acknowledged by suppliers themselves. The 2012 annual report of *Costamare Inc.*, a shipowner supplier states, "Our growth depends on our ability to expand relationships with existing charterers [buyers] … Generally, we compete for charters based upon… customer relationships…" (p. 12). Furthermore, highlighting shipowners' reliability as a key criterion for supplier selection, Dr. Evi Plomaritu, a shipping consultant, states in her book that "maintaining a long-term relationship with the same shipping company [supplier] helps reduce the perceived risk associated with the charter [exchange]. This is why charterers [buyers] … charter vessels from the same shipping company [supplier] over long periods of time" (Plomaritou, 2008, p. 121), suggesting the stability of relationships as a positive signal.

A related question then arises: whether a supplier's buyer turnover is mainly determined by the supplier's

TABLE A1 Qualitative triangulation via interviews with managers and industry experts.

Interviewee	Is a shipowner supplier's portfolio of buyer relations over time, especially the (in) stability of the portfolio, trackable, and do shipoperator buyers even look for such relational information?	Does the (in)stability of a shipowner supplier's portfolio of buyers served influence a potential shipoperator buyer's perceptions of supplier (un) reliability, and does it matter for charter fixture rate decisions?	Who has a major say in charter rate decisions—a shipoperator buyer or a shipowner suppliers?
Kelly, senior director of one of the world's largest players in the container shipping charter market (17 years of chartering experience).	Yes, charterer buyers draw upon all possible information sources available anytime, including historical relationship information.	Yes, buyer turnover trends in a shipowner's portfolio do matter. Instability creates negative rumors about service reliability and enhances the buyer's relationship risk perception in terms of potential operational failures and added costs.	Buyers generally held more power during the 2000–2018 period.
Mike, the global account manager of one of the world's largest firms in the container shipping charter market with 4 years of chartering experience and 13 years of sales experience.	Yes, buyers have a strong grasp of who allies with whom based on their own sources, fixture-based monthly reports, and databases such as Alphaliner. Charter fixture information cannot remain secret and will be known to market participants.	Yes, buyers usually go for the stable counterparts (those with low churn in their portfolio) unless they get a cheaper charter rate and are willing to take the risk.	Depends on market volatility.
Jane, customer insights manager in a major global shipoperator buyer with 2 years of data analytics experience.	Yes, it is observable based on charter fixture reports. Buyers also maintain their own proprietary databases.	There is some effect of stability on the negotiated rates.	Buyers mostly outweigh suppliers.
Roman, vice president in a major global shipoperator buyer and head of chartering (28 years of experience in the container shipping industry).	The container shipping charter market is transparent. It is also possible to get access to relational data either by subscription or via sources such as Clarksons, Howe Robinson, or Kontiki.	Yes, especially in comparison to the freight market, in the chartering market, reliability is a key concern.	Mixed views: Both the buyers and suppliers hold the decision-making power over rates.

TABLE A1 (Continued)

Interviewee	Is a shipowner supplier's portfolio of buyer relations over time, especially the (in) stability of the portfolio, trackable, and do shipoperator buyers even look for such relational information?	Does the (in)stability of a shipowner supplier's portfolio of buyers served influence a potential shipoperator buyer's perceptions of supplier (un) reliability, and does it matter for charter fixture rate decisions?	Who has a major say in charter rate decisions—a shipoperator buyer or a shipowner suppliers?
Dan, senior chartering manager of a non-container shipping (bulk) segment firm with 8 years of experience in chartering.	Though it is not readily observable in the bulk charter market, it *is* readily observable in the container ship charter market.	All things being equal, buyers will pay less for a new partner with an unstable portfolio, compared to a new one with a stable portfolio. A lot of fixtures are done with the same partners.	Buyers more or less control the deal.
Miles, chartering manager of a large Danish supplier in a non-container shipping (tanker) segment with 3 years of chartering experience.	Charter fixtures are observable in the industry.	High instability would be penalized (although this is not a deal-breaker) by a new buyer as compared to an old one.	Unsure.
Kenneth, a leading expert in the container shipping industry with, 22 years of experience.	Yes, most buyers subscribe to Alphaliner or similar databases and also have access to charter fixture information through public sources.	It depends; whereas downstream stability may not matter much for a buyer with a short-term orientation, a buyer with a long-term orientation would opt for a more stable partner. Here, instability arising from both exchange partner loss and gain provide negative signals. In a down market, a high buyer turnover suggests shipowners have trouble finding buyers, possibly negatively affecting owners' profitability.	During the 2000–2018 period, the container shipping charter market has been generally characterized by overcapacity, with buyer determining the price.
Rune, chief shipping analyst at one of the most important industry associations with 28 years of experience in the container shipping segment, consulting, and public administration.	Mostly available; Everyone follows the charter fixtures that are circulated. All ships specifications may not be publicly known at all times, but buyers do follow it closely so as not to lose money.	It depends; the network of relations is crucial. Buyers would go for a stable supplier with no changes in its portfolio, but they would also pay attention to the customers in the supplier's portfolio to assess potential threats. The decision also depends on the risk appetite of the buyer: A buyer with a long-term viewpoint would expect the supplier to always be available and would not want to change partners all the time.	It may be split between the buyers and the suppliers. Given that overcapacity has haunted the industry, the balance perhaps tilts slightly towards the buyers side.

characteristics (e.g., reliability). In this vein, Plomaritou et al. (2011) conduct an extensive review of extant research in maritime logistics regarding supplier selection criteria in the container shipping charter market context and mainly highlight the supplier-based aspects of these criteria—specifically, "the ship-owner's reputation for reliability" (p. 72).[18] Regarding buyer characteristics, Plomaritou et al. (2011) point out that "If charterers...have been satisfied in the past with the transport services, they have little incentive to risk trying a new shipping company" (p. 72), decreasing the likelihood that traits specific to the buyer determine a supplier's instability. That being said, we also controlled for buyer-related factors in our empirical analysis.

Admittedly, our theorization adopts a buyer's perspective (Monczka et al., 1998), reflecting the premise that the mainly the buyer determines the exchange price in a dyad. Our premise appears likely to hold in the chartering market context of container shipping during our sampling period. This setting is characterized by a highly competitive environment due to its globalized nature and the availability of other means of transportation such as rail, road, and air, as well as fixed costs due to capital intensiveness, making it difficult for any supplier to ignore the buyer's viewpoint (Davies, 1983; Poulsen et al., 2016). Additionally, the shipping market has generally faced overcapacity during the time period of the study (Cariou, 2008). As such, suppliers in this context "are increasingly forced to" put buyers' demand first to make themselves more attractive to the buyer (Jang et al., 2013, p. 494). Along similar lines, Stopford (2009) highlights the price elasticity of the container shipping market, in which a price reduction results in the substitution of cheap alternatives for expensive ones, with the buyer having the upper hand.

Regarding our arguments about the deletions and additions of buyers, one could counterargue that these may indicate the lack of lock-in effects and access to fresh knowledge in a supplier's downstream ego-network, suggesting the beneficial effects of instability (e.g., Fleming et al., 2007). However, we conjecture that such beneficial effects may apply in knowledge-intensive contexts but not in commoditized service contexts such as logistics where avoiding supply disruptions is the primary concern. A counterargument may also be that adding more buyers may reflect a supplier's increasing social status. However, even the most reputed supplier cannot devote its finest resources to every buyer firm (Pulles et al., 2014). The logic-wise interpretation of studies on turnover in a completely different setting suggests the same. For example, research elsewhere examining job mobility has shown that workers who switch often from one job to another bear a wage penalty due to speculation about instability and unclear identity (Fuller, 2008). At the very least, the focal buyer may not be the supplier's first priority, given the additional effort needed to learn from new partners (Gulati, 1995).

APPENDIX B

ROBUSTNESS CHECKS

Alternate dependent variables: In Table B1, for robustness, we employed various other operationalizations to capture the broader construct of supplier value—the potential value a buyer places on its exchange relationship with a supplier—as follows: Besides our main dependent variable of interest, *charter rate*, where the focus is on the exchange price actually agreed upon in the charter fixture, as a different dependent variable, we used the difference between the specific charter rate and the Harper Petersen Charter Rates Index (HARPEX), which reflects the average yearly worldwide market rate in the container shipping chartering market, to capture the *market premium* paid by the buyer.[19] As seen in Model 9 of Table B1, our results remain largely consistent. However, the main effect of a supplier's downstream ego-network instability becomes marginally significant at the 10 percent level. In addition, the magnitude of the coefficient of the interaction term is lower in comparison to the main analysis, possibly because this model expresses the "premium" over and above a market price index. Interestingly, the interaction effect of structural equivalence becomes significant in this model ($p = 0.000$).

We also calculated a *supplier's share* of its downstream buyer's business in terms of the charter duration. Given that the CSCM context mostly uses time charters, this alternate dependent variable captures the degree to which a buyer allocates longer time-charters to a supplier, normalized by its total requirements for time-charter duration. As reported in Model 10, our results remain similar. Next, we utilized a different dependent variable measuring a *buyer's share* of a supplier's business in terms of the dead weight tonnage (DWT) of vessels employed. We generally find similar results (Model 11; Table B1). However, the main effect of a supplier's downstream ego-network instability becomes marginally significant at the 10 percent level.

In Model 12, we dummy-coded another dependent variable, *multiple tie dummy*, as one when a buyer engages in more than one chartering arrangement with its supplier for a given year and zero otherwise. We model this relationship using a linear probability model (LPM) and find similar results. In Model 13, we created a related but different variable, *multiple ties*, to capture the actual frequency, that is, the total number of charter

TABLE B1 Robustness checks: Alternative dependent variables.

Dependent variables Model Modeling framework	Market premium (rate-HARPEX) M9 GLS random effects	Supplier's share (fixture duration) M10 GLS random effects	Buyer's share (DWT) M11 GLS random effects	Multiple ties (dummy) M12 LPM	Multiple ties (frequency) M13 GLS random effects
Controls					
Relative structural holes	−326.4*	2.743***	43.61***	−0.00986	0.00109
	(.064)	(.000)	(.000)	(.296)	(.325)
Relative centrality	6.211	−0.134***	−1.791***	0.0000658	0.00000104
	(.387)	(.002)	(.000)	(.930)	(.828)
Firm size difference	−0.000141	0.00000172**	0.0000426***	−1.33e−08	−7.64e−10
	(.371)	(.048)	(.000)	(.370)	(.321)
Buyer dependence	−1.007	0.946***		0.0000654	−0.0000252
	(.622)	(.000)		(.509)	(.318)
Supplier capability geared	−1606.2***	0.488	4.124***	0.291***	0.999***
	(.000)	(.362)	(.000)	(.000)	(.000)
Supplier capability gearless	−2025.4***	0.760	6.132***	0.314***	0.999***
	(.000)	(.205)	(.000)	(.000)	(.000)
Vessel size	0.0490***	−0.0000803***	0.00000218	−0.00000128***	9.37e−09
	(.000)	(.000)	(.898)	(.000)	(.321)
Supplier competitor	760.0	−1.628*	1.454	−0.00225	0.000240
	(.103)	(.092)	(.686)	(.858)	(.396)
Suppliers' financial distress	90.96	−0.258	−0.947*	−0.00989	0.000322
	(.237)	(.411)	(.094)	(.327)	(.321)
Dyadic instability	−74.30***	−0.994***	−0.594***	0.108***	0.0000471
	(.000)	(.000)	(.000)	(.000)	(.331)
Power distance difference	4.174	−0.00977	−0.0319	−0.000135	0.00000573
	(.483)	(.611)	(.648)	(.604)	(.373)
Long-term orientation difference	0.313	−0.00198	−0.0104	−0.000176	0.00000379
	(.943)	(.877)	(.694)	(.145)	(.381)
Uncertainty avoidance difference	−3.182**	−0.0251**	0.0104	0.0000442	0.00000400
	(.019)	(.039)	(.675)	(.735)	(.350)
Masculinity difference	−6.573**	0.0110	−0.0539	0.000278	0.00000532
	(.033)	(.443)	(.187)	(.114)	(.362)
Individualism difference	−0.0544	0.0228	−0.0366	0.000513***	0.000000549
	(.994)	(.158)	(.359)	(.008)	(.787)
Market volatility	−0.0555	−0.000370**	0.000575	−0.00000434	−0.000000152
	(.323)	(.014)	(.123)	(.106)	(.325)
Independent variables					
Supplier's ego-network instability	−404.5*	−4.813**	−4.882*	−0.0730**	−0.00367
	(.081)	(.015)	(.076)	(.038)	(.324)
Buyer–supplier relationship strength	252.9***	6.236***	−0.00380	0.0232***	0.0000325

(Continues)

TABLE B1 (Continued)

Dependent variables Model Modeling framework	Market premium (rate-HARPEX) M9 GLS random effects	Supplier's share (fixture duration) M10 GLS random effects	Buyer's share (DWT) M11 GLS random effects	Multiple ties (dummy) M12 LPM	Multiple ties (frequency) M13 GLS random effects
	(.000)	(.000)	(.989)	(.000)	(.425)
Structural equivalence	348.3***	0.0937	1.215	0.0207	−0.000267
	(.002)	(.962)	(.658)	(.364)	(.401)
Supplier's ego-network instability × Buyer–supplier relationship strength	177.1**	1.616**	2.357**	0.0345**	0.0000350
	(.024)	(.038)	(.031)	(.030)	(.860)
Supplier's ego-network instability × Structural equivalence	16,791.1***	−15.46	11.96	0.174	−0.000873
	(.000)	(.339)	(.801)	(.365)	(.645)
Intercept	−2513.0**	−9.485***	70.64***	0.497***	0.00204
	(.043)	(.000)	(.000)	(.000)	(.377)
Supplier country	Yes	Yes	Yes	No	Yes
Buyer country	Yes	Yes	Yes	No	Yes
N	5232	5257	5257	5257	5257

Note: *p*-values in parentheses. Since HARPEX index provides charter rates based on ship classes, we classified all fixtures in our sample accordingly based on the ship size. As such, we also included ship class dummies in Model 9 as controls (suppressed for brevity); For Models 10, 12, and 13, we also controlled for the fixture rates because prices may influence other decisions; All models use robust standard errors. Models 9 and 11 use cluster-robust standard errors at the supplier-country level and Models 10 and 13 at the dyad level. Model 12 uses robust standard errors.
**p* < .10; ***p* < .05; ****p* < .01.

fixtures between a buyer and a seller in a year. In Model 13, while the coefficient of the main independent variable and the interaction effect of relationship strength display the expected signs, they are not significant. One possible explanation of such non-finding is that the firms' goals, broadly speaking, may not be necessarily linked to closing more fixtures (contracts or deals), but rather longer ones, more so in the presence of the stipulated daily rates (compare Models 10–11 to Models 12–13).

Alternate independent variable of interest: In Table B2, we re-define our key independent variable, supplier's downstream ego-network instability. We used a year-over-year measure of instability in our main analyses. As such, our measure could be sensitive to short-term idiosyncratic events. To mitigate such concerns, we re-created instability measures for a rolling *two-year* and *three-year window* in Models 14 and 15 respectively. All coefficients of interest display the signs and significance, in line with our main findings. Interestingly, as the window for computing the churn increases, the negative effects of instability further increase in magnitude (compare coefficients of instability in Models 8, 14, and 15). At the same time, the beneficial contingent effects of the buyer–supplier relationship strength increase too, as evidenced by the increasing magnitude of the interaction coefficient. It could well be that over longer time windows buyers may be more "certain" about the instability signal, penalizing it more. However, it is during these times that the buffering effects of buyer–supplier relationship strength becomes more salient. Interestingly, even the interaction effect of structural equivalence becomes significant in Model 15.

In the main analyses, with a focus on *how much* a supplier's buyer composition changes, our original measure of a supplier's downstream ego-network instability weighted both buyers added and buyers removed equally. As a robustness check, we hone in on different types of instability because *how* a network changes could also be a relevant signal for a buyer. Accordingly, we introduce respectively an alternate instability measure as proportion of downstream *buyers lost* and the proportion of *buyers added* in Models 16 and 17. While both types of instability display the expected negative sign, suggesting

TABLE B2 Robustness checks: Alternative independent variables.

Independent variable: *Instability* **Model** **Modeling framework**	**Two-year window** **M14** **GLS random effects**	**Three-year window** **M15** **GLS random effects**	**Buyers lost** **M16** **GLS random effects**	**Buyers added** **M17** **GLS random effects**	**Reduction** **M18** **GLS random effects**	**Increase** **M19** **GLS random effects**	**Shrinkage** **M20** **GLS random effects**	**Expansion** **M21** **GLS random effects**
Controls								
Relative structural holes	−895.5***	−701.8**	−936.2***	−893.0***	−1036.0***	−975.2***	−934.8***	−900.8***
	(.004)	(.026)	(.001)	(.001)	(.000)	(.001)	(.001)	(.001)
Relative centrality	−23.53	−32.26	−6.684	−8.087	−17.16	−14.86	−4.237	−7.420
	(.247)	(.136)	(.715)	(.662)	(.351)	(.420)	(.817)	(.686)
Firm size difference	−0.000582	−0.000738**	−0.000801**	−0.000796**	−0.000642*	−0.000648*	−0.000818**	−0.000733**
	(.125)	(.042)	(.033)	(.034)	(.061)	(.059)	(.029)	(.049)
Buyer dependence	−3.121	−4.122	−5.167	−4.889	−3.184	−3.446	−5.688*	−5.194
	(.379)	(.265)	(.108)	(.130)	(.350)	(.312)	(.077)	(.106)
Supplier capability geared	−2868.5***	−3069.4***	−3032.7***	−3069.8***	−2897.3***	−2921.3***	−3059.6***	−3077.6***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Supplier capability gearless	−3162.8***	−3470.6***	−3306.3***	−3328.0***	−3171.4***	−3196.5***	−3319.5***	−3329.7***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Vessel size	0.0885***	0.103***	0.0921***	0.0924***	0.0894***	0.0893***	0.0924***	0.0928***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Supplier competitor	1677.8***	2410.1***	1580.3***	1510.0***	1864.3***	1868.4***	1555.6***	1514.6***
	(.002)	(.000)	(.001)	(.001)	(.002)	(.002)	(.001)	(.001)
Suppliers' financial distress	43.53	−31.89	85.16	74.92	47.92	59.81	90.24	64.99
	(.767)	(.832)	(.554)	(.602)	(.742)	(.681)	(.528)	(.655)
Dyadic instability	−287.7***	−283.7***	−294.6***	−297.1***	−282.3***	−289.6***	−293.3***	−294.6***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Power distance difference	12.99	10.10	4.290	4.399	14.12	15.16	4.684	5.171
	(.233)	(.430)	(.658)	(.649)	(.236)	(.204)	(.629)	(.592)
Long-term orientation difference	−5.764	−9.281	0.470	1.274	−3.621	−4.025	0.688	0.788
	(.379)	(.218)	(.936)	(.827)	(.622)	(.584)	(.906)	(.892)
Uncertainty avoidance difference	−1.756	−1.842	−1.599	−1.595	−2.556	−2.797	−1.742	−2.138
	(.741)	(.762)	(.741)	(.743)	(.692)	(.665)	(.719)	(.659)

(Continues)

TABLE B2 (Continued)

Independent variable: *Instability* **Model** **Modeling framework**	**Two-year window M14 GLS random effects**	**Three-year window M15 GLS random effects**	**Buyers lost M16 GLS random effects**	**Buyers added M17 GLS random effects**	**Reduction M18 GLS random effects**	**Increase M19 GLS random effects**	**Shrinkage M20 GLS random effects**	**Expansion M21 GLS random effects**
Masculinity difference	3.632	8.061	2.310	2.896	5.704	5.664	2.257	2.783
	(.576)	(.249)	(.695)	(.625)	(.476)	(.480)	(.700)	(.637)
Individualism difference	4.960	4.287	8.340	8.724	2.051	2.297	7.918	8.094
	(.461)	(.591)	(.194)	(.173)	(.815)	(.794)	(.217)	(.207)
Market volatility	2.030***	2.074***	1.927***	1.950***	1.992***	1.994***	1.931***	1.939***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Independent variables								
Supplier's ego-network instability	−3210.1***	−3846.1***	−2751.6*	−4790.7***	231.4	−2626.0***	397.5	−2095.7***
	(.000)	(.000)	(.071)	(.000)	(.811)	(.006)	(.476)	(.000)
Buyer–supplier relationship strength	1199.9***	1105.0***	1271.0***	1216.0***	1239.4***	1244.9***	1293.9***	1205.6***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Structural equivalence	437.3	−519.8	−219.5	478.4	246.4	224.5	−174.6	467.3
	(.638)	(.523)	(.793)	(.597)	(.719)	(.741)	(.835)	(.609)
Supplier's ego-network instability × Buyer–supplier relationship strength	734.9**	1092.6***	−158.2	1203.7***	419.6	768.2**	−242.7	794.0***
	(.017)	(.001)	(.786)	(.002)	(.187)	(.021)	(.256)	(.000)
Supplier ego-network instability × Structural equivalence	24,380.0	39,850.2**	132,118.6***	28,266.6	−3416.3	−4199.6	16,865.7***	5062.7
	(.168)	(.037)	(.000)	(.137)	(.338)	(.401)	(.000)	(.172)
Intercept	11,051.8***	12,716.5***	6691.8***	6974.4***	11,536.3**	13,230.5**	6615.6***	6721.2***
	(.000)	(.000)	(.003)	(.000)	(.038)	(.017)	(.002)	(.001)
Supplier country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Buyer country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	4764	4380	5257	5257	4796	4796	5257	5257

Note: p-values in parentheses. Models 18 and 19 use robust standard errors and other cluster-robust errors at the dyad level. Models 15, 16, 18, 19, and 20 use structural equivalence measure based on a two-year window.

*$p < .10$; **$p < .05$; ***$p < .01$.

TABLE B3 Robustness checks: Alternative models.

Dependent variable Model Modeling framework	Fixture rate M22 HDFE	Fixture rate M23 HDFE	Fixture rate M24 HDFE	Fixture rate M25 HDFE	Fixture rate M26 GLS random effects	Fixture rate M27 GMM
Controls						
Relative structural holes	−1004.2***	−399.7	−986.3***	−960.0**	−1395.0***	−1093.6***
	(.000)	(.172)	(.000)	(.020)	(.000)	(.007)
Relative centrality	−3.099	−42.41**	−47.92**	−87.68*	−79.72***	−73.07***
	(.865)	(.031)	(.019)	(.095)	(.003)	(.000)
Firm size difference	−0.000722**	0.0000796	−0.000778**	−0.000235	0.000466	0.00104**
	(.046)	(.858)	(.034)	(.754)	(.313)	(.010)
Buyer dependence	−3.855	−2.930	11.61***	7.737	−1.339	5.048
	(.228)	(.370)	(.008)	(.179)	(.813)	(.156)
Supplier capability geared	−3213.4***	−2531.1***	−2908.5***	−1764.2***	−2444.8***	−2228.0***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Supplier capability gearless	−3478.7***	−2784.7***	−2978.4***	−1619.3***	−2654.3***	−2498.9***
	(.000)	(.000)	(.000)	(.001)	(.000)	(.000)
Vessel size	0.0950***	0.0781***	0.0839***	0.0610***	0.0936***	0.0880***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Supplier competitor					1577.6**	1229.8*
					(.044)	(.061)
Supplier's financial distress	50.29	120.5	−8.105	64.51	−124.7	−185.7
	(.727)	(.444)	(.955)	(.828)	(.537)	(.300)
Dyadic instability	−302.6***	−284.0***	−283.8***	−189.8***	−222.1**	−487.5***
	(.000)	(.000)	(.000)	(.000)	(.046)	(.000)
Power distance difference					12.20	−2.816
					(.399)	(.452)
Long term difference					−0.922	−1.360
					(.930)	(.686)
Uncertainty avoidance difference					0.657	6.963
					(.948)	(.444)
Masculinity difference					2.721	2.817
					(.711)	(.369)
Individualism difference					−8.477	5.899
				(.482)	(.187)	
Market volatility	1.954***	1.933***	1.931***	1.949***	2.054***	1.890***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Lagged fixture rate					0.156***	0.354***
					(.000)	(.000)
Independent variables						
Supplier's ego-network stability	−3063.3***	−3165.3***	−4013.8***	−5873.0***	−4313.9**	−5335.9***
	(.000)	(.000)	(.000)	(.003)	(.034)	(.000)
Buyer–supplier relationship strength	1226.8***	1024.3***	1076.0***	322.9	262.0**	−81.91
	(.000)	(.000)	(.000)	(.325)	(.038)	(.139)

(Continues)

TABLE B3 (Continued)

Dependent variable Model Modeling framework	Fixture rate M22 HDFE	Fixture rate M23 HDFE	Fixture rate M24 HDFE	Fixture rate M25 HDFE	Fixture rate M26 GLS random effects	Fixture rate M27 GMM
Supplier's ego-network stability × Buyer–supplier relationship strength	652.0**	513.7*	706.6**	1108.5*	1178.3*	1496.6***
	(.016)	(.081)	(.011)	(.054)	(.075)	(.000)
Structural equivalence	746.4	547.4	350.8	−843.9	552.7	−321.8
	(.410)	(.524)	(.670)	(.435)	(.542)	(.146)
Supplier's ego-network stability × Structural equivalence	25,913.2	25,876.0	19,642.5	42,658.6***	22,511.2	33,180.1*
	(.175)	(.181)	(.268)	(.000)	(.279)	(.081)
Intercept	4324.5***	4641.7***	4767.6***	7073.8***	17,411.0***	4164.4***
	(.000)	(.000)	(.000)	(.000)	(.000)	(.000)
Supplier country	Yes	Yes	Yes	Yes	Yes	No
Buyer country	Yes	Yes	Yes	Yes	Yes	No
Supplier	No	Yes	No	Yes	No	No
Buyer	No	No	Yes	Yes	No	No
Dyad	No	No	No	Yes	No	No
N	5244	5144	5184	3038	2081	2081

Note: *p*-values in parentheses. All models use cluster-robust standard errors (Models 22–24 and 26—dyad level; Model 25—dyad, buyer, and buyer-country level; Model 27—buyer-country level).
*$p < .10$; **$p < .05$; ***$p < .01$.

that any type of instability is a negative signal, the instability due to the buyers lost is only marginally significant at the 10% level. Additionally, the interaction term between instability and relationship strength remains significant only for the latter (buyer-added) case, indicating that the buffering effects of relational strength possibly manifests in the presence of negative instability signals due to the other buyer additions. Indeed, as discussed in the hypothesis section, new additions entail disruptions in a supplier's coordination routines and may raise reliability concerns about the supplier's commitment under time and resource constraints. In contrast, the interaction term between instability and structural equivalence becomes significant for the former (buyer-lost) case.

To assess whether the "how" of changes in a supplier's downstream ego-network instability acts as a signal as well, our next two alternate measures of instability are dummy-coded one, capturing the overall *reduction* in a supplier's instability from one time period to the other (Model 18) and capturing the overall *increase* in a supplier's instability from one time period to the other (Model 19). We coded these measures zero otherwise. In Model 18, the coefficient of overall instability reduction stand-alone is positive but insignificant. This reflects a possible absence of a "penalty" when there is a signal of supplier-instability "repair," in that the supplier's relational patterns are becoming more stable. The coefficient of the other variable capturing an increase in a suppliers' instability, on the contrary, is negative and significant in Model 19. This coefficient is of a large magnitude, indicating that the penalty for the supplier becomes worse. The interaction term corresponding to relationship strength remains positive and significant in Models 19 but is only marginally significant based on a one-sided test in Model 18. We further evaluated the different kinds of instability using the variables, *shrinkage* (Model 20), dummy-coded one when "lost" buyers are greater than "added" buyers, and *expansion* (Model 21), when "added" buyers are greater than "lost" buyers. Both the main effect of instability and the interaction effect of relationship strength become insignificant in the shrinkage scenario. Interestingly, the interaction effect of structural equivalence becomes positive and significant. Nevertheless, the results in the expansion scenario are consistent with our main results.

TABLE B4 Robustness checks: Endogeneity checks.

Dependent variable	Tie	Dependent variable	Fixture rate	Instability	Fixture rate
Model	**M28**	**Model**	**M29**	**M30**	**M31**
Modeling framework	**Probit**	**Modeling framework**	**GLS (random effects)**	**2SLS (first-stage)**	**2SLS (second-stage)**
Controls					
Suplier structural holes	0.453***	Relative structural holes	−681.8**	0.0157*	−1048.2***
	(.000)		(.027)	(.084)	(.000)
Supplier centrality	0.00744	Relative centrality	−19.03	0.0000421	−0.640
	(.351)		(.321)	(.917)	(.968)
		Firm size difference	−0.000586	−9.21e-09	−0.000739**
			(.150)	(.132)	(.023)
		Buyer dependence	−5.000	0.0000630	−9.101***
			(.120)	(.475)	(.001)
Supplier capability geared	0.0407***	Supplier capability geared	−3075.6***	0.0132**	−3373.0***
	(.000)		(.000)	(.017)	(.000)
Supplier capability gearless	0.0380***	Supplier capability gearless	−3326.9***	0.00930*	−3642.3***
	(.000)		(.000)	(.073)	(.000)
Supplier total vessel size	−1.49e-08	Vessel size	0.0920***	−0.000000135**	0.0992***
	(.851)		(.000)	(.028)	(.000)
		Supplier competitor	1514.5***	0.0279**	927.4***
			(.001)	(.025)	(.004)
Suppliers' financial distress	−0.0102	Supplier financial distress	76.15	−0.000379	80.69
	(.539)		(.597)	(.931)	(.535)
		Dyadic instability	−300.6***	0.00128*	−300.0***
			(.000)	(.057)	(.000)
Supplier power distance	−0.00160***	Power distance difference	4.567	−0.000109	−3.526
	(.002)		(.637)	(.561)	(.594)
Supplier long-term orientation	−0.000957***	Long-term orientation difference	1.097	0.0000866	−6.219*
	(.002)		(.850)	(.462)	(.055)
Uncertainty avoidance	0.000184	Uncertainty avoidance difference	−1.499	0.000142	4.906
	(.280)		(.757)	(.296)	(.142)
Masculinity	0.000524*	Masculinity difference	2.756	0.000223*	−4.029
	(.072)		(.643)	(.099)	(.353)
Individualism	−0.000715	Individualism difference	7.905	−0.0000503	14.64***
	(.127)		(.215)	(.767)	(.004)
Collocated buyers	1.046***				
	(.000)				
		Market volatility	1.951***	0.00000171	1.967***
			(.000)	(.165)	(.000)
Independent variables					
Supplier's ego-network instability	0.0289**	Supplier ego-network instability	−3018.5***	0.853***	−4029.5***

(Continues)

TABLE B4 (Continued)

Dependent variable Model Modeling framework	Tie M28 Probit	Dependent variable Model Modeling framework	Fixture rate M29 GLS (random effects)	Instability M30 2SLS (first-stage)	Fixture rate M31 2SLS (second-stage)
	(.016)		(.000)	(.000)	(.000)
		Buyer–supplier relationship strength	1222.4***	−0.00204	1271.1***
			(.000)	(.258)	(.000)
		Structural equivalence	419.1	−0.0158*	391.3
			(.643)	(.053)	(.669)
		Supplier's ego-network instability x	565.5**	−0.00492	1162.8***
		Buyer–supplier relationship strength	(.041)	(.824)	(.002)
		Supplier's ego-network instability x	28,468.6	−0.117	36,849.7
		Structural equivalence	(.133)	(.749)	(.180)
		Selection correction	−379.1		
			(.128)		
Intercept	−2.211***		7849.8***	−0.00607	4484.7***
	(.000)		(.000)	(.626)	(.000)
Supplier country	No		Yes	Yes	Yes
Buyer country	No		Yes	Yes	Yes
N	206,670		5257	5257	5257

Note: *p*-values in parentheses. All models use cluster-robust or robust standard errors (Model 28—supplier-country level; Model 29—dyad level; Models 30–31—robust standard errors); Instrument, *social influence*, in the first stage regression of *instability* in Model 30 (results suppressed for the first-stage regression of *instability* × *relationship strength* and of *instability* × *structural equivalence*) and the fitted values of instability in Model 31.
*$p < .10$; **$p < .05$; ***$p < .01$.

Alternate models: In Table B3, we use alternative modeling frameworks to ascertain the robustness of our findings to other estimators besides the random-effects model. In Models 22–25, we employed a feasible estimator with multi-way fixed effects (Correia, 2016). We modeled the charter fixture rate with high dimensional fixed effects estimators (HDFE) and respectively use buyer and supplier country fixed effects (Model 22), both the country-level fixed effects and supplier fixed effects (Model 23), both the country-level fixed effects and buyer fixed effects (Model 24), and finally, both country-level, buyer, supplier, and dyad fixed effects (Model 25). Our main findings remain largely consistent in these fixed-effect models. H2 becomes marginally significant in Models 23 and 25. Furthermore, the interaction effect of structural equivalence becomes significant in Model 25.

As additional robustness tests, we employed dynamic models. In Model 26, we used a dynamic model, which included the lagged dependent variable as a control in the random-effects model to account for the fact that past exchange price may strongly determine the current charter fixture rate. To the extent that the lagged value influences current price, not including it may lead to omitted variable bias. At the same time, the lagged charter fixture rate may cause autocorrelation in residuals and be potentially endogenous, leading to dynamic panel bias and making GLS estimates inconsistent (Arellano & Bond, 1991; Judson & Owen, 1999). Thus, in Model 27, we also utilize a one-step linear system generalized method of moments (GMM) dynamic panel estimator, which uses deeper lags of the instrumented lagged dependent variable (Roodman, 2009a, 2009b). We assumed all other regressors to be exogenous for this estimation. The use of lagged values as instruments necessitates that the error term does not exhibit second-order serial correlation for an unbiased estimation (Arellano & Bond, 1991). The Arellano-Bond test indicated that serial correlation for AR (2) in first differences is not significant ($p = 0.452$). This suggested that past charter fixture rates' impact on current rates follow an autoregressive one (AR (1)) process. Additionally, we ran the Hansen test, which suggested that although weakened by many instruments, the model is robust and does not have an overidentification issue. Furthermore, the difference-in-Hansen tests indicated that there is not enough evidence to reject the null of the exogeneity of instruments ($p = .301$).Although both specifications significantly reduced our sample size, the results remain largely consistent with our main findings for Model 26, with H2 becoming marginally significant, and consistent for Model 27. Moreover, the interaction effect of structural equivalence becomes significant at the 10% level in Model 27.

Sample selection and omitted variable biases: Although the models reported in Table B3 addressed the unobserved, time-invariant buyer, supplier and even dyad level heterogeneity in a conservative fashion using the fixed effects estimation (Models 22–25) and the possibility of omitted variables using the dynamic models (Models 26–27), we further tackle two possible endogeneity risks in Table B4. First, despite care in the selection of controls and the checks discussed above, our study may suffer from sample-induced endogeneity in that the charter fixtures (buyer–supplier contract) that form the basis of our estimation sample are indeed the realized ones in which buyers self-selected into an exchange with a specific supplier, keeping their own performance in mind. If the choice to enter a fixture were correlated with residuals, our estimates would exhibit bias. To alleviate this possible self-selection concern, we employed Heckman's two-step correction (1979). In the first step, we needed to capture the likelihood of a buyer–supplier tie formation in a given year. Thus, our dependent variable, *presence or absence of a buyer–supplier tie*, also requires information about unrealized buyer–supplier dyadic relations that may have been part of the buyer's initial choice set but did not materialize. To proxy for these unrealized buyer–supplier dyads, for each year, we created a list of all suppliers that were part of any realized charter fixture. For a given buyer in a year, besides the suppliers with which the buyer had actual ties (we assigned the first-stage dependent variable one for these cases), all other suppliers from the list were considered "potential" suppliers and hence, part of the unrealized dyad (we assigned zero for these cases) resulting in 206,670 observations. We modeled the likelihood of a buyer–supplier tie formation in a given year (equivalent to whether the fixture was actually realized) using a probit estimator that included supplier-related variables, namely, *collocated buyers*, *structural holes*, *degree centrality*, *geared*, *gearless*, *total vessel size*, *supplier's financial distress*, *power distance*, *long-term orientation*, *uncertainty avoidance*, *masculinity*, *individualism*, and *downstream ego-network instability* in Table B4 and estimated the Inverse Mills Ratio (IMR). Among these variables, the number of *collocated buyers*, that is, buyers that are collocated with a focal buyer and that already have relationships with the potential supplier, suggests that the relationship with the supplier is in vogue locally and, hence, is related to the first-stage dependent variable (tie formation). However, it is not theoretically directly associated with the second-stage dependent variable (charter rates), acting as an exclusion restriction variable (for use of exclusion restriction variable in Heckman selection see Dhanorkar et al., 2018; Tong et al., 2023). In the second step, we added the IMR ratio as a control in our estimation of the main model. In Model 28, we model the likelihood of formation of a buyer–supplier tie (equivalent to a realized charter fixture) using a probit estimator. We then include the IMR computed after this estimation as a selection correction in our main model with random effects in Model 29. All of our results remain consistent with the main findings.

Second, another endogeneity risk may be that the omitted variables that affect both a supplier's downstream ego-network instability and charter fixture rate make our main independent variable of interest endogenous and confound our findings. We used two-stage least squares (2SLS) estimation to alleviate this endogeneity concern. For the first stage, in Table B4, we constructed *social influence*, the average downstream ego-network instability values of other suppliers located in the same city as the focal supplier, as an instrument for instability. The rationale is that the focal supplier's own decisions pertaining to the composition of downstream buyer relationships may be influenced by the relational longevity pattern exhibited by its geographically proximate peers. However, on its own, the instability of other suppliers cannot directly affect the charter fixture rate between the focal supplier and its buyers. In this regard, our instrument conceptually passes the exclusion restriction criterion. We note that there are three endogenous regressors, instability and the two interaction terms that include instability. Hence, we used three excluded instruments, social influence and the interactions comprising of social influence.

As regards tests for underidentification and weak identification, the Stock-Yogo weak identification test critical values corresponding to three endogenous regressors and three excluded instruments are not available in STATA (Stock & Yogo, 2005). That being said, Sanderson and Windmeijer (2016) point out the insufficiency of Stock-Yogo test in that weak identification can exist despite the high F-statistics. As regards the "relevance" of our excluded instruments, the Sanderson-Windmeijer Chi-squared tests ($p = .000$) rejected the null of under identification, suggesting that the instruments are correlated with the endogenous variables and the model is identified. Next, the Sanderson-Windmeijer multivariate F test statistics ($p = .000$) reject the null of weak identification that the excluded instruments correlate only weakly with the endogenous variables (Sanderson & Windmeijer, 2016). In addition, the weak-instrument-robust Chi-squared tests, namely, the Anderson-Rubin test and Stock-Wright test, are significant at 0.000 level, indicating the validity of our instruments. Regarding the validity of overidentifying restrictions, the Hansen J Statistic of zero suggested that the estimation is exactly identified. We obtained the predicted values for a supplier's downstream ego-network instability with social influence and its interactions as instruments in the first stage and then, utilized these values from the first-stage estimations in our full model in the second stage in Models 30 and 31, respectively. Our results remain similar to the main results in this specification as well.

APPENDIX C

TABLE C1 Extra robustness checks.

Dependent variable Model Modeling framework	Fixture rate M32 GLS random effects	Fixture rate M33 GLS random effects	Fixture rate M34 GLS random effects
Controls			
Relative structural holes	−553.4**	−887.6***	−777.1***
	(.028)	(.001)	(.004)
Relative centrality	−22.62	−10.44	−7.261
	(.222)	(.744)	(.695)
Firm size difference	−0.000762**	−0.000827**	−0.000508
	(.039)	(.048)	(.204)
Buyer dependence	−4.780	−4.710	15.89**
	(.126)	(.182)	(.023)
Supplier capability geared	−3004.8***	−3059.7***	−3096.0***
	(.000)	(.000)	(.000)
Supplier capability gearless	−3221.5***	−3321.6***	−3356.8***
	(.000)	(.000)	(.000)
Vessel size	0.0795***	0.0922***	0.0900***
	(.000)	(.000)	(.000)
Supplier competitor	1427.5***	1538.2***	1542.0***
	(.002)	(.001)	(.001)
Suppliers' financial distress	49.16	76.74	83.25
	(.729)	(.594)	(.563)
Dyadic instability	−404.6***	−297.5***	−292.1***
	(.000)	(.000)	(.000)
Power distance difference	1.781	4.219	4.363
	(.850)	(.663)	(.652)
Long-term orientation difference	0.371	1.022	0.970
	(.948)	(.860)	(.868)
Uncertainty avoidance difference	−0.976	−1.513	−1.737
	(.836)	(.755)	(.719)
Masculinity difference	2.079	2.875	3.829
	(.719)	(.629)	(.519)
Individualism difference	9.429	8.868	8.684
	(.130)	(.166)	(.177)
Market volatility	2.037***	1.946***	1.949***
	(.000)	(.000)	(.000)
Buyer with multiple suppliers		2.625	1973.5***
		(.945)	(.000)

TABLE C1 (Continued)

Dependent variable Model Modeling framework	Fixture rate M32 GLS random effects	Fixture rate M33 GLS random effects	Fixture rate M34 GLS random effects
Independent variables			
Supplier's ego-network instability	−9166.9***	−3042.4***	−3113.3***
	(.003)	(.000)	(.000)
Buyer–supplier relationship strength duration	992.0***	1222.4***	1213.6***
	(.000)	(.000)	(.000)
Buyer–supplier relationship strength volume	1142.2***		
	(.000)		
Supplier's ego-network instability × Buyer–supplier relationships strength	752.0**	574.8**	587.5**
	(.015)	(.039)	(.035)
Structural equivalence	360.7	437.9	409.2
	(.695)	(.629)	(.650)
Supplier's ego-network instability × Structural equivalence	27,964.7	28,831.5	29,588.5
	(.116)	(.129)	(.122)
Intercept	−3846.7	6881.1***	4876.1**
	(.270)	(.001)	(.019)
Supplier country dummies	Yes	Yes	Yes
Buyer country dummies	Yes	Yes	Yes
N	5257	5257	5257

Note: *p*-values in parentheses. Errors are clustered at the dyad level; The relationship strength interaction term captures cumulative volume until time *t* in M32 and duration in M33–34; Buyer with multiple suppliers is a count of suppliers (M33) and a dummy with a value of one for a buyer with multiple suppliers and zero otherwise (M34).

*$p < .10$;

**$p < .05$; ***$p < .01$.