Authority and Performance in Vertical Relations: Satellite-tracked Evidence*

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Abstract

Authority is characterized by the right to give orders and hold the residual claims of the firm. Using satellite-tracked real-time data on the operations of a vertically integrated fishing firm's own ships and its long-term supplier ships, this paper studies the effect of increased control after the acquisition of those suppliers. The results suggest an increase in fishing effort and speed, an improved coordination with downstream plants, higher ship productivity, and higher downstream product quality brought about by control. Evidence consistent with improved fleet deployment and coordination, and inconsistent with other mechanisms, is provided.

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The authority brought about by ownership enacts the right to give orders and hold the residual claims of the firm (Grossman and Hart 1986, Hart and Moore 1990). Authority is typically exercised within an organization rather than over the market, thus becoming one of the key constructs in the study of vertical integration under various frameworks (Gibbons 2005). Because the acquisition of control may broadly affect the way assets are allocated and output is transferred (Williamson 1975), while at the same time it may be motivated by the non-contractible nature of vertical relations (Hart and Moore 1990), arguments about authority vary substantially and sometimes conflict in the literature (Whinston 2001). Generally, it is well understood that the authority enacted by ownership has significant performance implications in vertical relations, at least in theory.

Despite the central role of authority in theories of vertical integration, empirical evidence on the impact of authority is very limited.[1] Recent work has proposed important value consequences for vertical integration in incomplete contracting environments (Novak and Stern 2008, Lederman and Forbes 2010), but the specific mechanisms enacted by authority have not been examined in isolation from other changes brought about by the vertical integration decision. This paper provides direct evidence on the effects of authority on firm operations and performance through a study of industrial fishing.

To study authority, this paper introduces a unique proprietary database with the satellite-tracked real-time operations of a large vertically integrated fishing firm (hereafter the Firm[2]) in running its own ships and its relationships with long-term contractual suppliers

[1]See Gibbons (2010) for a review of recent developments on authority in decision-making. A related empirical literature has studied *interpersonal* authority in organizations, a construct for which firm boundaries can remain fixed because variation in such type of authority is not due to ownership (Liberti 2005, Wulf 2006). Other studies have looked at changes in ownership that ensure *financial* control of investments, without examining authority in vertical relations (e.g., Pérez-González 2005).

[2]The Firm ranked among the five largest fishing companies in the world at some point during the period studied; this ranking changes frequently so it is not easy to identify any given firm. In keeping with our confidentiality agreement, the Firm's name is omitted.

providing it with fish for processing between 2003 and 2010. Because a great deal of decisions are made on the spot, when a ship is on the ocean and managers are on land, the satellite-tracked movements of ships allow us to observe the impact of authority on asset operations with precision. Moreover, because the market value of each ship's catch (i.e., price and quantity) is observable, the economic mechanisms linking authority, operations and performance can be established more directly. This real-time data set on ship locations and actions is combined with information on the hourly operations of the Firm's downstream seafood and fishmeal plants, as well as daily information on each and every firm in the industry. The effects of authority are thus assessed in the perspective of the internal and external demands faced by economic agents in a vertical industry more broadly.

To identify the effects of authority, this paper exploits *changes* in asset ownership enacted by corporate acquisitions, holding the measurement technology (e.g., satellite) fixed.[3] Specifically, at different points in time, the Firm decided to more fully integrate backwards by acquiring its long-term suppliers in order to directly control their fishing operations and residual claims jointly with its own fleet. After acquiring these fishing firms, which did not have downstream processing capabilities, the Firm gained authority in all details regarding their upstream operation. In turn, its authority over already-owned ships did not increase.

This empirical setting is unusually well suited to assess the effects of authority for several reasons. First, focusing only on the Firm's own ships and those of its long-term suppliers that fully shared information with it before integration allows for a sharper observation of property-based authority than in other types of vertical acquisitions. Second,

[3] Baker and Hubbard (2003) study whether different types of monitoring technology are associated with different degrees of asset ownership. My study is substantially different because the satellite tracking technology is *uniform* across owned assets and long-term contractual suppliers before and after integration, a feature exploited here as a source of granular data. The uniform nature of the monitoring technology is also helpful here because it makes mechanisms other than authority less likely, as will be detailed in the empirical design.

because changes in behavior and performance at the ship level were not anticipated by managers before the corporate acquisitions, the difference-in-differences design would remove biases due to omitted variables or endogeneity concerns. Third, the Firm acquired *all* the ships of *all* its long-term suppliers as a block, so a selection argument is not likely to drive the results. Fourth, because granular information is available on both external and internal ships before and after the acquisitions, the inclusion of ship fixed effects removes unobserved heterogeneity that is invariant at the micro level of each asset. Finally, institutional advantages of the industry such as the exogeneity of *fish* behavior — the location, depth, timing, and abundance of fish varying due to exogenous factors not anticipated by firms — and the invariance of alternative economic forces such as the information environment or the employment relation create an empirical laboratory closely resembling economic theory. In sum, the empirical setting allows us to observe shifts in control holding other important factors constant, thus facilitating the attribution of the effects of vertical integration to authority.

I start by analyzing whether control influences asset operations. Using trip-level regressions with ship fixed effects, I find that acquiring control leads to greater effort by formerly externally-owned ships, reflected in a longer distance traveled per trip, higher average speed per trip, and a higher propensity to return to ports that are *not* the nearest to the fishing zone. The increase in effort manifested by these findings is accompanied by changes in the extensive margin (i.e., how often the ships go out), as the rest period between trips is significantly reduced by an increase in control. These results are consistent with a change in the optimal way assets are allocated by a firm with joint operations both upstream and downstream. Because all these aspects of internal operations can be subject to disagreement, bargaining and disobedience, the evidence suggests that control leads formerly independent ships to exert more effort and do things differently when they become part of a vertical structure.

To gain insight into how this increase in control may affect the vertical coordination between ships and plants, I next focus on the real-time speed of ships at *each point of their trajectory* on a fishing trip. While real-time speed may have an ambiguous interpretation in this setting, as ships can be fishing, drifting, or searching at the same speed, linking speed to the synchronous operation of nearby plants is useful to assess whether control makes ships more responsive to the needs of downstream operations. I find that control increases the sensitivity of ships' speed to the level of activity of the closest plants of the Firm in real time. I also discover that control does not affect the sensitivity of a ship's speed to the activity of nearby *external* plants, that is, those not owned by the Firm. These contrasting results suggest that the effects of control are not indiscriminate, consistent with the notion that operations change when authority is exerted within firm boundaries and not otherwise.

Having found a strong influence of control on asset operations, I ask: Does it matter for payoffs and performance? Using trip-level regressions, I find significant performance implications of control. First, the weight of fish catches and the ship capacity utilization significantly increase after acquiring control, suggesting that formerly externally owned assets become more productive inside a vertical structure. Second, the market value of the catch is increased by control, confirming that the increase in output is not due to a composition effect. Because the payoffs to ship crews across the industry are directly proportional to the catch market value, moreover, the increase in control leads to substantial monetary benefits to asset operators even though the incentive scheme is the same across organizational forms and over time. Third, the propensity to sell the catch to firms located at ports *other than the Firm's ports* is significantly reduced after a change in control. But at the same time, the number of clients for the catch is significantly *increased* after a change in control; these findings jointly suggest that the Firm prefers to redirect its newly acquired ships only to ports where it has plants, though without foreclosing local buyers. Finally, an increase in control leads to producing more high-quality downstream goods (i.e., prime fishmeal) through the provision of fresher fish, without increasing input-output ratios, thus obtaining a more profitable product mix for downstream markets.

Authority is found to influence operations and performance through a coordination and deployment mechanism. Specifically, with more control over its formerly external ships, the Firm can more efficiently deploy them in a joint-maximization fashion with one another and with downstream plants. A key advantage of the data is the observation of distinct *fleet* affiliations before becoming part of the Firm, thus allowing for fleet-week regressions analyzing the deployment of *sets* of ships before and after the acquisition of control. I find that control leads formerly independent fleets to cover a greater geographic area and to position their ships farther from one another, consistent with a change in the way they conduct fishing operations that requires more effort but also leads to potentially better outcomes through finding better fishing areas. An increase in control also leads formerly external fleets to operate closer to the coastline, consistent with a greater responsiveness to the needs of plants. Because these navigation features are particularly beneficial to a vertically integrated structure and cannot be contracted over the market, the evidence suggests that the increase in authority leads to economic outcomes through changes in coordination and deployment only feasible inside firm boundaries. In contrast, I find no evidence of changes in internal ship personnel policies, increased technology investments, or changes in holdup risk reflected in docking wait times after the enactment of control, thus concluding that these alternative mechanisms are not driving the results.

To my knowledge, this paper is the first to empirically study authority, operations and performance in vertical structures, thus contributing to a growing literature in organizational economics.[4] The findings broadly fit the property-rights view of Hart and Moore (2005) emphasizing the gains from coordination accruing to a generalist (i.e., the integrated firm) with authority over specialists. Moreover, viewing the acquisition of not simply assets but their operators' real-time decision capabilities to access a highly-mobile resource is consistent with Rajan and Zingales's (1998) theory of *access* as a parallel to *ownership*. The greater investment gains in input search accruing to joint ownership and control are consistent with Feenstra and Hanson's (2005) model of outsourcing. The results also suggest that authority has important value implications even when asymmetric information may not drive the acquisition of control (Dessein 2002, Alonso 2008, Çelen and Thomas 2009).

This study also contributes to viewing organizational economics as inherently linked to industrial organization by introducing real-time operational measures to study the microstructure of incentives, competition and performance in connection with authority. The empirical design shares features with detailed single-firm studies in the fashion of insider econometrics (Bartel, Ichniowski, and Shaw 2004) with two significant additions. First, granular activity is observed *within* and *across* firm boundaries, thus allowing for a study of organizational form in conjunction with market interactions. Second, the influence of authority is assessed in conjunction with exogenous factors in a context where outcomes are largely random, thus revealing the existence of purposeful vertical arrangements against the background of a null hypothesis in which they should not matter.

[4] See Arruñada, Garicano, and Vázquez (2001) and Elfenbein and Lerner (2003) for some of the few empirical tests on control rights and ownership. These works emphasize contract design rather than the performance implications of switching from long-term contracts to ownership.

1 Basic Framework

I start by providing a very simple characterization of the Firm's problem to help interpret the empirical findings. The Firm produces an output that is a function of the input of raw material q_1 provided directly by its upstream assets, and the input q_2 purchased from a long-term external supplier. The Firm is a price taker in commodity markets so that the price p^w is fixed. The Firm's problem for a given year is then

$$\Pi = p^w * f(q_1, q_2) - c(q_1, q_2) - \delta * I_1 \tag{1}$$

where the costs of the internal upstream assets are summarized as a fixed rate per period, δ, multiplying the total capital stock I_1 representing the Firm's initial upstream assets. For simplicity, make the variable cost of providing the input be equal to zero. The cost function of the Firm can be represented as

$$c(q_1, q_2) = p_2 * q_2 + g(q_1, q_2) \tag{2}$$

where p_2 is the markup charged by the long-term supplier for the input over its marginal cost of zero, and g is a coordination cost function for handling raw material supplied by internal and external sources.

Now consider the Firm's decision to further vertically integrate by acquiring the long-term supplier. For this decision to be profitable, it must be the case that

$$p^w * [f(q_1 + q_2, 0) - f(q_1, q_2)] - [g(q_1 + q_2, 0) - g(q_1, q_2)] >= \delta * I_2 - p_2 * q_2 \tag{3}$$

The Firm's profits depend on a variety of factors. As detailed on the right-hand side of (3), for example, the long-term supplier could sell its assets at such a high price I_2 that it extract all the value from the Firm (i.e., the classic argument that "vertical integration should not matter.") The price of purchasing fish on the upstream market (p_2) may also become so high that the acquirer may benefit largely from eliminating double-marginalization, thus turning the acquisition profitable.

More importantly, as shown on the left-hand side of expression (3), the Firm can profit from integration through managing productivity or coordination costs by fully controlling its formerly external long-term suppliers. This paper proposes that the authority gained by the Firm over the newly acquired assets is the key driver of these changes in efficiency. For convenience, the components of expression (3) will be invoked directly in the analysis.

2 Institutional Background

A. The Activity

Industrial fishing consists in the capture of wild fish by large-scale vessels operated by large, professional crews. In Peruvian fisheries, the second most abundant in the world and the focus of this study, ships are only capable of extracting, not transforming. A fishing trip can have two mutually exclusive purposes: fish for fishmeal or fish for seafood. In the former case, ships carry their catch without need for refrigeration or stringent sanitary previsions, and trips are typically short (e.g., less than 24 hours). In the case of fishing for seafood, ships must activate their refrigeration system and trips are longer and more cautious with respect to how the raw fish is handled. This study includes both types of fishing.

Because fish is a highly perishable good, coordination between ships and plants is crucial. Although much of this coordination happens over the market, a significant part of these transfers also take place inside firm boundaries, in cases when plants and ships are part of the same firm. The randomness of the resource, moreover, makes the relationship between ships and plants particularly important, as significant transportation and wait costs complicate the compliance of procurement agreements.

The common nature of fish resources makes fishing a regulated activity. The Ministry of Production collects detailed information on many aspects of commercial activities such as extraction and production in real time (e.g., through computerized systems) and through mandatory monthly reports. This information is mostly used for policy-making in the determination of fishing seasons, fishing quotas, extraction taxes, and any other government activity mandated by law.

B. The Firm

The Firm is similar to other firms in the industry along several dimensions:[5] large, vertically integrated, geographically diversified with plants along the coastline, input-diversified in species, product-diversified into fishmeal and seafood, and mostly exports-oriented. The focus of this study is on how the Firm obtains fish.

The Firm obtains fish from four main sources. First, its own ships; second, its long-term contractual suppliers with whom it fully shares operating information and from whom it enjoys a special priority (without obligation on either part) to receive fish catches; third, weaker relationship suppliers, without shared information or special priority; and fourth, spot transactions with industrial fishing firms and small artisanal ships. While the total

[5] Specific details that may reveal the Firm's identity are omitted.

number of ships providing the Firm with fish surpasses 1,000, this study focuses exclusively on the first two groups, accounting for 53% of the Firm's fish before the latest corporate acquisitions and totaling between 50 and 100 ships, with the exact number omitted for confidentiality. The nature of the contracts for fish procurement in the industry is largely relational and informal, and will be further described in the next subsection.

The Firm places special emphasis on the process of managing its fleet to achieve firm-level gains. Specifically, the internal organization of the Firm includes a position for a supply manager that was initially different from that of the fleet manager but became fully integrated into the same job description before the beginning of the period studied. The supply-and-fleet manager's job consists of four activities: ship maintenance, fishing tactics for the season, real-time decision-making in the relation between ships and plants, and performance evaluation. These tasks require significant dedication, and they are at the core of the Firm's distinctive capabilities. This role is also important because the Firm's authority over its own fleet is precisely exercised through this manager's orders. For example, ship operators obey the supply-and-fleet manager's indications regarding the 'macro' regions where to fish (e.g., bands of several hundred kilometers along the coastline), though they also receive significant autonomy for their 'micro' fishing zones, the essence of fishing skills. Before the acquisition of its long-term suppliers, the Firm's managers did not have the authority to determine how, when, or where those ships should fish, as the Firm only had a say in approving the landing of ships to specific plants. As shown in Figure 1, corporate acquisitions led to a substantial increase in the asset base of the Firm, thus enhancing the authority of managers to influence upstream asset operations.

C. Vertical relations and the need for integration to ensure control

In this empirical setting, ownership changes in the form of acquisitions of independent ships by downstream plants facilitate the analysis of authority because they leave other important aspects of vertical integration fixed, as summarized below.[6]

- *Industry caps.*- Asset expansion (e.g., plants or ships) for fishmeal is forbidden by regulation; new assets are only authorized if they substitute old assets.

- *Asset ownership.*- Ship operators are not ship owners, as those individuals who can afford a ship with a license prefer to hire somebody else to run it. Ships are owned by firms, which may or may not be vertically integrated into fish processing.

- *Employment relation.*- Neither the captain nor any member of a ship's crew receives a salary or any fixed compensation. Their sole monetary payment is a share of the catch market value, disbursed in cash within a week of the operation. This proportional share is uniform across all ship crews and across organizational forms in the industry.

- *Information flow.*- Ship and plant operators communicate constantly and fluidly in real time, sharing both local and industry-wide information. Firm managers have direct observation of their affiliated and contractual ships through the satellite system. Ship captains communicate within firm boundaries and with their peers at other firms. Though the quality of this information flow cannot be verified instantly, the repeated nature of fishing operations suggests that truthful revelation is plausible.

- *Relation-specific investment and bilateral dependency.*- Both ships and plants are generically oriented to commodity inputs and outputs. Unloading fish does not entail differential investments across vessel types or plants, and skippers can switch almost

[6]The stylized facts presented here are obtained through first-hand observation during a 22-hour fishing trip, two weeks of field research at the Firm, and interviews with managers at a dozen other companies.

costlessly across ships. There are no single-plant ports throughout the coastline and over 50% of all ships in the industry are not vertically integrated. In sum, there are no relation-specific investments or bilateral dependencies.

While these institutional features facilitate the attribution of the effects of vertical integration to authority, as will be detailed in Section 4.1, they also raise the question of whether authority over ship operations could be contracted instead of acquired through ownership. Contracts for fish are extremely informal across the industry, partly because the availability of fish is largely random.[7] For example, in the case of the relationship between the Firm and its long-term suppliers, the supply agreements are verbal and cannot be taken to a court of law for infringement. Essentially, the Firm guarantees that the ships of its long-term suppliers will be allowed to unload their catches at the Firm's plants, and the long-term suppliers agree to provide fish as often as possible, depending on natural conditions and on their own interest in unloading at the Firm's locations. The price for fish is the market price. Interestingly, the informal nature of the agreement does not imply weakness: 86% of the catch (in weight) of the Firm's long-term suppliers was sold to the Firm in the pre-acquisition period. However, the inherent incompleteness of these contracts and all others in the industry suggests that contractual arrangements to accommodate operations to better serve the greater good of a vertically integrated entity face great resistance by upstream firms. In this setting, the only way to guarantee that fishing operations are conducted in a joint-maximizing way mostly beneficial to downstream activities is through integration.

[7] See Forbes and Lederman (2009) for arguments on why the set of possible scheduling conflicts of airline operations is large. By comparison, fishing randomness makes quantity or time scheduling problems substantially larger and has a more direct impact on the profit function of downstream parties contracting on those terms.

3 Data

A contribution of this paper is to bring a granular data set to bear on authority in organizations. Per Title VIII, Chapter III of the General Fishing Bill of Peru,[8] a system of satellite surveillance is mandated for all firms in the industry, with the goal of overseeing good fishing practices and controlling extraction of fish, a national good. Following this general law, the specific regulation for the satellite system[9] details that the functioning of the transmission equipment on board is mandatory for all industrial ships and for all periods regardless of whether the ships are fishing or not. The information transmitted by the approved device includes date and time, ship ID, longitude and latitude (with a precision of +/-100 meters), speed, and direction. The transmitter is required to allow for reprogramming the default interval between signals to any value in the range between 15 minutes and 24 hours at the regulator's request. Disconnecting the equipment from the system for whatever reason requires government authorization. The providers of the satellite system are private firms also authorized by the government.

A key advantage of the satellite information used in this study is that it is available for both the Firm's own fleet and the fleets of its long-term suppliers before and after they become integrated. Because these two groups are the sole focus of the analysis, the comparison between organizational forms is unlikely to pick up other drivers of vertical integration that would matter otherwise (e.g., in the integration of formerly spot suppliers about which no information was available). The satellite information was provided by the Firm and includes all operations between 1 January 2003 and 20 April 2010, totaling over 3 million records.

[8]Decreto Supremo 012-2001-PE of 13 March 2001.
[9]Decreto Supremo 026-2003-PRODUCE of 12 September 2003.

This satellite information on ship movements becomes much richer when combined with the hourly internal records of the Firm's plants and with daily economic information on all ships and plants in the industry. Government collects information on each fishing trip including purpose (i.e., fishmeal or seafood), catch quantity, species, arrival date, arrival port, ship identifier and plant identifier. Plant-level information such as average prices per species, quantity and product qualities (e.g., prime fishmeal) are collected monthly for all firms in the industry. This information is supplemented with ownership records and other regulatory information (e.g., ban announcements) maintained by Government or hand-collected by the author, and with detailed prices and quantitites for all the Firm's transactions. Because the Firm does not routinely merge its satellite information with its economic information, I employ simple algorithms to determine when the ship is actively fishing, resulting in a total of 13,529 trips with 689,084 satellite snapshots, an average of 51 snapshots per trip.

The exact location of each plant of the Firm, each plant of other firms in the industry, and every point on the coastline are specified using coordinates from the NOAA National Geophysical Data Center website. Distances between two points in the trajectory of a ship or between the exact location of a ship and a plant are calculated using the harvesine formula, which accounts for the curvature of the Earth and performs particularly well for the numerical computation of small distances.[10]

Table 1 provides summary statistics for the Firm's own ships and its long-term contractual suppliers. Each trip's catch has a mean (median) value of $25,000 ($18,000) dollars on the dockside raw-fish market, revealing the economic importance of each trip. However, catch values are also highly dispersed, as the standard deviation is almost as large as the mean. Several exogenous factors such as bans and ban announcements are also

[10]The harvesine formula is available at `http://www.movable-type.co.uk/scripts/latlong.html`.

summarized. More than half of the trips of the Firm and its suppliers are for fishmeal.

How are the satellite data exploited in the analysis of authority? Recall that the economic value of fishing operations is uncertain before starting a fishing trip, so that real-time marine operations are crucial to profitability. By knowing the exact time and location of each ship during a fishing trip, a number of operational variables such as the distance traveled to catch fish, the time spent searching, the speed in returning to port, and the choice of what port to return to after a catch can be easily observed. Moreover, by jointly analyzing granular ship and plant activities within a precise geographic range, the micro-mechanisms of vertical coordination can be assessed directly.

To illustrate, Figure 2 shows satellite information on two trips of the same ship before and after the acquisition of control by the Firm. The conditions of the trips are similar, but the trajectories are quite different. The goal of the empirical analysis is to assess the impact of authority after controlling for other factors that may influence the behavior and performance of a ship on a given trip.

Before detailing the empirical specification, it is useful to plot some key data. Figure 3 plots kernel densities of selected trip-level variables: the average speed of a trip, the dollar value of the catch, and the ship's capacity utilization. Observations for each variable are classified into two groups: those representing trips of long-term contractual ships that are to become controlled by the Firm through changes in ownership, and those representing the ships owned by the Firm. The observations are further split into the periods before and after the acquisition events, using the date of each event for the treated (i.e., acquired) ships, while only using the large-acquisition event for the baseline ships. If the acquisition of control generates any meaningful changes in the distribution of behavior and performance variables, such changes should be noticeable in this difference-in-differences density analysis.

The first clear pattern from Panels I, II and III of Figure 3 is that long-term supplying ships are significantly different from vertical ships *before* they become controlled by the Firm. That is, all three left-hand side graphs show significantly different distributions for these two groups. Untabulated Kolmogorov tests for each of the variables before treatment reject the null hypothesis that the distributions across groups are identical. These findings suggest that differences in authority may be directly linked to operational and performance differences across assets.

But a second pattern displayed on the right-hand side of Figure 3 is that the operations and performance of formerly external ships acquired by the Firm converge sharply to the distribution of the baseline ships *after* the acquisition events. The distributions of average speed and catch value are identical across these groups (in the Kolmogorov sense), and the distribution of capacity utilization of treated ships evolves to resemble that of internal ships more closely. This graphical evidence suggests that there is a peculiar way in which the Firm's authority effects behavior and performance over the whole distribution of vertical ships, and that this influence may not be replicable through long-term contracts despite the close relationship between the Firm and its long-term suppliers.

4 Empirical Design

The goal of this study is to assess the impact of authority on firm operations and performance. In terms of expression (3), does authority affect operational variables on the left-hand side, thus leading to higher profits? The institutional details described in Section 2 suggest that the fishing data are appropriate to identify the effect of authority as distinct from other factors driving outcomes. In this section, I detail the assumptions behind the empirical design and the specification for the main tests.

4.1 Identification

Identification is facilitated by the observation of *changes* in ownership brought about by corporate acquisition events. Specifically, at different points in time the Firm decided to more fully integrate backwards, ceasing to become a buyer of its long-term suppliers in order to directly control their operations. Focusing on *asset* (i.e., ship) level changes is justified by the fact that decisions are made by asset operators on the sea in conjunction with the Firm's managers on land, so that authority is directly reflected in such decisions at the micro-level of each ship. The main tests are therefore designed at the level of each ship's operation.

Consider two ships, each serving the downstream plants of the Firm. One of the ships is a long-term external supplier while the other is owned by the Firm. Neither ship is owner-operated. Both ships are guided by catch maximization incentives. At some point, the external ship's operator learns that its owner has changed, becoming the Firm. Under the null that the operation and performance of the ships are random, the ship operators do not care, so the acquisition will have no effect. However, if ownership by the Firm enacts policies affecting the way controlled ships operate, the acquisition will lead to substantial changes in the functioning of the external ship. More broadly, taking the acquisition events as shifting the level of operating control (i.e., authority) differentially in formerly independent ships, a difference-in-differences test would remove biases due to omitted variables or endogeneity concerns (Ashenfelter and Card 1985).

This empirical design requires that long-term contractual ships are acquired for reasons unrelated both to the way ships operate on the sea and to any anticipated reasons of long-term contractual ships to change their behavior after the acquisition. Extensive interviews with the Firm's owners and managers indicate that such changes were not anticipated. (In fact, the results of this paper were surprising to the CEO and other managers). Instead, the Firm motivated its acquisitions in financial terms. Two other advantages of the empirical setting further strengthen the use of corporate acquisitions as a valid shifter in authority: the exogenous variation of *fish* behavior and the quasi-experimental features of the acquisitions. I describe these aspects next.

A. Exogenous variation in fish behavior

Wild fishing is unpredictable in many ways. The geographical location, depth, timing, and abundance of fish vary according to exogenous factors that cannot be anticipated by firms. Specifically, marine biology research shows that fishing companies in Peru fish like natural predators in terms of their spatial strategy (Bertrand et al. 2007), as ships follow closely the actual location of fish in the sea (Bertrand et al. 2008). These patterns suggest that man-made advantages over natural predators may be relatively small. More importantly, the exogenous nature of fish behavior suggests that changes in ship ownership are plausibly uncorrelated with unobserved drivers of fish location, timing, or abundance that subsequently drive fishing operations.[11]

B. Quasi-experimental features of acquisition events

The test structure avoids biases from alternative drivers of behavior and performance

[11] Although natural factors benefit the design through creating randomness in the environment, I cannot explicitly use them to instrument for vertical integration, as this zone of the Pacific ocean does not face any high-frequency shocks that would allow for such kind of test.

such as a change in ship crew composition and economic incentives, relation-specific investments or the threat of holdup because these dimensions were held largely constant after the acquisition events, thereby allowing for the direct observation of the effects of authority. Although the Firm hypothetically could have decided to change these dimensions of vertical relations after its acquisitions, external factors precluded this. Specifically, industry-wide practices discussed in Section 2 suggest that unilaterally changing these dimensions would have been detrimental or useless to the Firm, as the norm of all other firms in the industry was different and suggests equilibrium behavior. The quasi-experimental nature of the acquisitions, therefore, consists in the invariance of competing explanations at the same time that authority varied. Empirical tests of these alternative mechanisms will also be provided in Section 6.

Another important feature of the acquisitions is that the Firm bought *all* the ships of *all* its long-term suppliers 'in block,' so that a selection argument is less likely to drive the results. Untabulated tests confirm this intuition: all formerly affiliated ships continue to be used after the acquisitions, and the number of distinct ships in operation does not go down in the months after the acquisitions.

4.2 Specification

For each trip k the following ship-fixed effects model is estimated:

$$Y_{i,k,t} = \alpha + \beta * Control_{i,t} + \gamma * X_{i,k,t} + \delta_i + \delta_i * \tau_i^2 + \theta_t + \sigma_g + \lambda_l + \epsilon_{i,k,t} \quad (4)$$

where $Control$ is equal to one when the ship i is owned by the Firm, and zero if it is a long-term contractual supplier of the Firm; X are control variables; δ_i is a ship fixed effect;

τ_i^2 is a quadratic term for weeks centered at zero for the date of the large acquisition event, except for the two ships acquired in the smaller event, with quadratic week terms centered at zero for their acquisition date; θ_t is a week fixed effect; σ_g is a fixed effect for the location of departure, equal to the Firm's plant nearest to the point of the departure; and λ_l is a fixed effect for the location of the ship at the point farthest off the coast, equal to the Firm's plant nearest to such location.

The identification conditions discussed in Section 4.1 are further strengthened in specification (4) by the inclusion of ship-level fixed effects, which mitigates an important class of endogeneity that would appear in cross-sectional analysis. For example, suppose that two ships arrive exactly at the same port at the same time but one is vertically integrated while the other is not, and the former has a larger catch than the latter. Unobserved differences inherent to the ship rather to organizational form would lead *Control* to be correlated with output in the cross section even if vertical integration did not cause productivity to improve. These time-invariant unobserved factors are captured by the ship fixed effects, while also leaving in the specification key geographic dummies to better approximate the ideal experiment of comparing the same ship under the same economic conditions only allowing for variation in control. To further distinguish the post-acquisition periods from general trends, the specification is allowed to vary flexibly for each ship over time using a quadratic term for the weeks after the acquisition events interacted with each ship fixed effect (e.g., Snyder 2010). To be conservative, error terms are assumed to be non-independent within ships, so all regressions are estimated clustering standard errors at the level of each ship.

Moreover, the inclusion of exogenous control variables also strengthens specification (4). Five out of the six control variables in $X_{i,k,t}$ are exogenous not only to the Firm but also to all firms in the industry. Fuel prices capture exogenous shocks to the cost of fishing.

Bans on anchovy or white anchovy are dummies reflecting whether government has imposed a ban on fishing these species for fishmeal at the exact location of the landing port at the moment of arrival; these variables control for potential changes in the behavior of ships trying to get into (or out of) a particular zone to avoid penalties. Announced bans on anchovy or white anchovy are dummies for the period immediately preceding (but after the announcement of) the enactment of such bans, thus capturing an increased intensity in fishing behavior. In addition, fish for fishmeal is a dummy that captures technical differences across fishing purposes described in Section 2. This variable becomes fixed immediately after the trip starts, as mandated by government regulation. Overall, the inclusion of these control variables helps distinguish the marginal effect of authority from other drivers of operations and performance.

It is important to note that while the specification in equation (4) accounts for many drivers of behavior and outcomes, it is silent about within-trip coordination between upstream (ships) and downstream (plants) assets that is central to the study of authority in organizations. In a sense, a trip-level specification may be *too coarse* to gauge such interrelations. To gain insight into this process, a more detailed specification at the level of each trajectory point s of ship i's trip k follows the form

$$Y_{i,k,s,t} = \alpha + \beta_1 * Control_{i,t} + \beta_2 * Control_{i,t} \times Z_{i,k,s} + \beta_3 * Z_{i,k,s} + \gamma * X_{i,s,k,t} + \delta_i + \delta_i * \tau^2 + \theta_t + \sigma_g + \lambda_l + \epsilon_{i,k,s,t} \tag{5}$$

where Y is the speed of the ship; $Z_{i,k,s,t}$ are variables capturing plant-level activities in real time, and X includes trip and point of trajectory measures; other variables are analogous to those in specification (4).

In addition to analyzing the impact of the Firm's authority on its newly acquired ships, the design includes tests for the influence of authority on lateral coordination gains of *existing* ships and on downstream production of *plants*. These tests are motivated by the different channels possibly leading to higher profits described in Section 1.

Before implementing the tests, I check that the measurement environment did not change after the Firm acquired its long-term contractual suppliers. Specifically, in an untabulated model, equation (4) is estimated using the number of satellite snapshots per hour traveled as the dependent variable, resulting in a point estimate for β equal to 0.00027 with a t-statistic of 0.01. This orthogonal relationship between ship ownership and satellite measurements indicates that the Firm faced the same information environment with respect to all ships across organizational forms.

5 Results

5.1 Control: Cross-sectional effects within a port-day

A useful baseline to start the analysis is a cross-sectional OLS specification analogous to the one proposed by Lederman and Forbes (2010) for the case of airline flights. Specifically, the effects of authority can be observed across assets for a given port at a given date.[12]

Table 2 shows that control is associated with significant changes in the cross section of fishing trips. Fixed effects for departure port-date combinations and fixed effects for the triple interaction of departure port, arrival port, and arrival date are alternatively used without significantly affecting the statistical or economic significance of control.

[12] Lederman and Forbes (2010) strenghten their baseline OLS analysis with a cross-sectional instrumental variable specification for the proportion of own aircraft used by a carrier in a given route. As described in Section 4.1, my identifying assumption is different from theirs, as I observe *changes* in vertical integration over time *within a given asset* and exploit these changes using ship fixed effects throughout the study.

Two key advantages of the fishing setting for the study of authority must be noted from Table 2. First, the dependent variables provide direct evidence of how firms behave (e.g., whether ships move faster) and how firms perform (e.g., whether catches increase or the asset is better utilized) without the need of further assumptions about profit functions, and with an intuitive link between control, behavior, and performance. Second, the economic value of a fishing trip is largely determined after the trip starts, so that the impact of authority through operations can greatly affect economic outcomes. The baseline specification confirms that these effects are important in the cross section and raise the question of whether *changes* in authority are driving the results, which is the next topic I consider.

5.2 Control and ship operations

Table 3 details the impact of control on fishing operations following equation (4). The first column shows that acquiring control leads to greater distance traveled (t-stat.=2.07) by formerly externally-owned assets. The distance variable, expressed in kilometers, is measured precisely using the satellite measurements for each point in a ship's trajectory and applying the harvesine formula for the curvature of the earth. The second column indicates that control leads to higher average speed per trip (t-stat.=2.80), a variable that divides distance by the precise time elapsed between departure and arrival. The economic significance of this first set of results is quite substantial compared with the mean of the dependent variables and suggests that authority drastically changes the way assets are operated through the exertion of more effort, though the net effect of faster speed and longer distance may be relatively indifferent for the downstream recipients of the catch.

The third column of Table 3, however, reflects a striking pattern in the way optimal routes may be chosen for the return trip. After the acquisition of control, ships have a higher propensity to return to ports that are *not* the nearest to the fishing zone (t-stat.=2.74). The measurements of the beginning of a return trip and the relative location of plants are again obtained through the satellite. In addition to reflecting increased effort, this result suggests that the different needs of plants may substantially affect the level of effort desirable by ship operators in terms of the distance and time to return. Because this decision is costly for ship operators given their opportunity cost to return to a closer port, and cannot be contracted ex ante given the randomness of fish locations, this finding is quite informative about the mechanism through which authority affects behavior.

The increase in within-trip effort shown by these tests is also accompanied by changes in how often the ships go out to fish. The fourth column of Table 3 details that the rest period between trips is significantly reduced by an increase in control (t-stat.=-2.79). Overall, the findings suggest that control brings about more effort in the intensive and extensive margins in aspects that would be difficult to contract outside firm boundaries, and reveal an explicit channel to the well-documented link between vertical integration and operational performance (Lederman and Forbes 2010).

5.3 Control and real-time coordination with downstream plants

To gain insight into the micro-operational changes enabled by authority, Table 4 analyzes variation in speed at each point of a trip's trajectory (e.g., every half-hour), following equation (5). Speed is a particularly important variable in vertical relations, especially in the case of a perishable upstream good that directly influences downstream product quality (Riordan and Sappington 1987). The new specification resembles that of Table 3 but is on average 50 times more disaggregated, thus introducing within-trip controls that reflect the real-time operations of both the ship and the nearby plants.

The first column of Table 4 shows that the micro speed of ships at different points on their fishing trips is significantly higher (t-stat.=3.47) after the acquisition of control, taking into account the time elapsed between departure and the moment of satellite measurement. This baseline result is not surprising in light of the second model of Table 3, but it is reassuring that higher speed is picking up *operations* rather than, for example, changes at the end points of a trip. The second model expands the baseline specification to include the real-time activity of nearby plants, measured in tons of fish received over the last three hours, confirming that control has a strongly positive (t-stat.=3.45) influence on speed. The third column of Table 4 interacts the activity of nearby plants with control to test for the differential sensitivity that newly acquired ships' speed has with respect to the demands of the Firm's plants. The interaction coefficients indicate that control significantly affects the sensitivity of the ship's speed to the Firm's locations, either by making it faster in the case of fishing for fishmeal (t-stat.=5.13) or slower in the case of fishing for seafood (t-stat.=-2.97). Because the downstream processing capacity of the Firm is much larger for fishmeal than for seafood, the asymmetric influence of control reveals different coordination needs depending on the plant type. These findings suggest that ships become more closely linked with plants after being acquired by the Firm.

In contrast to a higher sensitivity of micro ship speed to the Firm's downstream needs, no change is observed in the sensitivity for the needs of *other firms'* needs. The fourth column of Table 4 reveals that control does not affect the sensitivity of a ship's speed to the activity of plants not owned by the Firm, as the interaction term of control with the operation of these plants is insignificantly different from zero. This result suggests that the effects of control are not indiscriminate, consistent with the notion that operations change when authority is exerted within firm boundaries and not otherwise.

5.4 Control and ship performance

Table 5 presents the results of estimating trip-level equation (4) using key performance metrics as dependent variables. The first column shows that the weight of fish catches per trip is significantly increased (t-stat.=3.98) after a change in control, suggesting that formerly externally operated assets become more productive. The second column shows that the dollar value of the catch is also increased by control (t-stat.=1.74). Because crew payments depend on the market value of the catch, this result suggests that control leads to substantially greater payoffs to the crew even though the incentive scheme remains fixed. The third column of Table 5 indicates that assets are also better utilized, as the used capacity of a ship is significantly increased by control (t-stat=3.99).

How does control affect the clients of formerly independent ships? The fourth column shows that the the propensity to sell the catch to firms located at ports other than the Firm's ports is significantly reduced (t-stat.=4.14) after a change in control. By contrast, the fifth column reveals that the overall number of clients (including the Firm) is significantly increased after a change in control (t-stat.=6.73). Together, the findings suggest that the Firm prefers to internalize the productivity gains through its downstream processing capabilities, while at the same time it appropriates the residual profits of selling part of the catch more efficiently to more local buyers without foreclosing them.

Should these large performance effects be interpreted as being only partial, given the greater depreciation of ships in the long run due to higher effort? In untabulated tests of means, I find that the age of formerly external ships is statistically the same as that of the Firm's own ships, so that the results are not due to some kind of equalization of life cycles. It is also worth noting that the most valuable asset of a ship is not its tangible dimension (e.g., structure, engine) but the fishing license attached to it in perpetuity by Government.[13]

5.5 Are there lateral gains accruing to owned ships?

The acquisition of control over external assets may produce operational changes in the *existing* assets of the acquiring firm. This question is important, as the implications of this channel linking authority and firm performance can be quite different from those derived from focusing only on the newly acquired assets. The existence of such effects would be consistent with an effect of authority on function $g(\cdot)$ in expression (3), for example, through lateral coordination gains accruing to owned ships.

To gain insight into this issue, Table 6 models the differential effect of acquiring control on the performance of ships that were owned by the Firm before the large acquisition event, by comparing them with *themselves* and with *equivalent ships of all other firms in the industry.* To obtain valid inferences, the comparable ships should also be vertically integrated and should *not* have undergone any acquisition event affecting them or the firms to whom they belong. The sample is limited to the time window 1 January 2006 to 31 July 2008, and the information on external ships is based on government data, which are less detailed than those on the Firm's long-term suppliers.

Difference-in-differences models of the lateral effects of gaining control on the Firm's

[13] According to the Notes to the Audited Financial Statements of the Firm, "fishing licenses are considered intangible assets with indefinite life; consequently, they are not subject to depreciation . . . Re-valuations of these assets are conducted with sufficient regularity to ensure that their book value does not significantly differ from a reasonable value."

existing ships are displayed in Table 6. The coefficient of interest is the interaction between a dummy for ships owned by the Firm and a dummy for the post-acquisition period. The results suggest that no lateral performance gains are achieved through the acquisition of control, as the point estimates on weight of catch, resale, and clients served cannot be statistically distinguished from zero. Thus, the lateral channel for authority is not supported empirically.

5.6 Control and downstream production policies

The benefits of better *upstream* operations and performance might be reflected in *downstream* operations and performance. The detailed information on the fishmeal segment of the Firm and the industry allows for such tests.

Table 7 reports difference-in-differences models of fishmeal plant production activities around the large acquisition of long-term suppliers pursued by the Firm. Information is collapsed at the plant-month level and includes observations on all plants of the Firm and all plants of comparable firms in the industry. For the experiment to be valid, the comparable plants should also be vertically integrated and should *not* have undergone any acquisition event affecting their upstream fishing capabilities. Analogously to the tests of the lateral channel just described, the sample is limited to the time window 1 January 2006 to 31 July 2008. All specifications include plant fixed effects and month fixed effects. Plant-month level control variables are also included in the analysis.

The results in Table 7 show that the acquisition of its long-term suppliers enact important changes in downstream production. The Firm's plants smooth their fishmeal production, increasing their days of operation per month (t-stat.=2.62). Moreover, the plants do not decrease their yield after the acquisition of upstream control, as the coefficient on the fishmeal yield per ton of fish received is not statistically significant. However, the Firm significantly increases its production of high-quality fishmeal (t-stat=1.86), thus achieving a more profitable product mix, as high quality fishmeal trades at a premium. These results are suggestive that the upstream improvements in effort and speed, the higher sensitivity of fishing ships to internal plant demands, and the greater productivity in catches are not only generating cost savings but also directly enhancing revenue.

6 Mechanisms for the Impact of Control

Why does control enhance operations and performance? The evidence suggests that the main mechanism at work in this setting is coordination and deployment. This section reports empirical tests of this mechanism along with alternative explanations that do not receive empirical support.

6.1 Coordination and Deployment

With more authority over its formerly external suppliers, the Firm might be able to more efficiently deploy ships in a joint-maximization fashion among themselves and with plants. While Table 3 revealed changes in ship operations, these changes are the micro counterpart of a higher-order scheme seeking economies of scope and coordination at the firm level. Such analysis requires going beyond ship-level efficiency to assess the operations of the *fleet*. To analyze this fleet deployment mechanism, a key advantage of the data is the observation of distinct *fleet* affiliations before becoming part of the Firm.

Table 8 presents regressions at the fleet-week level for weeks before and after the acquisition of control.[14] The coefficient of interest is the interaction of whether the fleet is to be acquired by the Firm (that is, whether it is an external long-term supplier) and a dummy for the period post acquisition by the Firm. The fleets studied are those owned by the Firm before the large acquisition event, and those owned by its long-term contractual suppliers before the large acquisition event. In essence, the design of Table 8 tests whether formerly external fleets change their deployment after the acquisition of control.

The first column of Table 8 shows that the geographic coverage of an external fleet increases significantly (t-stat.=2.11) after being acquired by the Firm. The dependent variable reflects the distance between the extreme ends of a fleet's coverage by taking the northern and southern ends of where its ships are fishing at any point during a given week.[15] The results indicate that the acquisition of control leads to a wider coverage of the sea by formerly independent fleets.

The second column of Table 8 reports that fleet dispersion is significantly increased after the external fleets are absorbed into the Firm. Fleet dispersion is defined as the standard deviation of a fleet's ship latitudes at every point of their fishing operations during a given week. In contrast with the fleet coverage measure, the dispersion measure is less affected by outlier trajectories and reflects the density of a given fleet throughout the coast. The strong (t-stat.=2.54) change post acquisition for the formerly contractual fleets indicates that the Firm redeployed its newly acquired ships to position themselves farther from one another under a coordination scheme that drastically differed from their prior owners'.

[14]The sample for the new tests starts after the small acquisition event, to focus on the large acquisition events towards the latter part of the sample.

[15]The coverage measure is particularly appropriate in the case of the Peruvian coastline because of its relatively straight north-south orientation.

In addition to changing the range and density of operations, control affects the responsiveness of fleets to orders from land by making them operate closer to the coastline. The third column of Table 8 shows that a fleet's mean distance from the coast is significantly (t-stat.=-3.30) reduced after the acquisition of control by the Firm. This result is also important to understand that not every dimension of geographical deployment is unboundedly growing after the acquisition of control.

Taken together, the evidence on greater coverage, lower density, and closer operation to the coast suggests that the acquisition of control is accompanied by substantial changes in fleet deployment that are consistent with a new joint-optimization process in the vertical chain.[16] Next I provide quantitative evidence on alternative mechanisms that were explained away qualitatively through first-hand evidence on the industry and the Firm but that can be better understood through data analysis.

6.2 Internal Personnel Policies

Did the newly acquired ships change their behavior and performance because of changes in human capital after integration? Qualitative evidence from interviews suggests that this was not the case, as the Firm largely maintained the prior internal organization of ships. While the ideal data set to study potential changes would include internal team structures before the acquisition for all ships, such data are not available for the newly acquired ships. Instead, a detailed test of the internal personnel mechanism is conducted by looking at the evolution of personnel variables *after* vertical integration is enacted. Specifically, using ship-month as

[16] The advantage of this fleet-specific analysis is the difference-in-differences nature of the tests. In an untabulated pre and post analysis of the *Firm*'s overall geographic coverage, I find that it does *not* increase with the acquisition of long-term suppliers. This finding is important to conclude that the Firm is not shifting to a completely different way of operating; rather, it is bringing its newly acquired ships to the standards of operation and performance already in place for vertically owned ships.

the unit of observation, the following equation can be estimated:

$$Y_{i,m} = \alpha + \beta * Acquired_i * \theta_m + \theta_m + \delta_i + \epsilon_{i,m} \tag{6}$$

in which β captures differences in personnel policies $Y_{i,m}$ between formerly external ships (i.e., $Acquired_i = 1$) and the Firm's own ships. Because the months observed, m, are always posterior to the vertical integration events, β is not a difference-in-differences estimator. This coefficient is still informative in the perspective of the monthly evolution of the difference after the acquisition events.

Table 9 reports estimates of equation (6) using ship turnover, poaching, and span of control as dependent variables. Turnover is defined as the beginning-of-month crew size plus the new crew members minus the end-of-month crew size, all divided by the beginning-of-month crew size. Poaching is the fraction of distinct new members of the ship crew that come from the *opposite* group; for ships owned by the Firm before the acquisition event, the opposite group is the fleets of long-term contractual suppliers; for ships owned by the long-term contractual suppliers, the opposite group is the fleet of the Firm. Span of control is the total frequency of lower-ranked ship members divided by the total frequency of higher-ranked ship crew members (i.e., captain, first mate, and ship engineer).

The results in Table 9 indicate that no statistically significant differences in internal ship personnel policies are observed in the post-integration period across ship groups. The lack of significant differences in turnover and poaching suggests that the mechanism for changes in behavior and performance found in this paper is not a change in people or skill aboard a ship. Moreover, the lack of significant differences in the internal span of control of ships suggests that authority is not binding differently *within* teams but *over* teams, as the main construct of authority is that accruing to Firm's managers on land to maximize efficiency over the entire value chain.

6.3 Technology Improvements

An alternative mechanism for the increased effort and performance after the acquisition of control is an increased technological competence enacted through larger investments. However, the institutional background makes investment a relatively minor mechanism here. Specifically, there are no relation-specific investments in this industry and ship load capacity is capped by regulation. Undeniably, better ships can traverse farther distances and obey the coordination schemes of the Firm more effectively, so a technology mechanism would be partly consistent with the deployment mechanism for authority. To the extent that all regressions include ship-fixed effects, these technology improvements must be incremental and could be observed through maintenance expenses on ships.

In this logic, the ideal data set for a test of the technology improvement mechanism would observe detailed maintenance expenses for owned and external ships before and after becoming part of the Firm. Unfortunately, expenses in the pre-integration period are not observed for external ships, so a more limited test is based on post-integration differences in maintenance expenses. In untabulated tests of differences in means, I find that the budgeted maintenance expenses, executed maintenance expenses, and the ratio of executed over budgeted expenses are always indistinguishably different across owned and formerly-external ships. This insignificance suggests that the Firm invests in maintenance similarly across these kinds of ships. These tests are suggestive that the technology argument for increased effort and higher performance is not validated empirically.

6.4 Reduction of Holdup Risk

Even in the absence of bilateral dependency or relation-specific investments, the fishing setting may involve some kind of market power argument potentially alleviated through integration. Specifically, the racing environment in fishing for fishmeal puts independent ships at a disadvantage with respect to downstream plants or integrated ships. Under this mechanism, the increased effort and performance found throughout would be linked to vertical integration but not to *authority*, as the driver of efficiency would be the alleviation of vertical frictions. This is an unlikely explanation of the results found here for several reasons. First, the Firm and its suppliers are active in fishing for seafood (i.e., 44% of the trip-level observations), so that racing arguments are arguably nonexistent in that portion of the sample. Second and more importantly, the only subjects of study here are the Firm and its long-term contractual suppliers, that is, a very uniform sample that excludes any other types of vertical relations that may be more subject to frictions. Third, the Firm stands out among other firms in the industry for treating its own ships and its supplying ships equitably with regard to docking operations. This firm-specific characteristic was gauged through multiple interviews and suggests that the holdup mechanism for improved performance is unlikely.

To test for the holdup mechanism more formally, I employ data on ships' time in a queue before unloading. Note that this data item is unobserved even by the satellite, as a ship's positions are only measured every half-hour and would then be too coarse. I use internal minute-by-minute data for a clean test. In an untabulated regression following equation (4) exactly, I find that the wait times of ships after fishing for fishmeal are not significantly changed (t-stat.=-0.81) through the acquisition of control. In other words, vertical integration does not significantly reduce wait times of formerly independent contractual ships, suggesting that a reduction in holdup risk is not observed in the data.

7 Conclusion

In this paper I study the effect of authority on asset operations and performance. I make use of corporate acquisitions conducted by a large vertically integrated fishing firm that decided to more fully integrate backwards by acquiring long-term contract supplying ships to operate them jointly with its own fleet. I find that authority leads to an increase in fishing effort and speed, improved coordination with downstream plants, higher productivity, and higher downstream product quality. Authority is found to influence operations and performance through a coordination and deployment mechanism. Specifically, with more control over its formerly external ships, the Firm can efficiently deploy them in a joint-maximization fashion with one another and with downstream plants.

More broadly, the results suggest that property-based authority enables firms to achieve substantially better results than long-term contractual relationships. Importantly, the greater effort in coordinating upstream and downstream operations enacted by authority can create value not only for residual claimants but also for asset operators and clients.

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Figure 1: Assets, Sales, and Own Fleet Captures of The Firm

The figure plots end-of-year assets in book value (in local currency), yearly sales (in local currency), and yearly catches of ships owned by the Firm (in tons). All series are indexed with respect to year 9, the year preceding the acquisition of the long-term contractual suppliers by the Firm. The acquisition was enacted towards the end of year 10, with the precise date omitted for confidentiality.

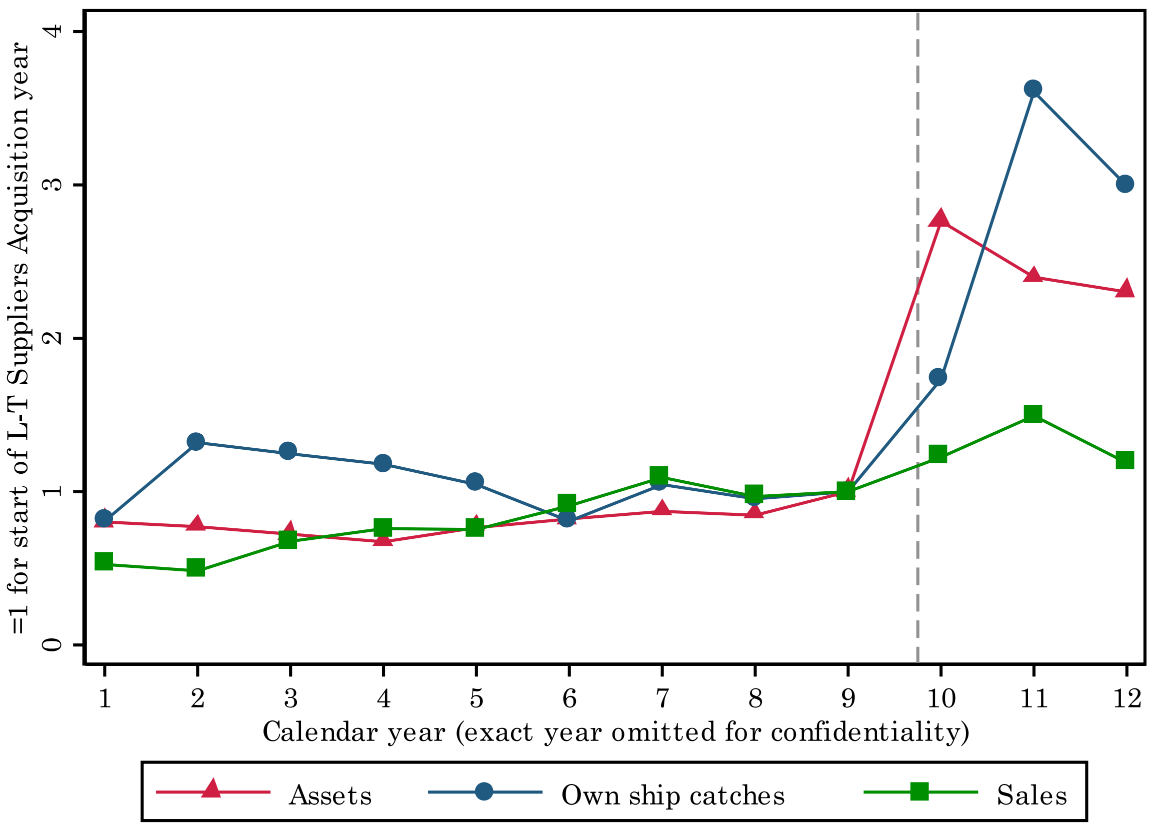


Figure 2: Satellite Snapshots of Ship Trajectories

The Cartesian maps show two trips of the same ship, before and after being acquired by the Firm, both times fishing for fishmeal and obtaining similar output (low). The solid squares are points in each trajectory, labeled with the ship's speed in km/hour rounded to integers (bottom map). The small dots represent the coastline, East of which there is land.

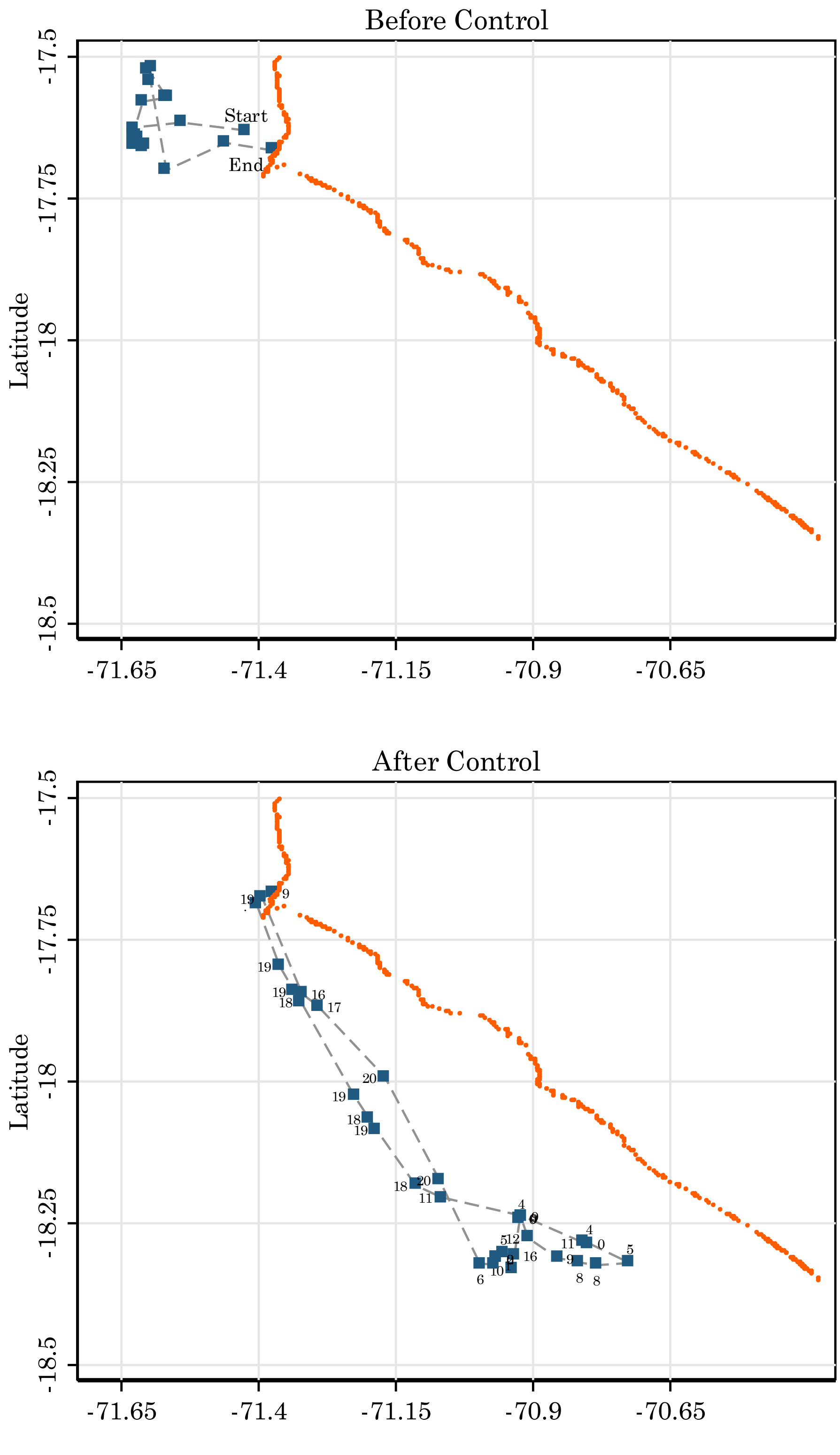
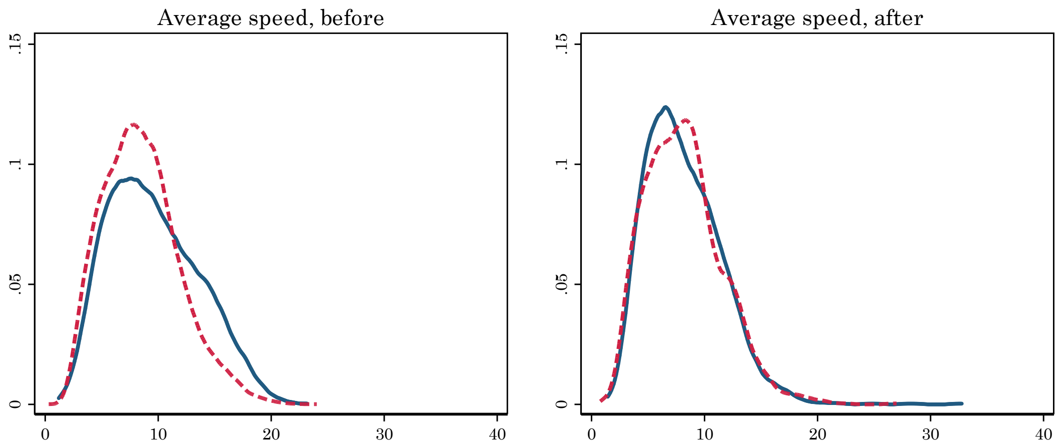


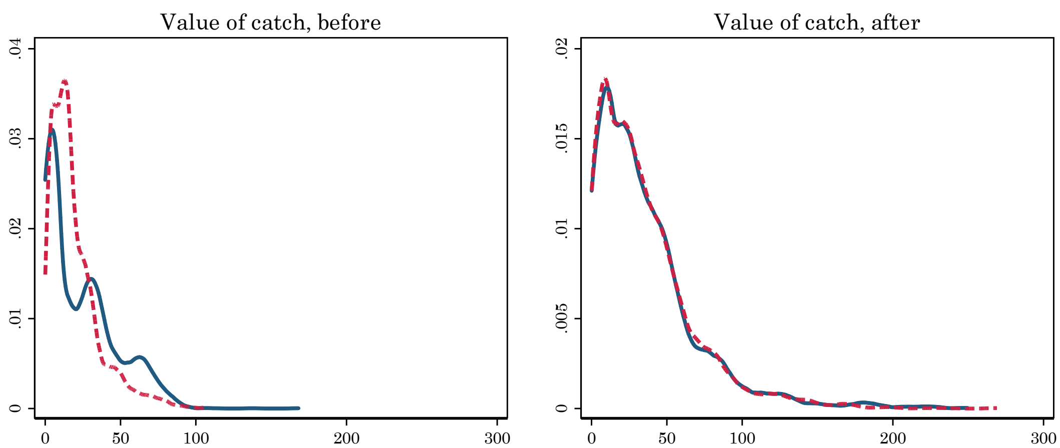
Figure 3: Kernel density of Speed, Value, and Capacity Utilization

Observations are at the trip level. The kernel densities show average speed (Panel I), dollar values of catches in $000 (Panel II) and the utilization of the ship's storage capacity (Panel III) for long-term suppliers that become controlled by the Firm through acquisitions (in dashed lines) and all other ships of the Firm (solid line) for the periods before (left-hand side charts) and after (right-hand side charts) the acquisition events. The plots use the Epanechnikov kernel with a bandwidth that would minimize the mean integrated squared error if the data were Gaussian and a Gaussian kernel were used.

Panel I



Panel II



Panel III

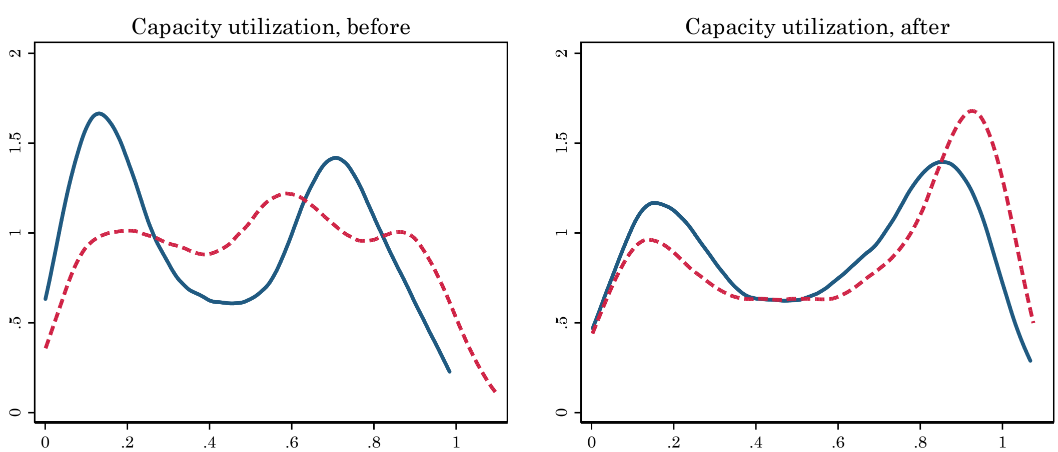


Table 1: Summary Statistics

The table reports trip-level and satellite snapshot-level variables on the complete records of the Firm for the period 1 January 2003 to 20 April 2010. The sample focuses exclusively on all controlled (i.e., owned) ships and all the long-term supply allies of the Firm. Control is a dummy for whether the ship is owned by the Firm, and zero for whether the ship is under a long-term supply contract with the Firm. Fuel price is a daily series of price per gallon of diesel expressed in dollars after national taxes. Fish for fishmeal is a dummy equal to one when the purpose of the trip is to catch fish for fishmeal, and zero when the purpose is to catch fish for seafood; by regulation, the purpose of a trip is always determined in advance so it is not contingent upon within-trip decisions. Ban is a dummy for whether there is a ban on fishing anchovy for fishmeal that day at the location of landing. Announced ban is a dummy for the days between government's announcement of a ban and the day of enactment of the ban. Equidistance is a dummy for whether the ship is geographically indifferent between two plants of the Firm when reaching the maximum distance point off the coast; Equidistance is thus a dummy equal to one for the top 10% observations in terms of the ratio of distance to second-closest plant over distance to closest plant. Speed is the geographic distance between the current snapshot and the previous snapshot of the satellite for the same ship divided by the time elapsed; geographic distance is calculated using satellite-measured coordinates and the harvesine formula that takes into account the curvature of the earth. Closest Fishmeal (FM) Landings is the sum of the tons for fishmeal received by the Firm's plant closest to this point of navigation over the last three hours, and Closest Seafood (SF) Landings is the equivalent measure for seafood fish. Closest External FM landings measure the total weight of fish for fishmeal received by firms *other than the Firm* and supplied by ships *other than* the Firm's or its long-term contractual suppliers on the previous day; the analogous variable is calculated for fish-for-seafood fishing. Panel III describes the evolution of control among the N ships of the Firm or its long-term contractual suppliers, where the precise value of N is omitted for confidentiality. Summary statistics (mean) of the dependent variables used in the empirical analysis are reported in each table of results.

I. Trip-level variables (n=13,529)	Mean	Median	Std. dev.	Min.	Max.
Control	0.51	1.00	0.50	0.00	1.00
Average speed	8.58	8.20	3.52	0.31	32.76
Weight of catch	203.34	177.44	150.29	0.05	624.97
Value of catch, $000	25.34	17.82	24.97	0.01	269.03
Fuel price	2.37	2.42	0.36	0.48	3.16
Ban on anchovy	0.22	0.00	0.42	0.00	1.00
Ban on white anchovy	0.19	0.00	0.39	0.00	1.00
Announced ban on anchovy	0.09	0.00	0.28	0.00	1.00
Announced ban on white anchovy	0.08	0.00	0.27	0.00	1.00
Fish for fishmeal	0.56	1.00	0.50	0.00	1.00
II. Satellite snapshot-level variables (n=689,084)	Mean	Median	Std.dev.	Min.	Max.
Control	0.57	1.00	0.50	0.00	1.00
Speed (kms/hour)	9.54	8.31	7.80	0.00	220.91
Nearest FM Landings last 3 hours	0.15	0.00	0.26	0.00	3.02
Nearest SF Landings last 3 hours	0.01	0.00	0.06	0.00	1.84
Nearest External FM Landings, last day (n=558,602)	2.96	1.03	4.23	0.00	31.73
Nearest External SF Landings, last day (n=558,602)	0.06	0.01	0.23	0.00	9.85
Time traveled	29.56	17.85	35.21	0.02	397.00
III. Ship-level description	Count				
Total number of ships	$50 < N < 100$				
Always control, no long-term contract	$\approx 0.37N$				
First long-term contract, then control	$\approx 0.60N$				
Always long-term contract	$< 0.03N$				

Table 2: Cross-Sectional influence of Control within Port-Day combinations

The observations are at the trip level and include all trips of the Firm's ships or its long-term contractual suppliers. The variable of interest is control. Average speed (kms/hr) divides distance traveled over time elapsed between departure and arrival. Value of catch is quantity times price, in \$000. Capacity used is the weight of the catch divided by the capacity of the ship. t-statistics clustered at the port-day or port-port-day level are reported.

Dependent Variable:	**Average speed**		**Value of catch**		**Capacity used**	
	(2.1)	(2.2)	(2.3)	(2.4)	(2.5)	(2.6)
Control	0.671***	0.325***	6.073***	5.166***	0.019**	0.019**
	(6.72)	(3.53)	(11.83)	(9.16)	(2.40)	(2.16)
Fish for fishmeal	0.248***	0.197***	−1.368**	−1.464**	0.010	0.005
	(3.31)	(2.71)	(−2.29)	(−2.19)	(1.60)	(0.74)
Departs 2am-5am	−0.021	0.028	−0.794	−1.010	−0.025*	−0.026
	(−0.11)	(0.14)	(−0.70)	(−0.80)	(−1.78)	(−1.57)
Departs 5am-8am	−0.401**	−0.355*	−1.263	−1.920	−0.027*	−0.032*
	(−2.03)	(−1.81)	(−1.10)	(−1.53)	(−1.84)	(−1.89)
Departs 8am-11am	−0.068	−0.406*	0.653	−0.237	−0.007	−0.008
	(−0.29)	(−1.92)	(0.51)	(−0.17)	(−0.42)	(−0.40)
Departs 2pm-5pm	0.343	0.034	1.042	−0.458	0.008	−0.001
	(1.55)	(0.16)	(0.74)	(−0.30)	(0.49)	(−0.04)
Departs 5pm-8pm	0.490**	0.382*	0.277	−0.762	0.019	0.008
	(2.40)	(1.94)	(0.21)	(−0.53)	(1.26)	(0.46)
Departs 8pm-11pm	0.490**	0.443**	−0.679	−1.337	0.000	−0.009
	(2.53)	(2.38)	(−0.57)	(−1.02)	(0.00)	(−0.55)
Departs 11pm-2am	0.348*	0.325*	0.176	−0.345	−0.010	−0.013
	(1.78)	(1.75)	(0.15)	(−0.26)	(−0.71)	(−0.82)
Fixed effects:						
Departure Port-Date	Yes		Yes		Yes	
Departure Port-Arrival Port-Date		Yes		Yes		Yes
Mean of dependent variable	8.571	8.571	25.357	25.357	0.525	0.525
R^2	0.67	0.80	0.72	0.78	0.70	0.75
Number of clusters	3539	4693	3539	4693	3539	4693
n	13529	13529	13529	13529	13529	13529

***, **,* significant at the 1%, 5% and 10% level. Standard errors are heteroskedasticity-robust and clustered by D.port-date (1,3,5) or D.port-A.port-date (2,4,6).

Table 3: Control and Operations

The observations are at the trip level and include all trips of the Firm's ships or its long-term contractual suppliers. The variable of interest is control. Distance traveled (kms.) is measured using all the points of the navigation trajectory between the point of departure and the point of landing using coordinates and the harvesine formula for the curvature of the earth. Return to farther point is a dummy based on the location of the ship at the farthest point off the coast, and is equal to one when the ship does *not* return to the Firm's closest plant to that point. Average speed (kms/hr) divides distance traveled over time elapsed between departure and arrival. Rest between trips is the difference in hours between the time of departure of the current trip and the time of arrival from the previous trip (resulting in dropping N observations totaling the initial trip of each ship). t-statistics based on ship-level clusters $50 < N < 100$ are shown in parentheses, with N omitted for confidentiality.

Dependent Variable:	**Distance traveled**	**Average speed**	**Return to farther port**	**Rest between trips**
	(3.1)	(3.2)	(3.3)	(3.4)
Control	37.051**	0.830***	0.068***	−108.113***
	(2.07)	(2.80)	(2.74)	(−2.79)
Fuel price	−56.771	0.110	−0.019	147.316
	(−1.23)	(0.18)	(−0.23)	(1.02)
Ban on anchovy	−1.023	0.275	0.080***	−60.634
	(−0.07)	(1.25)	(3.09)	(−1.00)
Ban on white anchovy	157.171***	0.669***	0.113***	60.708
	(9.54)	(3.29)	(3.83)	(0.94)
Announced ban on anchovy	2.731	1.089***	−0.015	−77.916***
	(0.18)	(3.06)	(−0.37)	(−3.02)
Announced ban on white anchovy	42.395**	−0.815*	0.093**	66.087**
	(2.36)	(−2.00)	(2.11)	(2.42)
Fish for fishmeal	−44.398***	0.088	0.164***	73.405***
	(−3.99)	(1.61)	(12.01)	(6.59)
Fixed effects:				
Ship	Yes	Yes	Yes	Yes
Week	Yes	Yes	Yes	Yes
Firm's plant closest to departure port	Yes	Yes	Yes	Yes
Firm's plant closest to max.distance	Yes	Yes	Yes	Yes
Quadratic week term× Ship F.E.	Yes	Yes	Yes	Yes
Mean of dependent variable	304.11	8.57	0.23	138.19
R^2	0.78	0.44	0.34	0.23
n	13529	13529	13529	13529−N
Number of clusters	N	N	N	N

***, **,* significant at the 1%, 5% and 10% level. Standard errors are heteroskedasticity-robust and clustered by ship.

Table 4: Control and Real-Time Vertical Coordination

The observations are at the satellite snapshot level and include all trips of the Firm's ships or its long-term contractual suppliers. The variable of interest is control in levels and interacted with the level of activity of nearby fishmeal (FM) or seafood (SF) plants, either the Firm's or others'. The dependent variable is speed, measured between each two consecutive snapshots of the satellite for a given ship using the difference in geographical location and time from the previous snapshot. The fourth model includes detailed daily information on all firms in the industry, which is available only through July 2008, resulting in fewer observations than in the other three models. The table omits reporting all the control variables of Table 3 for brevity, though they are also included in the estimation. *t*-statistics based on ship-level clusters $50 < N < 100$ are shown in parentheses, with N omitted for confidentiality.

	Dependent Variable: **Speed**			
	(4.1)	(4.2)	(4.3)	(4.4)
Control	0.703***	0.711***	0.611***	1.065***
	(3.47)	(3.45)	(3.16)	(4.72)
Control × Nearest Firm's FM Landings, last 3 hours			1.216***	0.474**
			(5.13)	(2.08)
Control × Nearest Firm's SF Landings, last 3 hours			−3.293***	−2.121*
			(−2.97)	(−1.94)
Nearest Firm's FM Landings, last 3 hours		0.439***	−0.305**	0.043
		(3.88)	(−2.21)	(0.32)
Nearest Firm's SF Landings, last 3 hours		3.778***	5.946***	6.072***
		(6.78)	(6.99)	(7.31)
Control × Nearest External FM Landings, last day				−0.015
				(−0.75)
Control × Nearest External SF Landings, last day				−0.542
				(−1.24)
Nearest External FM Landings, last day				−0.191***
				(−13.48)
Nearest External SF Landings, last day				−0.306
				(−0.79)
Time traveled	−0.016***	−0.017***	−0.017***	−0.018***
	(−11.36)	(−11.37)	(−11.34)	(−10.27)
Additional control variables as in Table 3	Yes	Yes	Yes	Yes
Fixed Effects:				
Ship	Yes	Yes	Yes	Yes
Week	Yes	Yes	Yes	Yes
Firm's plant closest to departure port	Yes	Yes	Yes	Yes
Firm's plant closest to max.distance	Yes	Yes	Yes	Yes
Quadratic week term× Ship F.E.	Yes	Yes	Yes	Yes
Mean of dependent variable	9.544	9.544	9.544	9.768
R^2	0.15	0.15	0.15	0.17
n	689084	689084	689084	558602
Number of clusters	N	N	N	N

***, **,* significant at the 1%, 5% and 10% level. Standard errors are heteroskedasticity-robust and clustered by ship.

Table 5: Control and Performance

The observations are at the trip level and include all trips of the Firm's ships or its long-term contractual suppliers. The variable of interest is control. Weight of catch is in tons (000 of kilos) of the catch landed at the port. Resale at other ports is a dummy for whether the ship lands at a port different from the Firm's ports to sell the fish to an external client. Clients served is the count of internal or external clients (including the Firm) for the catch of the ship. $ Value of catch is the weight of the catch multiplied by the price of the fish caught. t-statistics based on ship-level clusters $50 < N < 100$ are shown in parentheses, with N omitted for confidentiality.

Dependent Variable:	**Weight of catch**	**$ Value of catch**	**Capacity utilization**	**Resale at other ports**	**Clients served**
	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)
Control	44.248***	5.449*	0.078***	−0.065***	3.236***
	(3.98)	(1.74)	(3.99)	(−4.14)	(6.73)
Fuel price	−11.831	3.265	−0.122*	−0.063*	0.615
	(−0.36)	(0.39)	(−1.95)	(−1.73)	(0.89)
Fish for Fishmeal	3.157	−2.993***	−0.002	−0.080***	−1.069***
	(1.20)	(−4.18)	(−0.29)	(−8.59)	(−3.79)
Ban on anchovy	6.123	−0.101	−0.001	0.007	−0.572**
	(0.96)	(−0.08)	(−0.07)	(0.51)	(−2.20)
Ban on white anchovy	−17.465**	0.261	−0.018	−0.002	1.692***
	(−2.16)	(0.17)	(−1.07)	(−0.09)	(5.58)
Announced ban on anchovy	10.985	2.278**	0.026	−0.009	−0.065
	(1.54)	(2.47)	(1.46)	(−0.54)	(−0.50)
Announced ban on white anchovy	−7.882	−1.343	−0.014	0.029	0.426***
	(−0.94)	(−1.22)	(−0.66)	(1.51)	(3.14)
Fixed effects:					
Ship	Yes	Yes	Yes	Yes	Yes
Week	Yes	Yes	Yes	Yes	Yes
Firm's plant closest to departure port	Yes	Yes	Yes	Yes	Yes
Firm's plant closest to max.distance	Yes	Yes	Yes	Yes	Yes
Quadratic week term× Ship F.E.	Yes	Yes	Yes	Yes	Yes
Mean of dependent variable	203.436	25.357	0.525	0.067	1.854
R^2	0.65	0.65	0.53	0.26	0.51
n	13529	13529	13529	13529	13529
Number of clusters	N	N	N	N	N

***, **,* significant at the 1%, 5% and 10% level. Standard errors are heteroskedasticity-robust and clustered by ship.

Table 6: Control and Lateral Performance

The observations are at the trip level. The period is between 1 January 2006 and 31 July 2008. The observations include all trips of the ships *owned by the Firm before it acquired* its long-term supplying firms in the large acquisition event, as well as all trips of vertically integrated firms' ships that do not pursue or are subject to any ship acquisition during the sample period. Weight of catch is in tons (000 of kilos) of the catch landed at the port. Resale at other ports is a dummy for whether the ship lands at a port different from the Firm's ports to sell the fish to an external client. Clients served is the count of internal or external clients (including the Firm) for the catch of the ship. t-statistics based on ship-level clusters $M < 50$ are shown in parentheses, with M omitted for confidentiality.

Dependent Variable:	**Weight of catch**	**Resale at other ports**	**Clients served**
	(6.1)	(6.2)	(6.3)
The Firm × Post period	−2.672	0.014	−0.040
	(−0.22)	(0.32)	(−0.27)
Fuel price	153.397	−0.212	0.242
	(1.03)	(−0.56)	(0.35)
Ban on anchovy	−26.631***	0.001	−0.128**
	(−5.09)	(0.09)	(−2.51)
Ban on white anchovy	−21.198*	−0.082**	0.222
	(−1.79)	(−2.72)	(1.69)
Announced ban on anchovy	−25.683**	0.004	−0.048
	(−2.52)	(0.22)	(−1.07)
Announced ban on white anchovy	22.370*	0.008	0.046
	(2.06)	(0.35)	(0.84)
Fish for Fishmeal	178.458***	−0.016	−1.939***
	(7.02)	(−0.49)	(−7.19)
Fixed effects:			
Ship	Yes	Yes	Yes
Week	Yes	Yes	Yes
Arrival port	Yes	Yes	Yes
Quadratic week term× Ship F.E.	Yes	Yes	Yes
Mean of dependent variable	136.842	0.623	1.324
R^2	0.67	0.88	0.64
n	3844	3844	3844
Number of clusters	M	M	M

***, **,* significant at the 1%, 5% and 10% level.

Standard errors are heteroskedasticity-robust and clustered by ship.

Table 7: Control and Downstream Production

The observations are at the plant-month level and include all months of the fishmeal seasons between 1 January 2006 and 31 July 2008. The sample is all fishmeal plants of the Firm and all plants of vertically integrated fishmeal processing firms that do not pursue or are not subject of any upstream acquisition during the sample period. Post period is defined as the months after the Firm gains control of its long-term supplying ships. Days operating is the count of day of each month when the plant is processing fish for fishmeal. Yield is the ratio of fishmeal tons over fish tons that enter each plant each month. High quality fishmeal is super prime and prime fishmeal, defined by IFFO. Regular fishmeal is FAQ fishmeal, defined by IFFO. The ratio of vertical ships over all ships is based on distinct ships unloading at the plant that month. Normalized port catches are the monthly port catches divided by the 75th-percentile monthly catch for that port over the whole history of fishmeal season months between January 1998 and July 2008. t-statistics based on plant-level clusters $P < 20$ are shown in parentheses, with P omitted for confidentiality.

Dependent Variable:	**Days operating**	**Yield**	**High Quality Fishmeal tons**	**Regular Fishmeal tons**
	(7.1)	(7.2)	(7.3)	(7.4)
The Firm × Post period	2.286**	−0.022	1496.790*	−112.907
	(2.62)	(−1.65)	(1.86)	(−1.14)
(Vertical ships/All ships)$_{i,k,t}$	−0.287	0.010	−2284.295	68.742
	(−0.20)	(0.34)	(−1.17)	(0.20)
Normalized Port Catches$_{k,t}$	1.389**	0.007	186.075	−28.976
	(2.95)	(1.31)	(0.48)	(−0.47)
Fixed effects:				
Plant	Yes	Yes	Yes	Yes
Month	Yes	Yes	Yes	Yes
Mean of dependent variable	8.68	0.23	2792.50	226.48
R^2	0.72	0.56	0.74	0.74
n	91	88	91	91
Number of clusters	P	P	P	P

***, **,* significant at the 1%, 5% and 10% level. Standard errors are heteroskedasticity-robust and clustered by plant.

Table 8: Control and Fleet Deployment

The observations are at the fleet-week level and include all weeks with fishing operations between May 2004 and April 2010. A fleet is defined as a set of ships linked by common ownership before the large acquisition event that brought long-external suppliers into the Firm. Fleets are therefore observed as distinct units of analysis before and after the large acquisition event, even if after such event they were fully integrated into a single fleet of the Firm. The ships whose fleets are studied are only those owned by the Firm before the large acquisition event, and those owned by its long-term contractual suppliers before the large acquisition event. The total number of fleets analyzed is therefore greater than or equal to two, with the exact number omitted for confidentiality. Acquired fleet is a dummy equal to one for the long-term supplier fleets, and zero for the Firm's existent fleet. Post is a dummy equal to one for months after the large acquisition event. The coefficient of interest is on the interaction of Acquired fleet and Post. Geographic coverage is the distance in kilometers between the extreme coordinate points (north and south) of ships' locations in a given week. Geographic dispersion is the standard deviation of a fleet's ship latitudes in a given week. Mean distance from coast is calculated over all ship locations of a fleet in a given week. No clustering of standard errors is possible because the number of subjects (i.e., fleets) is by design small.

Dependent Variable:	**Geographic Coverage**	**Geographic Dispersion**	**Mean Distance from Coast**
	(8.1)	(8.2)	(8.3)
Acquired Fleet × Post	121.341**	0.345**	−2.930***
	(2.11)	(2.54)	(−3.30)
Fixed effects:			
Fleet	Yes	Yes	Yes
Week	Yes	Yes	Yes
Mean of dependent variable	571.492	1.870	15.803
R^2	0.70	0.77	0.85
n	640	640	640

***, **,* significant at the 1%, 5% and 10% level.

Table 9: Evolution of Ships' Internal Personnel Policies after Control

The observations are at the ship-month level and include all months between the date of the large acquisition event and the end of the sample period, April 2010. The sample is all the ships owned by the Firm or its long-term contractual suppliers before the large acquisition event. The total number of ships, K, is less than N because it excludes ships that were not previously owned by the Firm or by its long-term suppliers and yet were acquired by the Firm at that time. Turnover is measured over all member of a ship's crew during the month. Poaching is the fraction of distinct new members of the ship crew that come from the *opposite* group; for ships owned by the Firm before the acquisition event, the opposite group is the fleets of long-term contractual suppliers; for ships owned by the long-term contractual suppliers, the opposite group is the fleet of the Firm. Span of control is the total frequency of lower-ranked ship members divided by the total frequency of higher-ranked ship crew members (i.e., captain, first mate, and ship engineer) in a month. Regressors are a dummy for each month relative to the acquisition event interacted with Acquired, a dummy equal to one for long-term supplier ships brought into the firm. t-statistics based on ship-level clusters K are omitted for brevity.

Dependent Variable:	**Turnover**	**Poaching**	**Span of Control**
	(9.1)	(9.2)	(9.3)
Acquired ×...			
Month 2	0.192	0.091	−0.290
Month 3	0.138	0.138	−0.539**
Month 4	0.149	0.050	0.205
Month 5	−0.054	0.074	0.260
Month 6	0.144	0.041	0.204
Month 7	0.060	0.165*	−0.049
Month 8	−0.196	−0.159	−0.231
Month 9	0.005	0.116	0.005
Month 11	0.291	0.014	0.331
Month 12	0.108	0.107	0.038
Month 13	0.120	0.044	−0.079
Month 14	0.144	0.111	−0.146
Month 15	0.296**	0.129	0.601
Month 16	−0.032	0.074	0.346
Month 17	0.127	0.007	−0.070
Month 18	0.212*	0.176*	−0.064
Month 19	0.074	0.117	−0.300
Month 20	0.153	0.141	−0.638
Month 24	0.181	0.099	0.006
Month 25	0.145	0.224**	−0.168
Month 26	0.173	0.190	0.088
Month 27	0.347*	0.030	−0.143
Month 28	0.202	0.111	−0.103
Month 29	0.055	0.108	−1.352
Fixed effects:			
Ship	Yes	Yes	Yes
Month	Yes	Yes	Yes
Mean of dependent variable	0.092	0.061	6.361
R^2	0.35	0.39	0.76
n	577	577	577
Number of clusters	K	K	K

***, **,* significant at the 1%, 5% and 10% level based on heteroskedasticity-robust clusters by ship