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

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Abstract

Using satellite-tracked real-time data on the movements of a vertically integrated fishing firm's own ships and its long-term supplier ships, this paper studies the impact of integration after the acquisition of those suppliers. The results suggest an increase in obedience to deployment policies, no change in fishing skills, higher productivity, and higher downstream product quality brought about by integration. Evidence consistent with ownership-based authority, and inconsistent with other mechanisms, is provided.

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The authority brought about by ownership enacts the right to give orders and control the operations and profitability of the firm (Grossman and Hart 1986, Hart and Moore 1990, Bolton and Dewatripont 2011). Authority is typically exercised within an organization rather than over the market, thus becoming one of the key constructs in theories of vertical integration (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 growing interest in understanding the value consequences of vertical integration, empirical evidence on the specific impact of increased authority in vertical relations is very limited.[1] Recent work has discovered important performance implications of vertical integration in incomplete contracting environments (Novak and Stern 2008, Lederman and Forbes 2010), but the potential benefits and costs enacted by the increased authority brought about by integration have not yet been explored. This paper provides direct evidence on the consequences of vertical integration on costly obedience and productivity consistent with the existence of an authority mechanism that may have lain hidden in the broader study of vertical scope and organizational form.

To explore the authority channel in vertical integration, 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 providing it with fish for processing between 2003 and 2010. (Vertical integration is defined as a firm's capability to transform fish on land). 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 vertical integration on asset operations with precision. Moreover, because the asset operators' incentives and the market value of ship catches are observable, the authority mechanism linking authority, obedience, and performance under vertical integration can be explored.

The difficulty in analyzing the performance implications of vertical integration must be stressed from the outset. Ideally, to estimate the causal effects of integration on performance, an identical

[1]Recent papers have studied interpersonal authority in organizations without emphasizing changes in ownership (Liberti 2005, Wu 2011). Other research has focused on changes in ownership that ensure financial control of investments, without examining authority in vertical relations (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.

transaction must be observed under integration and non-integration for the same asset, but this kind of variation is difficult to obtain because, in theory, firms optimally match organizational form to transaction characteristics, and integration is not instantaneously reversible. Fortunately, the fishing data capture substantial time-series variation in ownership at the level of each *asset*, thus allowing for a two-pronged approach to study vertical integration. The impact of vertical integration can be assessed cross-sectionally by comparing nearly identical simultaneous transactions across integrated and non-integrated assets, and it can also be evaluated using changes in vertical integration at the level of each ship to distinguish organizational form from asset-specific unobservables.

An additional advantage of the panel structure of the data is that it helps uncover the causal mechanism for the effects of integration. 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 jointly with its own fleet. After acquiring these non-integrated suppliers, the Firm gained authority in all details regarding their upstream operation. In turn, its authority over already-owned ships did not increase. The empirical design therefore takes a difference-in-differences approach to identify the impact of vertical integration on behavior and performance, exploiting additional institutional features to uncover authority as the mechanism driving the results.

I start by analyzing whether vertical integration influences decisions regarding the 'macro' deployment of ships. Using ship fixed-effects regressions at the trip level, I find that integration reduces the distance of a trip's macro fishing zone with respect to the macro fishing zone of the same ship on the previous trip, consistent with a more stringent policy to exploit an area further before quitting. Moreover, integration leads ships to return to a port that is not the closest to their fishing zone, suggesting a post-operation investment more costly in terms of the crew's time. Finally, integration decreases the likelihood that a ship's catch will be sold to third parties, suggesting that the Firm prefers to be the sole beneficiary of ship operations regardless of the ship's convenience in selling the catch to another firm. The results therefore indicate an increased level of obedience to macro policies binding for formerly contractual ships that become part of a vertical structure.

By contrast, I find no effect of vertical integration on the 'micro' fishing behavior of ships. Using classic operational measures grounded in marine biology —fishing style, fishing risk, the intensity of fishing effort on site, and the geographical clustering of ships in their fishing trajectories— I do not observe any change in the way formerly external ships do their job after integration. This evidence strongly suggests that vertical integration affects the macro realm of decisions differently from the micro realm, consistent with an equilibrium demarcation of authority within corporate hierarchies.

Having found a clear pattern in the operational consequences of vertical control, I ask: does it matter for performance? I find that the acquisition of control leads to a substantial improvement in productivity, alternatively measured as the weight of a trip's catch, the utilized capacity of a ship, and a two-factor productivity residual. Moreover, much of this improvement is gradual, not inordinately quick, and it has important value consequences for downstream operations. What is, then, the way in which vertical control leads to higher performance in this setting? Because the micro fishing operations of ships are not changing, and fishing transactions are tightly fixed in the regressions, the most compelling explanation is that the deployment policies enacted by the Firm have the direct consequence of helping firms discover more fish and become more productive. 'Costly' obedience therefore pays off through tangible rewards impossible to achieve without ownership-based authority.

By advancing the authority component of vertical integration, this study provides novel evidence of the role of ownership and management in a broad class of contracting environments. Specifically, the paper contributes to three related yet distinct literatures. First, the study provides some of the first direct tests of ownership-based authority consistent with the property-right theory of the firm, a broad framework that has received limited robust evidence. Hart and Moore (2005) emphasize the gains from integration accruing to a generalist with authority over specialists; Rajan and Zingales (1998) view access as a parallel construct to ownership; and Feenstra and Hanson (2005) predict greater investment gains in input search accruing to joint ownership and control. All these precedents lay the ground to understand how vertical integration enhances performance through ownership-based control.

Second, by analyzing the obedient actions enacted by authority (as well as actions that remain unchanged), the paper complements recent work on the mechanisms why integration matters. Aghion and Tirole (1997) model the importance of preference alignment between principals and agents in the optimality of delegation, as well as the tradeoffs between exerting more control and limiting initiative. Because preferences are a gray area of vertical contracts, the authority channel differs from the 'adaptation' channel (Forbes and Lederman 2009, Lederman and Forbes 2010): authority enacts actions that are subject to the *willingness* of external suppliers that naturally cannot be contracted ex ante, actions that change when suppliers become part of the firm.

Finally, the study also advances a strategy literature focused on the interplay of governance mechanisms and firm boundaries (e.g., Poppo and Zenger 1998). Specifically, the hand of management in increasing performance through governance has been found most useful when problems are more complex (Sampson 2004, Macher 2006); by dissecting operations into macro-deployment and micro-tasks, the nature of the underlying processes affected by integration is illuminated.[3]

1 Authority, Performance, and Vertical Relations in Fishing

The study of vertical relations in fishing bears resemblance to work on trucking (Baker and Hubbard 2004), cement (Hortaçsu and Syverson 2007), and airlines (Lederman and Forbes 2010) that has exploited geographical, ownership, and time variation in relatively homogenous environments. In fishing, all these dimensions vary substantially, so it is helpful to understand its fundamentals before considering the empirical relationships of interest.

1.1 The activity

Industrial fishing consists in the capture of wild fish by large-scale vessels operated by professional crews. In the Peruvian fishery, the second most abundant in the world and the focus of this study, ships are only capable of extracting fish, not transforming it.[4] A fishing trip can have two mutually exclusive purposes: fish for fishmeal production or fish for seafood production. 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 and can be arranged either over the market or inside firm boundaries, that is, in cases when plants and ships are part of the same firm. The randomness of the resource, however, makes the relationship between ship operators and plant managers particularly delicate, as significant transportation and wait costs complicate the compliance of procurement agreements.

Although all firms in this vertical industry are profit-seeking private entities, the common-good nature of marine 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, using this information in its regulatory activities. This study makes use of this information to examine the effects of vertical integration on the behavior and performance of one of the largest fishing firms in the world.

[3] The paper also speaks to a growing literature using granular geographical data to link institutions, organization, and economic outcomes (e.g., Dell 2010, Henderson, Storeygard, and Weil 2011).

[4] See Bertrand et al. (2007) and Bertrand et al. (2008) for oceanographic descriptions of Peruvian fishing.

1.2 The Firm

The Firm that constitutes the focus of this study obtains fish for processing from four sources. First, its own ships; second, its long-term contractual supplier firms 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 priority; and fourth, spot transactions. While the total 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 own fleet to achieve firm-level gains. Specifically, the internal organization of the Firm includes a position for a supply manager whose 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 manager's indications regarding the 'macro' regions where to fish (e.g., bands of several hundred kilometers along the coastline). By contrast, ship operators retain significant autonomy for their 'micro' fishing operations.

It is important to note that there is no explicit model of how the Firm chooses between owned and long-term contractual ships for obvious reasons. Essentially, a long-term contractual ship operator is external to the Firm, so it does whatever it wants without requiring the approval of the Firm. External ships simply strive to comply with bringing as much fish as they can to plants if that suits them well. Therefore, fish quantities and delivery times are not contractible because they depend on nature and on the willingness of the supplying firm to travel. Because contractual agreements are informal and never binding, and because there are no exclusionary fishing grounds in the Peruvian sea, it cannot be argued that the Firm is forcing external ships to be *less* productive before the acquisition by sending them to worse fishing grounds or requesting more difficult tasks: external ships cannot be sent, they can only be received. Thus, the classic theoretical characterization of fishing provided by Gordon (1954) applies remarkably well to this setting and is a strong argument that ship operations converge in their difficulty because ships, left to their own designs, seek to maximize catch and minimize effort.

1.3 The nature of vertical relations in the fishing industry

Some industry characteristics are key to the study of vertical relations because they help to interpret changes in vertical integration as a shift in authority that leaves other factors constant.[5]

- *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. 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 ships or plants, and skippers can switch across firms. There are no single-plant ports throughout the coastline, and over 50% of all ships in the industry are not vertically integrated.

- *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.

While these institutional features facilitate the interpretation of the effects of vertical integration through acquisitions, as will be detailed in Section 3.1, 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.[6] For example, in the case of the relationship between the Firm and its long-term suppliers, the supply

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

[6]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.

agreements 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. Interestingly, these informal agreements are quite effective: 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 resistance by upstream firms.

1.4 Empirical propositions

I propose that the impact of integration on performance occurs through changes in fishing operations, and that these effects are consistent with a shift in ownership-based authority, a mechanism clearly observable in the case of the Firm acquiring its long-term supplier firms. The propositions briefly outlined here exploit the panel nature of within-asset changes in vertical integration, though they are also assessed cross-sectionally for nearly simultaneous operations of integrated vs. non-integrated ships.

As discussed above, a first-order concern in studying the impact of vertical scope is whether firms match organizational form with task characteristics. In this sense, purported changes in fishing operations brought about by integration can be both interesting and problematic: they capture the variation induced by integration, but they raise the concern that newly-integrated assets may be endogenously assigned different tasks. An empirical advantage of fishing operations is that *they have two different non-overlapping dimensions: 'macro' and 'micro.'* Macro fishing operations are those broad policies through which the Firm may naturally influence the way ships move on the sea. These policies include actions determined before micro fishing operations start (e.g., the macro bands of the ocean where ships will fish) or after they end (e.g., whether ships return to the closest port, or whether ships sell their catch to third-party plants) but have little to do with actual fishing. Given the dimension of these broad policies and their close link to what the Firm can do as an integrated producer, I therefore propose that integration significantly drives changes in macro fishing behavior (**P1**). By contrast, micro fishing operations involve how each ship operator and his crew conduct fishing operations (e.g. how they move on the ocean, how hard they try to catch fish). To the extent that the incentives and information of ship operators do not change with regard to these micro operations, I propose that vertical integration does not have an effect on micro fishing behavior (**P2**).

The idea that ownership-based authority has different domains in a corporate environment is well grounded in theory (Aghion and Tirole 1997, Bolton and Dewatripont 2011). Hence, the contrasting effects of integration in P1 and P2 are consistent with an authority mechanism in fishing. The Firm's managers are on land and should be expected to exert much influence on macro policies, while they may not really reach the more autonomous domain of asset operators performing micro tasks on the sea. In fact, at the very beginning of this research project, during my interviews with the Firm's managers, I asked what was the fundamental change brought about by the acquisition of former long-term suppliers and the answer was the increase in authority to give deployment orders. Evidence with respect to P1 and P2 is important because it sheds light on the costly obedience that is not contractible given the highly uncertain nature of fish abundance and ship behavior.

Whether this costly obedience pays off, becoming an overall gain, constitutes a different proposition. By deploying ships differently and yet letting them operate as they do best, the Firm may expect to achieve greater catches. I therefore propose that vertical integration leads to higher productivity (**P3**). Note that the operational mechanism for P3 is clear from P1 and P2, and the causal mechanism is the shift in authority proper of a hierarchical relation inside the Firm rather than a long-term agreement over the market. Because productivity in the fishing industry consists in catching more fish with the same resources, it must be the case that those different macro deployment policies are leading ship operators to better finds, even if they do not really change their fishing skills. Indeed, field evidence that ship operators disagree with some of the Firm's deployment orders yet traverse different before-fishing- or after-fishing routes to accommodate to the Firm's orders suggests that this is quite plausible. Moreover, it is likely that these productivity improvements are only gradual for recently integrated ships. I therefore propose that productivity increases over time for these ships (**P4**). Finally, if the benefits accruing to the upstream (i.e., fishing) operations are meaningful to the whole vertical structure of the Firm, they should be noticeable in its downstream (i.e., transformation) operations, as well. Hence, I propose that integration leads to downstream performance improvements (**P5**).

2 Data

A contribution of this paper is to bring a granular data set to bear on authority in organizations. Per the General Fishing Bill of Peru,[7] 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[8] details that the functioning of

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

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 is that it is available for both the Firm's own fleet and the fleets of its long-term suppliers before and after integration. Because these two groups are the sole focus of the analysis, the comparison is unlikely to pick up other drivers of vertical integration that would matter otherwise. 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.

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: trip purpose (i.e., fishmeal or seafood), catch quantity, species, arrival date, arrival port, ship identifier and plant identifier. This information is supplemented with hand-collected ownership records and other regulatory information (e.g., ban announcements), 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 13,536 trips with 689,084 satellite snapshots, an average of 51 snapshots per trip. The exact location of each plant of the Firm, each point in the trajectory of a ship, and points 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 haversine formula, which accounts for the curvature of the Earth and performs particularly well for the numerical computation of small distances.[9]

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 \$25,350 (\$17,830) 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 summarized.

How are the satellite data exploited in the analysis of vertical relations? Recall that the economic

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

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 as well as its output, a number of unique operational constructs can be gauged. To illustrate, Figure 1 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 authority component of vertical integration after controlling for other factors that may influence the behavior and performance of a ship on a given trip.

3 Empirical Design

I now detail the assumptions behind the empirical design and the specification for the main tests.

3.1 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 operational 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.

Consider two ships, each supplying fish to 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. 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 changes in the functioning of the external ship. More broadly, taking the acquisition events as shifting the level of authority differentially among formerly independent ships, a difference-in-differences test would remove biases due to omitted variables or endogeneity concerns.

This empirical design requires that long-term contractual firms are acquired for reasons unrelated both to the way ships operate on the sea, and to any anticipated reasons for these ships to change their fishing behavior after the acquisitions. Understanding the cause of the acquisitions is important because, if there are unobservables that are correlated with the Firm's decision to acquire its long-term suppliers and are also correlated with the operations and performance of the acquired ships, the tests could be problematic. Note that I do *not* need to assume that the acquisitions were randomly determined — acquisitions are never random. Rather, I need to inquire whether acquisition-related unobservables are mechanically determining the behavior and performance of ships.[10]

Several pieces of qualitative evidence indicate that the operational and behavioral changes were not anticipated by those involved in the acquisition deals. (In fact, the results of this paper were surprising to the CEO and other managers). First, in interviews with shareholders and managers of the Firm, I learned about the conditions leading to the acquisitions: the need of larger corporate size to face a more competitive environment,[11] the need of a larger balance sheet to raise more banking funds, and a largely-exogenous request of more collateral for a syndicate of banks as the basis for more sophisticated financing operations in the future. Because none of these aspects is linked to any differential behavior of newly-acquired vs. already owned ships, the assumption of uncorrelated unobservables seems plausible.

Second, I also met with other direct participants in the acquisition decision: the law firm and the investment bank advising the Firm. When asked whether changes in fishing behavior and productivity were foreseen at the moment of negotiations, the principals of these advising firms admitted that that was not the case.[12] The driving force behind the acquisitions was largely financial and it was never expected to affect differentially only one set of ships. 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 conditions 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 fishermen 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

[10] My identification strategy bears resemblance to Oyer's (1998) use of just two firms, out of many, to claim that acquisitions are shocks to the fiscal vs. calendar year-end of accounting reporting. Like Oyer, I do not assume that all acquisitions in the fishing industry are ex ante unrelated to micro behavior and performance: I state, in the face of abundant first-hand evidence, that the ones studied here are.

[11] See `http://hugin.info/137275/R/1486821/422138.pdf` for a corporate report documenting the aggressive acquisition strategy of firms in the industry.

[12] I brought a research assistant to these meetings to make sure that my testimony is backed up by an external observer of these answers. All supplementary evidence is available from the author upon request.

that subsequently drive fishing operations.[13]

B. Quasi-experimental features of acquisition events

The test structure avoids biases from alternative drivers of behavior and performance 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, industry-wide practices discussed in Section 1 suggest that unilaterally changing these dimensions would have been detrimental, as the norm of all other firms reveals equilibrium behavior. The quasi-experimental nature of the acquisitions, therefore, consists in the invariance of mechanisms other than authority.

Another important feature of the acquisitions is that the Firm bought *all* the ships of *all* its long-term suppliers as a 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.

3.2 Specification

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

$$Y_{i,k,t} = \alpha + \beta * Control_{i,t} + \gamma * X_{i,k,t} + \delta_i + \delta_i * \tau_i^2 + \theta_t + \sigma_g + \lambda_l + \epsilon_{i,k,t} \qquad (1)$$

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 3.1 are further strengthened in specification (1) 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

[13] Although natural factors benefit the design by creating randomness in the environment, I cannot directly 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.

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. To be conservative, error terms are assumed to be non-independent within ships, clustering standard errors at the level of each ship.

However, there might be a more fundamental objection to the panel-data approach just proposed. To estimate the causal effects of integration on performance, it might be deemed more suitable to focus on an identical transaction under integration and non-integration. Fortunately, the structure of the data allows for two advantages. First, it is possible to implement very stringent cross-sectional tests. If, after focusing on nearly identical simultaneous transactions across integrated and non-integrated assets in this cross-sectional approach the results were significantly different from the panel, within-ship changes approach, then one would worry that the approaches are contradictory; but if the results were similar, that would be strong extensive evidence in favor of identification. Second, the satellite-tracked measurement of ship behavior allows to explore whether organizational form leads to substantial changes in transaction characteristics, or if, by contrast, even within the same class of activities, vertical control leads to higher performance. These considerations are at the heart of the tests shown in Section 4.

In addition, the inclusion of exogenous control variables strengthens specification (1). 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 1. 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.

4 Results

4.1 Control and ship deployment

I start by analyzing the impact of integration on the macro deployment of ships. Table 2 details the impact of vertical integration on deployment proxies per equation (1). The first column shows that acquiring control leads to a *lower* distance (in kilometers) with respect to the prior trip's fishing area of the same ship (t-stat.=-2.35). In other words, under a vertical integration regime, ships deviate *less* from their prior trip's macro zone and insist more on trying the same geographical region as potentially fruitful. This behavior is consistent with an obedience argument by which the Firm asks ships to direct their activities to a given macro zone even if the preference of ships is to quit and try a different location.

The second column of Table 2 shows 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.=2.73). In addition to reflecting increased deployment effort, this result suggests that the needs of plants may conflict with the preferences of 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 authority mechanism in vertical integration.

Moreover, the change in geographical deployment shown by these tests is also accompanied by changes in the propensity to sell the catch to third parties. The third column of Table 2 details that an integration regime leads to a lower proportion of trips being devoted to third-party sales (t-stat.=-4.14). This commercial deployment decision supplements the geographical deployment argument by highlighting that the Firm may not be interested in selling a ship's catch, thus disagreeing with ship operators and enforcing its policy. Overall, the findings suggest that vertical integration leads to costly obedience on the part of formerly independent asset operators.

While the findings are consistent with an authority mechanism, they do not address the more problematic interpretation that ships may be endogenously asked to conduct their micro operations differently after integration. I turn to these tests next.

4.2 Control and micro fishing operations

I now analyze whether integration leads to a change in the micro fishing behavior of ships within each trip. To do this, I rely on four dependent variables grounded in the marine biology of fishing.

First, I consider the Lèvy flight parameter capturing the power law properties of fish movements in the water (Viswanathan et al. 1999). A fascinating empirical regularity of ship operators in the Peruvian context is that they also follow a power law in their movements,[14] thus resembling both their prey and the prey's natural foragers (Betrand et al. 2005). I construct this trajectory parameter, which requires the observation of the satellite points in the trajectory of the ship, to characterize how ships fish. As seen in Figure 2, before acquisitions took place, contractual and own ships did not show differences in μ, suggesting that ships show a remarkable similarity in their micro movements.

The other three micro fishing dependent variables are more straightforward. The maximum distance to coast is measured in logged kilometers and captures risk-taking behavior. The number of "fishing sets" (i.e., attempts to cast the purse net to the water on a given trip) is defined in marine biology as instances of ship movement at speeds lower than 2.9 kilometers per hour. Finally, the distance to the nearest neighbor ship is an average of the minimum distance of the ship with its nearest neighbor *at each point in its trajectory*; in the extreme case that two ships operate side-by-side throughout their whole trajectories, this value is zero. As shown in Figure 2, the distribution of the number of fishing sets is remarkably similar across ship groups before the acquisitions; by contrast, there is more heterogeneity in the maximum distance to the coast and the distance to the nearest neighbor across distributions. The key message of the density plots is that firms may have been similar yet different in their ways to fish; if integration affects these operations, it is plausible that the nature of fishing operations is varying with organizational form, thus making it difficult to attribute any changes to organizational form.

When analyzing these four dependent variables in Table 3, vertical integration is found to have no influence on them. The insignificant coefficient on *Control* suggests that vertical control does not change the way asset operators use their fishing skills. It is therefore clear that vertical control leads to costly obedience in the compliance of macro policies, and yet it does not alter the way ship operators performed their basic functions. Does vertical control affect performance? I turn to this question next.

[14] The specification for the power law of how ships move on a given trip is

$$P(l_j) \sim l_j^{-\mu}$$

where l_j is the statistical event corresponding to a move of length comprised in the interval j; $P(l_j)$ is the probability for this event to happen, and μ is the characteristic constant (trajectory parameter)of this dynamic process. See Gabaix (2009) for an overview of power laws in social sciences and for estimation methods.

4.3 Control and productivity

Figure 3 presents a standard difference-in-differences graph analyzing the weight of catches before and after vertical control. Raw data and unconditional means are shown, without removing any variation from the data. For convenience, weight of catches is collapsed at the monthly level. The overall pattern in Figure 3 is that integration leads to a substantial increase in productivity among formerly contractual ships, leaving vertical ships relatively unaffected. However, the scattered data show much variation that must be more formally addressed in regression analysis.

Table 4 presents the results of estimating trip-level equation (1) using key performance metrics as dependent variables: ship productivity and market value of the catch. 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. Note that the presence of granular fixed effects for departure location and fishing zone location suggest that the within-ship changes in operations are not due to the systematic differences across fishing grounds. Moreover, the increase in catch weight is economically meaningful, amounting to over 20% of the mean value of a trip's catch.

Two other proxies for productivity analyzed are hold capacity utilization and total factor productivity (TFP) at the trip level. The former is defined as the ratio of the catch over the ship's capacity. The latter is obtained from the residuals of an unusually detailed (untabulated) regression of the log of catches on the log of the time invested by the ship's crew (in total man-hours) and on the log of the time of capital invested (in storage capacity-hours). Table 4 indicates that vertical control leads to a significant increase in the used capacity of a ship (t-stat=3.99), and to a 17.8% increase in TFP (t-stat=2.93). Taken together, the evidence is strongly in favor of substantial performance effects of controls.

The fourth column of Table 4 shows that the dollar value of the catch is also increased by integration (t-stat.=1.75). Because crew payments depend on the market value of the catch, this result suggests that control leads to greater payoffs to the crew even though the incentive scheme remains fixed. However, though the point estimate is substantial (around 20% of the mean value), it is less precisely estimated than the productivity results; this is likely due to exogenous price changes affecting all firms in the industry, as the productivity of the Firm's new ships has clearly increased.

What is, then, the link between vertical control and performance improvements in this setting? Because the micro fishing operations of ships are not changing with respect to the pre-acquisition regime

(Table 3), and fishing transactions are tightly fixed in the regressions, the most compelling explanation is that the deployment policies enacted by the Firm have the direct consequence of helping firms discover more fish and become more productive. Clearly, the policies are costly for ship operators; however, they do not affect their micro behavior and skills. The Firm simply asks ships for compliance on how long to persist in a given macro fishing area and where to return, leaving ships in freedom to fish as they used to before the acquisition. Moreover, the difference in deployment policies after acquisition does not disqualify the identification strategy for vertical integration because these policies were freely available to ships before acquisition: nobody forced the external ships to move in one direction or the other before the acquisition.

Should these large performance effects be interpreted as being only partial, given the more costly deployment of ships in the long run? 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., hull, engine) but the fishing license attached to it by the government.[15] Therefore, a net assessment of the benefits and costs of vertical control would yield a largely positive balance even when factoring in more general life-cycle considerations.

4.4 An alternative specification centered on transactions in the cross-section

I complement the panel ship-fixed effect approach just reported with 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 integration can be observed across assets for a given port of origin *and* a given port of destination *and* at a given date: a triple-interaction fixed effect makes sure that transactions are largely identical and simultaneous.[16] Because this triple interaction takes substantial variation out of the data to compare nearly identical operations, the cross-sectional exercise is meaningful. Although the detailed qualitative evidence provided in Section 3.1 that the acquisition decisions are not related to performance optimization unobservables suggests that the panel ship fixed effect models help identification, I replicate all tests of the paper using this cross-sectional approach for robustness.

Table 5 shows that vertical integration is strongly associated with macro deployment (top panel) and also strongly associated with higher productivity (bottom panel) in the cross-section. With the only

[15]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."

[16]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.

exception of the insignificant distance to prior fishing area (t-stat.=-1.52), all the results are essentially the same as the panel ship-fixed effects estimates in terms of the direction and significance of the coefficients. Moreover, as shown in the middle panel of Table 5, the integration status of a ship across nearly identical fishing tasks is not associated with significant differences in micro fishing operations; again, this result is the same as that obtained in the panel ship-fixed effects specifications. Taken together, the evidence indicates an increase in costly deployment practices, no change in micro fishing behavior, and significant productivity improvements brought about by vertical control.

4.5 Control and the dynamics of productivity improvement

Having found that both the panel ship-fixed effect estimates and the cross-sectional estimates are largely the same, I return to the panel specification to investigate the timing of the productivity gains enacted by integration. This analysis is facilitated by the panel approach and not feasible under the cross-sectional approach, to shed light on whether the timing for the effects of control makes sense.

Table 6 shows the dynamics of productivity improvement after the acquisition of control. The variable of interest is *Gained Control*, which is equal to one for the formerly-long term contractual ships that become acquired by the Firm. This variable is interacted with *First-year, Second-year,* and *Third-year* dummies, each one measured after the acquisition events. The results indicate that productivity improvements occur after acquisition and yet the magnitudes grow gradually over time for the case of weight of catch and TFP residuals, with untabulated Wald tests indicating significant differences over time for the latter. These findings are consistent with a change in productivity attributed to integration and not to confounding factors; moreover, the pattern of continued productivity improvements subsequent to the acquisitions suggests that ship operators take some time to assimilate the new policies of integration. Interestingly, the value of the catch does significantly improve in the second and third year of acquisition, suggesting that price changes exogenous to the Firm's actions tamper the strong productivity effects of integration noted in quantities. Because the Firm profits not from selling its catch but from processing it, the quantity effects are far more important.

4.6 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. The sample is limited to the time window 1 January 2006 to 31 July 2008, the period in which fishmeal production data on the whole industry is available. 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.

4.7 Alternative mechanisms and sample considerations

As argued in Section 3.1, the tight institutional conditions of the fishing industry assuage the concern that well-known alternative mechanisms are actually binding in the empirical setting. Moreover, many potential sources of correlation are controlled for by the week fixed effects in specification (1). To be sure, I conducted more work (untabulated here for brevity) empirically investigating whether internal personnel policies, technology improvements, or a reduction in docking wait-times may be shifting for acquired ships differentially after integration and found no evidence of such additional explanations.

One last concern is that all the empirical results come from a single firm. While the observability of granular actions is an advantage of single-firm studies (e.g., Mas and Moretti 2009), I go one step further to test whether my basic result bears out in the whole industry. In an untabulated version of equation (1) using trip-level data of all trips of all ships of all firms in the industry (excluding those studied in the main tests), with ship fixed effects and week fixed effects, I find that vertical integration has a point estimate of 13.46 on the weight of the catch, with a t-statistic of 3.87, a result that is economically and statistically significant. Naturally, in this supplementary analysis of the universe of vertical relations in the industry, I lose the tight sample selection of only owned vs. long-term contractual assets, I lack the satellite tracking of all fishing operations, and I stray from the identification of authority as a causal mechanism. Aware of these tradeoffs, I conclude that much can be learned from the proposed design, and I leave a number of interesting questions about vertical relations in fishing for future work.

5 Conclusion

The performance implications of firm boundaries constitute a central research theme in strategy. In this paper, I employ satellite-tracked real-time data on the movements of a vertically integrated fishing firm's own ships and its long-term supplier ships to study the effect of integration after the acquisition of those suppliers. I find an increase in costly obedience to deployment policies, no change in fishing skills, higher productivity, and higher downstream product quality brought about by integration. The results, if correct, point to a positive impact of vertical scope through a change in operational practices oriented towards generating substantially greater value.

In the broad research agenda on firm scope, this paper advances the authority channel of vertical integration. Authority is characterized by the right to give orders and control the operations and profitability of the firm. Recent work has proposed important value consequences for vertical integration in incomplete contracting environments, without focusing on the potential benefits and costs enacted by increased authority within vertical structures. This paper uncovers the impact of vertical integration on costly obedience and productivity, consistent with the existence of an authority mechanism that illuminates the classic property rights theory of the firm and calls for renewed attention to the hand of management and organization in why firm boundaries matter.

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Figure 1: 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.

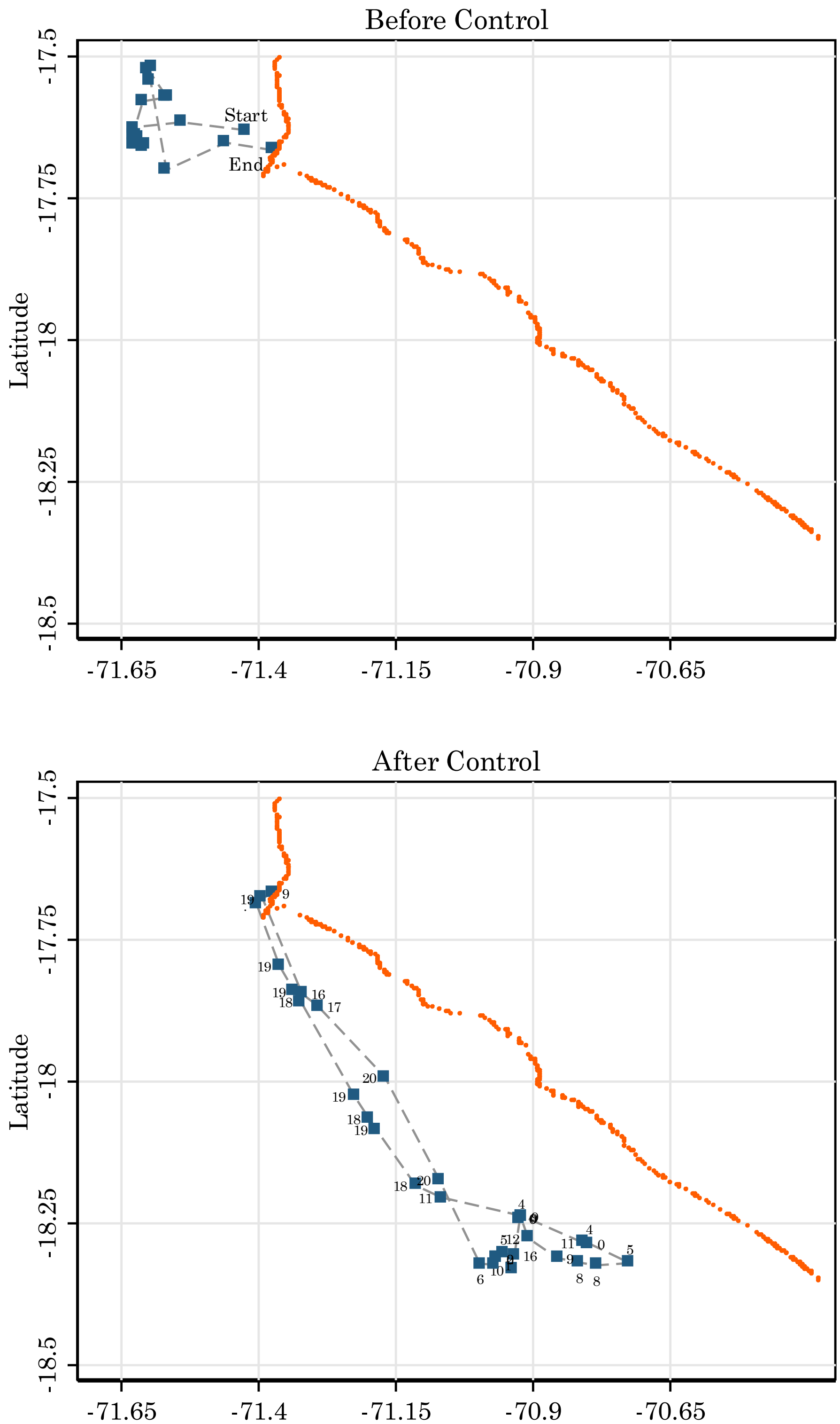

Figure 2: Kernel density of Fishing Operations before Control

Observations are at the trip level, and kernel densities are presented as solid lines for the owned ships and dashed lines for the acquired ships. Trajectory parameter "μ" is the characteristic constant of a trip's dynamic process, as defined by Bertrand et al. (2008). Maximum distance to the coast is calculated in kilometers and logged. # of fishing sets is the number of times that the ship is detected to be moving at less than 2.9 kilometers per hour. Average distance to the nearest ship is based on precise locations calculated at each point of the trajectory of the ship with respect to any ship of the Firm or its long-term contractual suppliers.

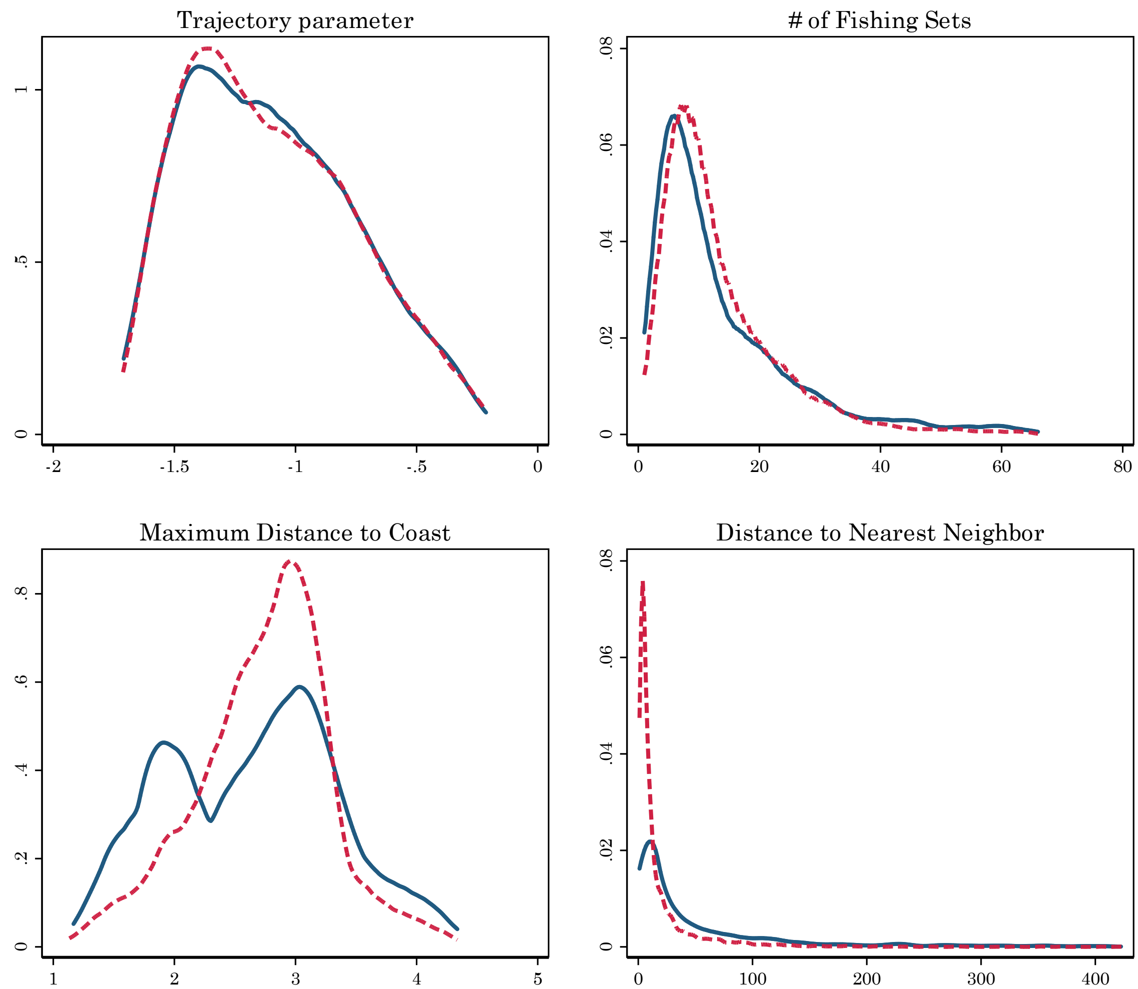

Figure 3: Weight of Catches by Treatment Before and After Control

The weight of catches is summarized at the monthly level for all trips of owned ships (circles) and long-term supplier ships that become integrated after being acquired by the Firm (squares). Months are expressed relative to the date of ownership changes from non-integration to integration. The pre- and post- sample means are presented as solid lines for the owned ships and dashed lines for the acquired ships.

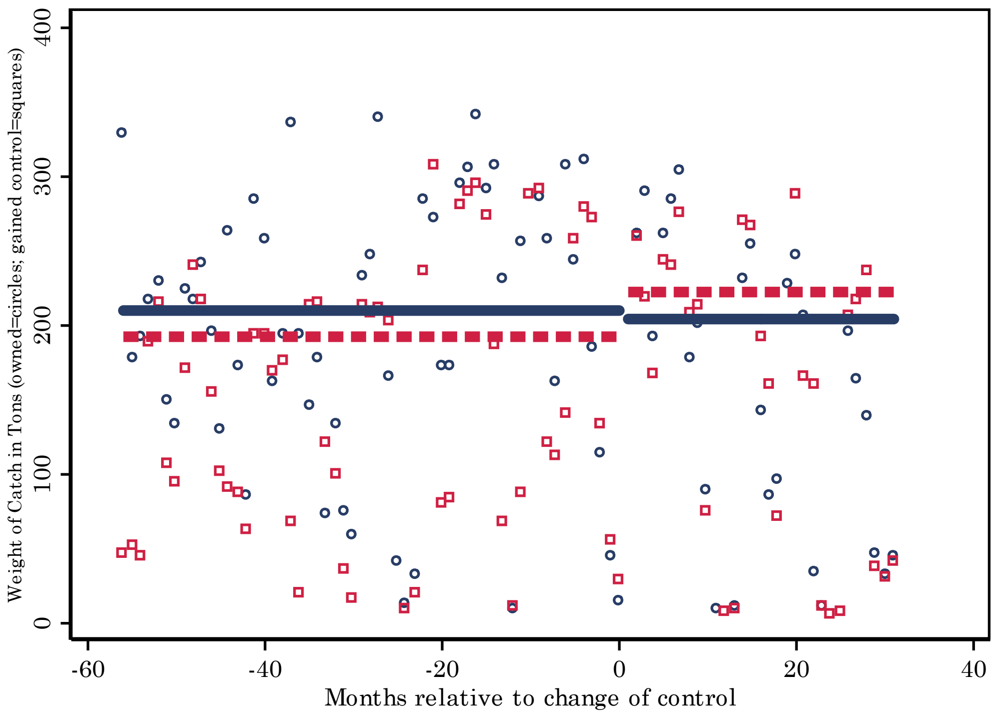

Table 1: Summary Statistics

The table reports trip-level variables on the complete records of the Firm for the period 1 January 2003 to 20 April 2010, as well as some ship level information. The sample focuses exclusively on all controlled (i.e., owned) ships and all the long-term supply allies of the Firm. Panel I describes the main variables of the study. Control is a dummy for whether the ship is owned by the Firm, and zero for whether the ship belongs to a non-integrated long-term supplier firm. Distance to prior macro fishing area is the distance of the current trip's maximum point off the coast and the same ship's maximum point off the coast on the immediately preceding trip, measured in kilometers and logged. 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. Resale to third parties is a dummy for whether the ship sells its catch to a firm different from the Firm. Trajectory parameter "μ" is the characteristic constant of a trip's dynamic process, as defined by Bertrand et al. (2008). Maximum distance to the coast is calculated in kilometers and logged. # of fishing sets is the number of times that the ship is detected to be moving at less than 2.9 kilometers per hour. Average distance to the nearest ship is based on precise measurements calculated at each point of the trajectory of the ship with respect to any ship of the Firm or its long-term contractual suppliers. Weight of catch is in tons (000 of kilos) of the catch landed at the port. Hold capacity utilization is the ratio of a ship's hold capacity that is filled with fish during the trip. TFP residual is a two-factor productivity residual of the expression $y_{i,k,t} = \beta_0 + \beta_1 * k_{i,k,t} + \beta_2 * l_{i,k,t} + \epsilon_{i,k,t}$ where labor and capital are estimated using the ship's hold capacity and the ship's crew multiplied by the duration of the trip in hours, and output and inputs are expressed in logs. Value of catch (in $000) is the weight of the catch multiplied by the price of the fish caught.

Fuel price is a daily series of price per gallon of diesel expressed in dollars after national taxes. 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. 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.

Panel II 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=13,536)	Mean	Median	Std. dev.	Min.	Max.
Control	0.51	1.00		0.00	1.00
Distance to prior macro fishing area	3.85	3.89	1.35	0.00	7.25
Return to farther port	0.23	0.00		0.00	1.00
Resale to third parties	0.07	0.00		0.00	1.00
Trajectory parameter "μ"	-1.13	-1.19	0.35	-2.55	1.06
Maximum distance to coast	2.67	2.75	0.64	-0.46	5.00
# fishing sets	15.19	11.00	18.20	0.00	451.00
Average distance to nearest ship	33.98	9.45	82.86	0.02	1433.01
Weight of catch	203.45	177.60	150.24	0.05	624.97
Hold capacity utilization	0.53	0.55	0.30	0.00	1.10
TFP residual	0.00	0.23	0.93	-6.25	1.59
Value of catch	25.35	17.83	24.98	0.01	269.03
Fuel price	2.37	2.42	0.36	0.48	3.16
Ban on anchovy	0.22	0.00		0.00	1.00
Ban on white anchovy	0.19	0.00		0.00	1.00
Announced ban on anchovy	0.09	0.00		0.00	1.00
Announced ban on white anchovy	0.08	0.00		0.00	1.00
Fish for fishmeal	0.56	1.00		0.00	1.00

II. 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: Control and Macro Ship Deployment

This table reports estimates of equation (1) using macro deployment policies as the dependent variables. 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 to prior macro fishing area is the distance of the current trip's maximum point off the coast and the same ship's maximum point off the coast on the immediately preceding trip, measured in kilometers and logged. 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. Resale to third parties is a dummy for whether the ship sells its catch to a firm different from the Firm. t-statistics based on robust standard errors clustered by ship are reported.

Dependent Variable:	**Distance to Prior Macro Fishing Area**	**Return to Farther Port**	**Resale to Third Parties**
	(2.1)	(2.2)	(2.3)
Control	-0.188^{**}	0.068^{***}	-0.065^{***}
	(-2.35)	(2.73)	(-4.14)
Fuel price	0.092	-0.020	-0.064^{*}
	(0.21)	(-0.23)	(-1.74)
Ban on anchovy	-0.178^{**}	0.080^{***}	0.007
	(-2.04)	(3.10)	(0.52)
Ban on white anchovy	0.171^{*}	0.113^{***}	-0.001
	(1.82)	(3.78)	(-0.08)
Announced ban on anchovy	0.006	-0.015	-0.009
	(0.04)	(-0.37)	(-0.54)
Announced ban on white anchovy	-0.269^{*}	0.093^{**}	0.029
	(-1.85)	(2.11)	(1.51)
Fish for fishmeal	0.174^{***}	0.163^{***}	-0.080^{***}
	(6.71)	(12.00)	(-8.59)
Fixed effects:			
Ship	Yes	Yes	Yes
Week	Yes	Yes	Yes
Firm's plant closest to departure port	Yes	Yes	Yes
Firm's plant closest to max.distance	Yes	Yes	Yes
Quadratic week term× Ship F.E.	Yes	Yes	Yes
R^2	0.26	0.34	0.26
n	13536-N	13536	13536
Number of clusters	N	N	N

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

Table 3: Control and Micro Fishing Operations

This table reports estimates of equation (1) using micro fishing operations of each ship as the dependent variables. 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*. Trajectory parameter "μ" is the characteristic constant of a trip's dynamic process, as defined by Bertrand et al. (2008). Maximum distance to the coast is calculated in kilometers and logged. # of fishing sets is the number of times that the ship is detected to be moving at less than 2.9 kilometers per hour. Average distance to the nearest ship is based on precise measurements calculated at each point of the trajectory of the ship with respect to any ship of the Firm or its long-term contractual suppliers. t-statistics based on robust standard errors clustered by ship are reported.

Dependent Variable:	**Trajectory parameter "μ"**	**Max.Distance to Coast**	**# Fishing Sets**	**Av.Distance to Nearest Ship**
	(3.1)	(3.2)	(3.3)	(3.4)
Control	0.034	0.026	−2.111	1.835
	(1.25)	(0.67)	(−0.70)	(0.27)
Fuel price	0.043	−0.148	−4.516	101.991
	(0.60)	(−1.17)	(−0.72)	(1.20)
Ban on anchovy	−0.003	0.019	−0.660	12.784*
	(−0.14)	(0.33)	(−0.66)	(1.93)
Ban on white anchovy	0.062**	0.157**	5.441***	5.256
	(2.42)	(2.46)	(4.11)	(0.48)
Announced ban on anchovy	0.010	0.038	−1.892	−3.324
	(0.27)	(0.70)	(−1.54)	(−0.67)
Announced ban on white anchovy	0.018	0.014	3.457**	7.545
	(0.51)	(0.23)	(2.52)	(1.03)
Fish for fishmeal	0.001	−0.052***	−1.579***	−1.775
	(0.14)	(−3.70)	(−4.13)	(−0.91)
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
R^2	0.19	0.65	0.47	0.49
n	12875	13536	13536	13533
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 Productivity

This table reports estimates of equation (1) using productivity measures as the dependent variables. 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. Hold capacity utilization is the ratio of a ship's hold capacity that is filled with fish during the trip. TFP residual is a two-factor productivity residual of the expression $y_{i,k,t} = \beta_0 + \beta_1 * k_{i,k,t} + \beta_2 * l_{i,k,t} + \epsilon_{i,k,t}$ where labor and capital are estimated using the ship's hold capacity and the ship's crew multiplied by the duration of the trip in hours, and output and inputs are expressed in logs. Value of catch is the weight of the catch multiplied by the price of the fish caught. t-statistics based on robust standard errors clustered by ship are reported.

Dependent Variable:	**Weight of Catch**	**Hold Capacity Utilization**	**TFP Residual**	**Value of Catch**
	(4.1)	(4.2)	(4.3)	(4.4)
Control	44.161***	0.077***	0.178***	5.462*
	(3.98)	(3.99)	(2.93)	(1.75)
Fuel price	−12.141	−0.122*	−0.240	3.234
	(−0.37)	(−1.97)	(−0.68)	(0.38)
Ban on anchovy	6.097	−0.001	−0.058	−0.105
	(0.96)	(−0.07)	(−1.31)	(−0.08)
Ban on white anchovy	−17.658**	−0.019	0.044	0.269
	(−2.20)	(−1.10)	(0.79)	(0.18)
Announced ban on anchovy	10.969	0.026	0.038	2.282**
	(1.54)	(1.46)	(0.66)	(2.48)
Announced ban on white anchovy	−7.973	−0.014	−0.002	−1.330
	(−0.96)	(−0.68)	(−0.03)	(−1.21)
Fish for fishmeal	3.043	−0.002	−0.007	−3.010***
	(1.16)	(−0.32)	(−0.37)	(−4.19)
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
R^2	0.65	0.53	0.50	0.65
n	13536	13536	13536	13536
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 Simultaneous Transactions in the Cross-Section

The observations are at the trip level and include all trips of the Firm's ships or its long-term contractual suppliers. Each entry in the table comes from a different regression estimating β in a cross-sectional equation

$$Y_{i,k,t} = \alpha + \beta * Control_{i,t} + h_{i,k,t} + \lambda_l + t_d * \sigma_{g0} * \sigma_{g1} + \epsilon_{i,k,t}$$

where the variable of interest is $Control$; h are hour fixed effects for the 24 hours of the day when the ship departs; λ_l is a fixed effect for the location of the point farthest off the coast, equal to the Firm's plant nearest to such location; $t_d * \sigma_{g0} * \sigma_{g1}$ is a triple interaction fixed effect of the day of departure, the port of departure, and the port of arrival for the trip in question. The dependent variables and samples are all as in Tables 2, 3, and 4. For brevity, only β, t-statistics clustered at the port of departure, port of arrival, and date triple interaction, and R^2 values are reported here.

	Distance to Prior Macro Fishing Area	**Return to Farther Port**	**Resale to Third Parties**	
Coefficient	-0.069	0.037^{***}	-0.086^{***}	
t-statistic	(-1.52)	(2.84)	(-8.92)	
R^2	0.69	0.77	0.49	
	Trajectory parameter "μ"	**Max.Distance to Coast**	**# Fishing Sets**	**Av. Distance to Nearest Ship**
Coefficient	-0.021	0.002	0.563	0.971
t-statistic	(-1.56)	(0.22)	(1.24)	(0.78)
R^2	0.55	0.91	0.75	0.94
	Weight of Catch	**Hold Capacity Utilization**	**TFP Residual**	**Value of Catch**
Coefficient	44.296^{***}	0.022^{**}	0.057^{*}	5.297^{***}
t-statistic	(9.22)	(2.50)	(1.88)	(9.67)
R^2	0.72	0.75	0.74	0.78

***, **,* significant at the 1%, 5% and 10% level. Robust clustered standard errors are reported.

Table 6: Control and the Dynamics of Productivity Improvement

This table reports a variant of equation (1) focusing on the dynamics of productivity improvement for each of the three years following the acquisition of control by the Firm. The observations are at the trip level and include all trips of the Firm's ships or its long-term contractual suppliers. The variables of interest are the interaction of *Gained Control*, a dummy equal to one for all those ships of long-term contractual suppliers that became part of the Firm through a merger, and *First-year, Second-year* or *Third-year* dummies; each year post acquisition is only 310 days long (the post-acquisition period is not fully three years) but each of these periods is labeled 'year' for convenience. All dependent variables are as in Table 4. t-statistics based on robust standard errors clustered by ship are reported.

Dependent Variable:	**Weight of Catch**	**Hold Capacity Utilization**	**TFP Residual**	**Value of Catch**
	(6.1)	(6.2)	(6.3)	(6.4)
Gained Control × First-year	40.809***	0.078***	0.129**	5.329**
	(3.79)	(3.67)	(2.03)	(2.14)
Gained Control × Second-year	44.531***	0.077***	0.137**	4.941
	(3.54)	(3.60)	(2.04)	(1.42)
Gained Control × Third-year	51.041***	0.076***	0.356***	6.655
	(3.30)	(2.78)	(4.73)	(1.13)
Fuel price	−12.956	−0.122*	−0.261	3.097
	(−0.40)	(−1.97)	(−0.77)	(0.37)
Ban on anchovy	6.142	−0.001	−0.055	−0.076
	(0.96)	(−0.07)	(−1.26)	(−0.06)
Ban on white anchovy	−17.697**	−0.019	0.042	0.251
	(−2.21)	(−1.10)	(0.77)	(0.16)
Announced ban on anchovy	10.967	0.026	0.038	2.288**
	(1.54)	(1.46)	(0.66)	(2.49)
Announced ban on white anchovy	−7.955	−0.014	−0.002	−1.334
	(−0.95)	(−0.68)	(−0.03)	(−1.22)
Fish for fishmeal	3.027	−0.002	−0.007	−3.011***
	(1.15)	(−0.32)	(−0.39)	(−4.20)
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
R^2	0.65	0.53	0.50	0.65
n	13536	13536	13536	13536
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 7: The Downstream Benefits of Control

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
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.