Relationships, Risk and Rents: Evidence from a Market for Ice*

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Abstract

Firms frequently engage in repeated trade despite the availability of alternative business partners. A large literature shows how such relationships affect market outcomes, but less is known about how changes in market structure affect these relationships. We study a market for an intermediate input—ice—in which customers—fishermen—are regularly loyal to retailers, who prioritize loyal customers for deliveries when supply is scarce from the monopolistic manufacturer. When entry of additional manufacturers reduces supply risk, retailers can no longer extract loyalty as a rent to abate the risk and switching between customers and retailers becomes more common. Retailers respond by expanding trade credit to customers, particularly previously loyal ones. We interpret this as evidence that supply risk and demand volatility can contribute to loyalty in relationships, particularly in developing countries. Further, we show that entry into ice manufacturing leads to substantial improvements in fishermen's productivity and reductions in the consumer price of fish, indicating that increased competition in low income economies can lead to improvements in productivity and welfare.

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1 Introduction

Firms routinely form relational contracts, valuing consistent business with one trading partner over a potential short run gain from switching to another.[1] The standard explanation for such relationships is they help overcome incomplete formal contracts involving specific investments (Williamson, 1975; Hart, 1995; Board, 2011). Empirical work has also shown that the opportunity cost of losing a relationship may deter default on trade credit (McMillan and Woodruff, 1999), or incentivize the sharing valuable information on unobserved quality of a good (Geertz, 1978; Bestor, 2004). But these explanations are not fully satisfactory in explaining relationships between firms trading homogenous commodities, which are pervasive, particularly in developing countries.

We provide evidence from the market for one such commodity—ice—to argue that relational contracts emerge as a mechanism to insure against risk associated with supply shortages and demand volatility. Specifically, we offer a market study in the tradition of Greif (1989) and Uzzi (1997) of the Sierra Leone fishing industry, where ice is a crucial input that helps fishermen cool their catch so they can remain longer at sea. There, the unexpected entry of additional ice manufacturers caused a reduction in the risk that ice is unavailable, and a subsequent disruption of relational contracts in which ice retailers receive more loyalty from their customers, in exchange for a ration of supply when it is scarce. In the absence of risk, these contracts are redrawn, transferring rents from retailers to their customers, who are then more likely to receive credit services from retailers. While most research on relational contracting focuses on how inter-firm relationships affect market structure (Baker et al., 2002), here we examine how changes in market structure affect the nature of relationships.[2]

We are able to make progress on this issue by exploiting unexpected shocks to barriers of entry into ice production. In this market, entry of additional manufacturers into ice produc-

[1] We distinguish relational contracts (or "relationships") with a history of repeated trade by two partners from both anonymized, monetized exchange and personalized, non-monetized actions in social networks.

[2] As a recent literature review by Jackson et al. (2017) confirms, the endogeneity of social networks is a longstanding concern for studies of the economic consequences of social networks, but few studies have sought to address how market features help explain variation in the economic institutions of relationships.

tion is triggered by the accumulation of capital by local entrepreneurs and the development of trade finance for imported ice machines. Give these shocks, we argue that the timing of entry, which was wholly unexpected by the incumbent manufacturer, is plausibly uncorrelated with other factors that may have affected relationships between ice retailers and their fishermen customers. The entry of ice manufactures therefore creates quasi-experimental variation in risk over the availability of input supply. Our results are supported further by the inclusion of controls for ice demand, such as seasonal effects and weather, the other potential driver of vertical relationships between ice retailers and fishermen.

The evolution of the market studied is as follows. At the start, the ice industry is dominated by a monopolistic manufacturer, Ice Ice Baby (henceforth, M1), that sells on commission through five retailers to over 150 fishing firms (henceforth, fishermen) across three wharves near the capital Freetown. The risk that ice is unavailable when fishermen need it is high. During the baseline first six months of our study, 22% of ice orders are delivered late, imposing costs on the fishermen who must catch the tide on time. Late deliveries occur when M1 prioritizes higher margin customers in the city: A one standard deviation spike in demand for ice outside the fishing industry can cause a further 6-11 percentage point increase in the likelihood that an order is late.

Despite this, however, loyalty between fishermen and the retailers is the norm. In a survey, retailers report that 74% of their fishermen customers would not buy from other retailers, and we observe that less than 5% in fact do so.[3] While retailers do provide trade credit during this period, they do so for less than 15% of transactions, and thus the demand for trade credit alone cannot explain their customer's behavior. Rather, loyalty is rewarded through informal insurance, as retailers ration ice to loyal customers, prioritizing them when ice is scarce. During a one standard deviation spike in outside demand for M1's ice, customers identified as loyal by retailers are 16% less likely to receive their deliveries late. We argue

[3]In two wharves, retailers are monopolists, but fishermen can travel to purchase from a retailer a different wharf, or directly from the factory. Prior to new manufacturer entry, there are no alternative ice sources, particularly given the mean order size is 714 kilograms, which highlights the industrial scale of production.

that in this sense, loyalty is a rent retailers extract from the risk of late deliveries put upon fishermen by M1's prioritization of other customers; non-loyal fishermen must accept a higher likelihood of delays, and be ready to fish without ice if necessary. In exchange for more reliable supply, retailers ask that the fishermen forgo competing sources and provide them with more predictable demand, enabling them to reduce effort while securing a reliable revenue stream.[4]

Then, unannounced, 4 new ice manufacturers (referred to below as M2, M3, M4 and M5) establish themselves and begin offering ice to fishermen, more than doubling production capacity. Two entrants are supported by a local entrepreneur that establishes a new venture to finance the import of industrial ice machines, and two others enter having accumulated enough cash to do so from other consumer businesses.[5] The immediate impact of entry is to reduce the risk that ice is unavailable to fishermen. Six months after entry, just 1% of orders are delivered late. As risk falls, relationships in which customers are loyal to retailers dissolve. In particular, where multiple retailers compete in the same wharf, the likelihood of switching retailers increased by 12 percentage points following manufacturer entry. Before the new manufacturer entry, about 5% of fishing firms completed a total of less than 20 switches; after entry, 50% of fishing firms made over 200 total switches.

The breakdown in loyalty in relationships coincides with large improvements in the terms of trade for fishermen. Manufacturers reduce the price of ice by about 8%, while quantity consumed rises by at least 15%. Retailers themselves begin to compete on an additional margin, trade credit.[6] After entry, there is a 9 percentage point increase in likelihood that trade credit is provided for a sale, an effect concentrated in the wharf with multiple retailers. Also, in this market, credit increases are largest among previously loyal customers, indicating

[4]Our emphasis on how relationships help prioritize deliveries under scarcity is closely related to that of Macchiavello and Morjaria (2015), who analyze which relationships between exporters and buyers persist during the 2007 Kenyan election crisis.

[5]As discussed below, manufacturers introduce three new retailers to the market, but they are largely unsuccessful in establishing relationships with fishermen. By contrast, existing retailers position to supply from multiple manufacturers and consolidate their position.

[6]Ice manufacturers have a retail price maintenance agreement in place, as is common for locally-produced commodities in sub-Saharan Africa such as the widely-observed example of Coca-Cola consumer sales.

that some—perhaps the more valuable—relationships persist after entry.[7] While benefits are transfered from retailers to customers, exchanging loyalty for credit, retailers are also able to retain their market share. In this sense, relationships persist, but are redrawn.

These benefits propagate downstream. Using survey data collected from fishermen every two weeks, we find the average number of fish caught with ice during a 2-week period increases by 25% after manufacturer entry. Fish retail prices in the independently collected CPI micro data fall 10% after the new manufacturers entry—but only for the types of fish located further offshore and that require ice to be caught. We estimate a lower bound for the aggregate benefit to consumers to be $33.5 Mn (in PPP 2011 dollars), or $5.22 per capita, 0.3% of national per capita GDP. As a result of upstream competition, a rent created by supply risk is transferred from retailers of an intermediate good, ice, to the consumers of the final good, fish.

Low income economies are characterized by higher levels of uncertainty and volatility (Collier and Gunning, 1999; Asker et al., 2013). The function of loyalty as a rent extracted from market risk may then help explain the well-documented fact that loyalty in trading relationships, even in the absence of trade credit or heterogeneous quality, is particularly widespread in developing economies.[8] This observation is also relevant in rich economies, where such types of risk may be lower but not zero, as it echoes an older literature in industrial organization that motivated vertical integration as tool to assure the supply of essential inputs (Carlton, 1979; Bolton and Whinston, 1993).

Our work also highlights the importance of credit in emerging economies (Genicot and Ray, 2006; Deb and Suri, 2013), and complements the existing literature on the relationship between trade credit and competition (Fafchamps, 1997; McMillan and Woodruff, 1999;

[7] As trade credit is sustained by a relational contract, this strategy helps deter entry by new retailers who lack private information to compete. Furthermore, a fisherman who wants to switch retailers now faces an adverse selection problem, in that he may appear as a worse credit risk to his new retailer.

[8] For instance, Bigsten et al. (2000) documents widespread norms of relational contracting by sub-Saharan African manufacturing firms with input suppliers in basic industries. Fafchamps (2004) shows that sub-Saharan African agricultural commodity traders consistently rank relationships as more important for success than factors including credit, price or equipment.

Macchiavello and Morjaria, 2016). While this literature typically finds in the cross section that the provision of credit falls with increased competition, emphasizing that increased opportunities to default may be the cause, we observe the opposite in our time-series data. Casaburi and Reed (2017) find similar results to ours in Sierra Leone's cocoa industry. Our case suggests that while competition may increase the costs of offering credit through increased default, it may also increase the necessity that firms provide credit in order to retain customers. The relationship between competition and credit supply in interlinked markets is thus ambiguous.

Finally, this work helps to integrate two older literatures on the costs of monopoly power and the rate of economic development, which have generally remained separate (Rodrik, 1988; Stiglitz, 1989). We show, as originally argued by Tullock (1967) and recently noted by Legros and Newman (2014), that the indirect costs of monopoly include more than inflated prices and restricted output relative to the competitive levels. Here, the relaxation of seemingly small barriers to entry in production of an intermediate good—led to significant improvements in consumer welfare. Furthermore, in the baseline, while risk creates a rent for retailers in the form loyalty, we show that the distribution of this rent between retailers and fishermen customers is a function of the retail market structure.[9]

The remainder of the paper is structured as follows. Section 2 provides a narrative of the shifts in market structure observed in this paper, and provides background on the setting. Section 3 describes the data and presents summary statistics. Section 4 presents our core results, quantifying the effect of ice manufacturer entry on outcomes in the ice retail market including risk, prices and loyalty, and on the outcomes relevant for the final consumer market, fishermen productivity and fish prices. Section 5 concludes.

[9]The policy imperative to address market power for growth and development affirms the conclusions of more recent analysis showing that production in African industrial sectors are concentrated in a small number of superstar firms. See studies by Sutton and Kellow (2010); Sutton and Kpentey (2012); Sutton and Olomi (2012); Sutton and Langmead (2013) on Ghana, Ethiopia, Tanzania and Zambia.

2 Competition in Sierra Leone's Ice Industry

Here we provide a brief overview of Sierra Leone's ice industry, and describe the evolution of market structure during 2013 and 2014 in which it transitioned from one dominated by a monopolist manufacturer to an industry with five competitors.

2.1 Setting

Sierra Leone is a low income country on the coast of West Africa.[10] The country's ice industry, which is concentrated on the Freetown peninsula, serves primarily small-scale (or"artisanal") fishermen and other consumers in the capital. Artisanal fishermen comprise the largest customer segment.[11] Despite being considered small scale, in the sense that they do not operate industrial trawlers, all of the fishermen in our study are formal, paying license fees to operate from the fishing wharves. The average fisherman also runs a firm that can be considered large sized by local and international standards, employing a crew of ten, and reporting assets of over $9,000, and monthly gross profits of over $1,000.

Ice retailers operate in the three major fishing wharves on the Freetown Peninsula, the locations of which are highlighted in Figure 1. Tombo (W1) is the largest artisanal landing on the peninsula, representing approximately 250 large fishing boats, though only about 15% of these vessels regularly purchase ice. This due in part to the fact that it is located approximately 90 minutes away by truck from the Freetown urban area, where the initial monopolistic manufacturer (M1) is located, and so cannot, at least at the beginning of our study, be served at scale. The remaining two wharves, Aberdeen (W2), with approximately

[10]For reference, Sierra Leone had population of 6.3 million and PPP per capita GDP of $1,770 in 2014 according to the World Development Indicators. For helpful overviews of the economy and recent history see Bellows and Miguel (2006) and Collier and Duponchel (2013). Our study takes place immediately prior to the outbreak of the ebola virus, which reached Freetown in July 2014, and brought much of the economy to a standstill.

[11]The fishing industry is itself a vital sector in Sierra Leone, accounting for approximately 10% of GDP and employing approximately 30,000 fishermen distributed along the country's coastline using over 8,000 boats (World Bank, 2006, 2009), in addition to a growing commercial segment. Commercial operators use large trawling vessels that typically fish further out to sea, and freeze fish on board for export. Artisanal fishermen serve primarily the domestic market.

100 boats, and Goderich (W3), with 200, are located within a 10-20 minute driving distance of M1's location in Freetown. In Aberdeen, 30% regularly purchase ice, and in Goderich, 50%.

2.2 Pre-competition

We will refer to pre-competition and post-competition periods in the study, corresponding to whether multiple manufacturers compete for retailers' business in a particular wharf. Pre-competition, ice was supplied to all retailers by a single manufacturer, M1.[12] At the start of the pre-competition period, the firm made a gross margin of 50%, indicative of its market power as a monopolist. At that time, the strongest competition M1 had faced was the government, which in 2012 established a fishing business and ice facilities in a smaller fourth wharf called Murray Town, forcing their exit.[13] M1 maintains retail prices by publicly announcing the price to fishermen, and then paying retailers a fixed commission on each bag sold.[14] As will become important post-competition, retailers do not receive a fixed wage and are not employees of M1, meaning they are free to make sales on behalf of other manufacturers.

Ice is an important input into fishing that raises productivity.[15] With ice, fishermen can cool their catch while at sea, and therefore fish longer and further away from shore, where larger, higher value fish swim. Without ice, fishermen must either catch the lower value fish that swim close to shore, or conduct only short overnight trips if they wish to go off shore. Given that all fishing costs are not continuously variable in time, ice offers economies

[12]The company has 29-ton daily capacity in one plant and is wholly owned by ManoCap, a private equity fund manager that operates in Sierra Leone, Liberia and Ghana. Two Sierra Leoneans returned from the diaspora founded the firm in 2005, and launched initial production in fall 2006. ManoCap acquired the business in 2008.

[13]When M1 entered the market in 2006, it initially competed with two smaller ice manufacturers for the artisanal fishermen market, but these competitors were unable to sustain their operations and soon exited the market.

[14]Public announcement of prices is a common retail price maintenance strategy used by large firms in emerging markets, for instance Coca-Cola. In interviews, both M1 and retailers acknowledged a belief that price stability was important to achieve the appropriate level of demand from fishermen.

[15]On a typical fishing trip, ice comprises approximately one fourth of costs

of scale. Specifically, while the key per trip costs include fuel (44%), ice (26%), and food (14%) - the fixed costs involved with purchasing and maintaining boats, motors and fishing equipment are substantial; the average value of fixed assets exceeded $9,000 per fishing firm, while the average trip expenses were under $400, or less than 5% of fixed assets. Longer trips involving ice could contribute to better utilization of these fixed assets—and the fixed allocation of time spent planning trips—by reducing downtime.

Pre-competition, the fishermen face risk that ice will not be available when they need it. Fishermen and retailers do not have access to large freezers or a reliable supply of electricity with which to operate them, and so they cannot store the ice. Instead, they rely on the manufacturer to deliver it at an appointed time. Fishermen typically require ice in the morning immediately before going to sea, and typically make their orders the day prior to departure with a retailer based at the wharf. By the end of the day, retailers aggregate orders, collect payment (sometimes supplying trade credit), and communicate the required quantity to the manufacturer.[16] If the ice is not delivered on time, the fishermen lose part or all of the day at sea, paying both the wages of the fishermen they have retained for the day, and the opportunity cost of their own time. Since fishermen often arrange in advance to deliver their catch on a specific day to a specific fishmonger, late deliveries often require them to shorten their trips, or risk their credibility with customers.

M1 faced difficulty in delivering ice to all wharves on time, with adverse consequences for fishermen profits. Delays lasting half a day or more were common for two reasons: capacity constraints and competing demand. M1's production capacity is itself stochastic, with a number of factors constraining the factory's ability to produce fishermen's orders overnight. Despite substantial investment, mechanical problems with the ice machines, generators, and delivery vehicles occurred frequently. Employees regularly show up late or report sick, and electricity outages, as well as shortages of diesel for the backup generator, are common. Fishermen's orders must also compete with other higher margin demand. Restaurants,

[16]Fishermen can also purchase directly from the factory, but then they must show up in person, pay a higher price, and organize their own delivery, so this is rare.

bars, supermarkets, party planners and others frequently make large orders without notice, and have a substantially higher willingness to pay for immediate service.[17] M1 frequently prioritizes these high value customers at the expense of fishermen. Finally, even if enough ice is produced, the truck to deliver it may break down, run out of fuel, or lack a driver.

2.3 Post-competition

Initially, with extremely limited financial sector development, the upfront capital costs of the ice manufacturing business created a barrier to entry. The cost of a 13-ton daily capacity machine (less than half of M1's capacity) typically exceeds $100,000. Payment terms for machines were typically 50% upfront and 50% on delivery, and required a personal visit to vendor' facilities abroad, either in China, Germany or Italy, to agree on final terms.[18] In initial interviews with M1 in early 2013, the firm's owners and managers did not consider new entry to be a likely outcome given the capital costs. In fact, they expressed greater concern that eventual improvements in electrification would allow for self-production of ice.

Ultimately however, between the 3rd quarter of 2013 and the 2nd quarter of 2014, four additional manufacturers would enter the three fishing wharves served by M1 pre-competition. Figure 1 indicates the locations of the new entrants, indicated as M2, M3, M4 and M5. Two of the manufacturers (M2 and M3) were initially operators in Sierra Leone's packaged water and cubed ice market, which has lower entry costs. Having established themselves in these markets, the firms had built up cash and used it to entirely self-finance their expansion into industrial ice production. The other two manufacturers (M4 and M5) used the trade finance facilities of an importer. The importer, who had an established business importing refrigerators and air conditioners for the regional consumer market, began offering buyers of ice machines an opportunity to purchase one without travel abroad, and with financing that allowed 25% of the cost to be paid after six months of production. The onset of competition

[17] The average price per kilogram of ice sold to this segment is about twice as high as the price for retailers at the fishing wharves.

[18] As Startz (2017) finds in Nigeria, search and contracting can be major frictions in developing economies.

was then induced by a confluence of the outcomes of Sierra Leone's slow but steady post war recovery: the emergence of local entrepreneurs with cash to invest, and the development of trade finance, specifically for imported capital goods. Interviews with each of the new manufacturers confirm that their entry was determined by these two factors, with the exact timing due to a set of idiosyncratic factors such as delays in receiving and installing equipment, recruiting skilled staff, and establishing production processes.

Figure 2 presents the market structure in each wharf before and after competition, with the arrows indicating supply relationships between manufacturers and retailers. Post-competition, we observe that all but one of the incumbent retailers (i.e., R1, R2, R3 and R4) establish alternative supply relationships with at least one new manufacturer. In Tombo, R1 begins ordering from both M1 and M2. In Aberdeen, R2 continues to purchase from M1, but also became a supplier for M4, who supported R2's initial purchases with a substantial upfront loan and a higher commission per bag. In Goderich, the two of three incumbent retailers with the greatest market share, R3 and R4, also both begin to buy from M4. Competition among manufacturers also induces the entry of new retailers: In Aberdeen, M3 sells directly to fishermen and through a new retailer, R6; in Goderich, M5 does the same with R8. As a result, the incumbent M1's market share falls substantially, from 1 in each market to 0.65 in Tombo, 0.58 in Aberdeen, and 0.92 in Goderich.

While M1's market share was reduced after entry, those of the incumbent retailers are more stable: In Tombo, for R1, a market share of 1 becomes 0.87; in Aberdeen, for R2, $1 \rightarrow 0.89$; and in Goderich, for R3, $0.51 \rightarrow 0.41$, R4, $0.41 \rightarrow 0.5$, and R5, $0.08 \rightarrow 0.05$. Figure 3 shows the sales of each retailer over time. In general, quantities sold by each are similar when comparing Q1 and Q2 of 2013 and of 2014, except in Aberdeen, where total sales appear to have declined somewhat. Though we observe entry of several new retailers (R6 and R7 in Aberdeen and R8 in Goderich), they ultimately have limited success in taking market share from the incumbents. Further, as shown in Figure 4, each of the new retailers was only active for a short period of time. Overall, there is limited reallocation of share

across retailers, and overall, they cede little to new retailers that enter.

The persistence of the incumbent retailers' market positions post-competition speaks to their strong relationships with their customers. While under fixed pricing from the manufacturers, retailers cannot vary their prices; they provide two services to customers that help keep customers loyal. First, when retailers lack sufficient supply to fill all their orders, they prioritize certain customers for on time deliveries, a form of informal insurance. Second, at times they provide trade credit at 0% interest, allowing fishermen to pay for orders after they have taken their trips and sold their fish.[19] According to one retailer, these services are the substance of the relationship:

> "Providing credit does not tie a customer to an agent [i.e. retailer]. But not providing credit will make a customer leave you. What ties a customer to an agent is the relationship—the confidence and trust he has in you the agent that you can give him ice when he orders and in times of financial troubles he can depend on you to provide credit."

3 Data

For 18 months, from January 2013 through June 2014, we collected panel data from actors at all levels of the ice supply chain—upstream ice manufacturers, mid-level ice retailers, and downstream fishermen customers—that collectively provide a comprehensive view of all trading relationships in the ice industry. For the incumbent and the four subsequent competitor ice manufacturers, we collected administrative data on price schedules and quantities produced and sold. Specifically, we observe daily aggregate totals of ice produced and daily aggregate sales data, broken down by retailer and whether the customer is in the fishing industry or not. In addition, we conducted interviews with the leadership of each ice factory on strategic decisions related to competition and policies on production, delivery, credit, and

[19] Informal lenders (i.e. susu accounts) charge a weekly interest rate of 2-3%

other industry context.

We collected transaction level data from the five independent retailers originally serving the incumbent manufacturer on their informal contracts with fishermen customers, including the buyer identity, contractual terms (price, quantity demanded, credit), and contractual outcomes (quantity delivered and timeliness).[20] Since the manufacturer data includes daily aggregate sales for each retailer, we were able to independently verify that the individual orders and deliveries they report are closely correlated to the aggregate supply and payments noted by the factory managers. Finally, we also conducted interviews with each of the original five retailers on their strategic decision-making, and collected their rankings of customers across multiple dimensions including loyalty, friendship, and length of relationship.

We also used the retailers' records to create a sample of all current fishermen customers of the incumbent manufacturer, and completed a face-to-face baseline survey with each of them in April 2013, in order to better understand their relationships with retailers. The baseline survey includes information about respondent demographics, fishing practices, experience with the ice retailers, assets and expenditures. We were able to locate and survey all current regular customers at the time of the baseline survey, and continued to add new fishermen customers to our survey data collection as they entered the sample.[21] Starting in May 2013 and continuing until July 2014, fishermen received brief follow-up biweekly phone surveys that addressed their fishing trips over the past two weeks, including the use of ice, the selection of retailers, and fishing trip outcomes. In September 2013, immediately following the entry of Manufacturer 2 into Tombo but prior to entry by other manufacturers, we surveyed all five original retailers to assess perceptions of customer loyalty and collect other potential indicators of relationship strength including friendship or common ethnicity.

In addition to the original sources of data listed above, we exploit two existing data

[20]Similarly detailed transaction data was not forthcoming from the other retailers who enter following manufacturer entry, but as we document above their aggregate sales are a negligible share of the market.

[21]Retailers are unable to identify occasional fishermen customers who are not based in one of three wharfs - primarily seasonal fishermen from neighboring Guinea. 347 out of 5,281 orders (6.6%) in our transaction data are unidentified, and we assign them a common identifier to conduct inference.

sources in our analysis below. We use data on the daily average temperature, hours of rain and average wind speed as controls for ice demand in some of our regressions. These data are collected from a weather station located at the Lungi airport near Freetown and made available by the commercial service MeteoBlue. Separately, we use monthly market price microdata for 12 types of fish collected in the government's consumer price index survey in 6 markets in downtown Freetown from January 2013 to December 2014.

Table 1 summarizes the demographic variables associated with our sample of customers, or fishermen, in order to give a sense of the group of customers studied. With an average age of 40 years, and over 17 years of years of fishing experience, about sixty percent of the fishermen respondents owned their own fishing boat and over eighty percent served as boat captain for regular trips.[22] Fishermen reported that a typical month during the dry season involved almost 10 trips, and that they had been buying from their ice retailer for an average of 4 years. In our retailer survey data, 73% of fishermen are identified by their primary retailer as a "Loyal Client," more specifically "someone who will wait for his agent to come even if he has another way of getting ice earlier?"[23] The same fraction, 73%, are identified as a close friend by their retailer, and only one-third are identified as sharing the same ethnicity as their retailer. In the high frequency data summarized in Appendix Table A1, we observe that the average planned trip length is almost 3 days, with one-quarter of trips not involving ice. The average ice purchase was 460 kilograms (∼$75 using the ice prices at the start of the data), though this rises to 615 kilograms (∼$85) conditional on making an ice purchase. Average trip gross profit margins, defined as total trip revenues minus total trip expenses (including labor costs), were approximately $110, with a large standard deviation of about $150.[24] Relative to the per capita income of Sierra Leone, which was

[22] As our sample was defined as customers of the ice retailer and not by the owners or captains of boats, these are not mutually exclusive groups. This sample of 154 fishermen customers includes 26 owners who are not captains, 59 captains who are not owners, with the remainder fitting into both categories.

[23] 68% of fishermen customers were designated as loyal by the three retailers in Goderich (W3). The corresponding figures for the Tombo (W1) and Aberdeen (W2) retailers were 68% and 93%, suggesting that even monopolistic retailers had concerns about the threat of new retailer entrants stealing their customers.

[24] About 14% of trips had negative profits, reflecting the risky production process in fishing.

approximately $360 in 2011 PPP USD at the time, these are businesses of substantial size.

4 Results

We establish two results. First, we show that relational contracts may form to reduce risk that an essential input—ice—is unavailable. Further, the nature of these contracts is that they provide a rent to the agent that is in a position to reduce the supply risk through rationing. Second, we show that a reduction in this risk, in this case led by entry of additional manufacturers of the input, can lead to substantial downstream gains for consumers of the final good—fish.

4.1 Relationships can form to reduce risk

We establish our first result with three facts:

- *Relational contracts reduce the risk that ice is unavailable.* We first establish that, in the presence of stochastic ice supply, implicit relational contracts exist that reward loyalty. Retailers ration ice to "loyal" customers, those who they report would not buy from their competitors.

- *Ice manufacturer entry reduces risk that ice is unavailable.* We then show that the entry of additional upstream ice suppliers reduces the supply risk, making it so that retailers can no longer ration ice to their customers. Ice becomes readily available in the market. As discussed above, we argue that, conditional on the time series controls used, it is unlikely that this entry is correlated with other factors that might subsequently change the vertical relational contracts between ice retailers and fishermen.

- *Ice manufacturer entry causes relational contracts to be redrawn, shifting the balance of benefits from retailers to their customers.* We then show that the reduction in uncertainty after ice manufacturer entry coincided with a breakdown of loyalty in

relationships, and a corresponding increase in the supply of trade credit from retailers to their customers. In the absence of risk, retailers were no longer able to extract loyalty from customers, and customers recieved more value through credit services. Previous relationships however continue to shape the terms of new relational contracts; during the credit expansion, retailers allocate more credit to previously loyal customers.

Together, we take these facts as evidence that relationships can function primarily to reduce uncertainty, in this case over input supply. Rents in these relationships accrue to those who can manage risk by rationing supply.

4.1.1 Relational contracts reduce the risk that ice is unavailable.

We first provide evidence that retailers use relationships to smooth stochastic volatility of supply. Given that a central component of our analysis concerns the differential effects of competition for loyal customers, we present first in Table 2 the correlates of the "Loyal Client" indicator variable in order to provide a sense of what it means to be a loyal in a business relationship in this context. In columns (1) and (2) we find a quadratic positive relationship between perceived loyalty and the number of years a fisherman customer reports purchasing from that retailer in our baseline survey data, suggesting that experience with one another matters. This correlation does not persist in column (3) when substituting an indicator variable, Bought Longer (=1), which equals one for the top tercile of relationship lengths, which suggests the effect is not driven solely by extreme values. In columns (4) and (5) we find strong positive correlations with both the close friend and coethnic indicator variables also collected in the retailer survey, and in column (6) we also find a positive correlation with an indicator variable, More Ice (=1), for the top tercile of self-reported ice expenditure as a share of total trip expenditure. This suggests that fishermen, who are more reliant on ice as part of their costs, and therefore may suffer more from late deliveries, are more likely to be loyal. In column (7), we find no correlation between loyalty and a composite measure of fisherman risk tolerance composed of the average of three binary questions about

readiness to participate in risky fishing behavior when experiencing a unproductive fishing trip (i.e. staying out to sea longer than planned, travelling further than planned, or fishing in prohibited areas).

Next, we document that late deliveries, which we take as a measure of uncertainty over ice supply, are common in our baseline period, where there is a monopolistic ice manufacturer. From January to June 2013, prior to the start of the rainy season, approximately 22% of fishermens orders were delivered late, often entailing a half-day delay to the planned departure of the fishing trip. Fishermen indicated in focus group discussions that the unpredictability of late deliveries made it difficult to plan for future trips, and imposed real costs on their fishing production. In the words of one fisherman:

> "Whenever we get ice late, it disrupts all our plans. Of all the things we need before we make a trip, ice is the only thing we have to wait for. When we need fuel, we just go to the fuel station and get it, but for ice they [the retailers] must come with it. And any time we do get our ice late it cost us money. When you have put a crew together for a trip, their feeding becomes your responsibility. Which means even if you don't get to leave early, or not leave at all on that day because you couldn't get ice on time, you still get to feed the crew. That is an extra and unnecessary cost we can avoid if we get the ice on time. It dampens the morale of the crew, it makes us lose valuable time, and we miss the ideal time to set out for fishing which might in turn affect our catch, fuel consumption and our duration at sea."

In Figure 5 we observe the daily ice production totals in kilograms for M1, the incumbent manufacturer, and the aggregate share of orders arriving late to all fishing wharves. It is striking to note the daily variation in the likelihood of late deliveries during Jan-June 2013, before the entry of the first additional manufacturer.

Next, we show that lateness is driven by outside demand for ice from non-fishermen sources, and is largely beyond the retailers control. Below we will compare responsiveness

of deliveries across loyal and non-loyal customers to this risk, but can be assured that the relationships are not due to some specificity of the risk to particular types of customers. In interviews, fishermen frequently identified the source of lateness as operational factors under the manufacturer's control (e.g. issues with machines, vehicles or workers), but retailers were aware that an important component of late deliveries was the level of demand from outside markets like supermarkets, restaurants and parties, who would on average offer the manufacturer twice the profit margin on each sale.[25] To demonstrate how outside demand shocks affect late deliveries to fishermen customers, we merge our administrative data on factory sales to retailer records of each order i by fisherman j from retailer k on date t. We estimate the following linear probability model, which includes time-varying weather controls, X_t, which may affect demand for ice, retailer fixed effects, η_k, and month fixed effects, $\tau_{m(t)}$, for each calendar month m, to flexibly control for seasonal trends.[26] Standard errors are two-way clustered by delivery date (t) and fisherman customer (j) to address serial correlation in the timing of shocks and the time-invariant characteristics of fishermen.

$$\text{Late}_{ijkt} = \theta_1 \text{Outside Sales}_t + \eta_k + \tau_{m(t)} + X_t'\beta + \epsilon_{ijkt}. \tag{1}$$

In the above equation, Late_{ijkt} is an indicator variable that equals one if that order was not delivered on time to a fishing wharf, and Outside Sales_t is the daily factory sales by M1 to non-fishing sources of demand, where the latter has been transformed by subtracting the mean and dividing by the standard deviation.[27] In Table 3, we observe a consistently positive and significant correlation between outside sales of ice and the share of orders delivered late to fishermen across a variety of specifications. In column (1), we examine the raw correlation

[25] Figure A1 shows the separate time series for the incumbents sales to fishermen and non-fishermen customers. The two are positively correlated (ρ=.12) due to seasonal patterns—e.g. during the rainy season from July to September, demand drops for both sources—but both contain a high degree of daily variation.

[26] Time-varying weather controls include average daily temperature, rainfall and windspeed on the day of ice order, which are factors that fishermen report are important in their trip planning process.

[27] While we do not directly observe non-fishing demand, interviews with the incumbent manufacturer confirm sales to non-fishing sources are a reasonable proxy for non-fishing demand given a constant willingness to prioritize non-fishing orders.

in the pre-period before new manufacturer entry, and find a one standard deviation in outside sales is associated with a 11 percentage point increase in the likelihood of a late delivery. Adding weather controls, retailer fixed effects, and month fixed effects in column (2) attenuates the magnitude to 6 percentage points, but the results remain statistically significant at the 1% level. This evidence supports the qualitative findings from interviews with the incumbent manufacturers leadership, in which they confirmed a practice of prioritizing the allocation of production to time-sensitive outside demand with higher profit margins over the lower margin fishermen demand.

We now show that customers perceived as loyal by a retailer are less exposed to the risk of late deliveries from outside demand shocks. This is consistent with loyalty functioning as a mechanism to smooth uncertainty in dynamic relationships, and contrary to the static prediction that retailers should prioritize the customers most likely to switch to an alternate source. In column (3) of Table 3, we interact Outside Sales$_t$ with an indicator variable for Loyal Client $(=1)_{jk}$ where this variable is coded for each retailer-fisherman pair using the retailer survey data discussed above. The interaction term is negative and significant, with a magnitude of 3 percentage points, a 17% decrease from the mean value for lateness. Furthermore, the uninteracted effect of loyalty is not statistically different from zero, indicating that loyalty is only relevant for lateness on average in the presence of outside sales by the manufacturer.

Next, we examine heterogeneity in the importance of loyalty across wharves, in particular testing if Goderich wharf (where multiple retailers are based) has a different intercept for loyal customers than the remaining two wharfs (where only one local retailer exists). In column (4), we see that the level effect of loyalty, with no outside demand shock, has a large negative level effect on lateness in Goderich, but actually a positive effect in the other two wharves. The interaction between loyalty and outside sales remains negative and significant at the 10% level. This speaks to the importance of loyalty even in the absence of a specific upstream risk; when retailers have direct competitors, they prioritize loyal customers regardless of the

reason for the other deliveries being late. As we shall see in the discussion of Table 6 below, which presents results on trade credit, the fact that loyalty indicates a higher likelihood of late deliveries in the two other wharves is consistent with loyal customers substituting timeliness for increased trade credit. In column (5), we add interaction terms for outside demand in Goderich and outside demand in Goderich for loyal customers, and find a consistent level effect of loyalty in Goderich that is not differential by outside demand shocks.

Finally, in columns (6) - (8), we estimate our key specifications during the post-period after manufacturer entry, and find that the previously documented patterns generally no longer hold after entry occurs and, as shown above, the frequency of lateness falls dramatically. In columns (7) and (8), we see suggestive evidence that loyal customers outside Goderich are more likely to receive late deliveries, but given the sizeable decline in the importance of outside demand shocks and the likelihood of lateness post-entry, we do not overemphasize this result. In general, the post-entry patterns in prioritization is consistent with retailers now being able to procure ice from other manufacturers when the incumbent prioritizes other customers.

Overall, these results show that retailers reward loyal customers with more reliable deliveries when manufacturer supply is volatile. In interviews, retailers reported that they derived reciprocal value from these loyal relationships: loyal buyers, who refused to buy from other retailers, contributed to more stable demand for retailers, reducing the effort required to sustain a sufficient order volume to cover expenses.

In Table 4, we test the robustness of our main result from column (3) of Table 3 to alternative sources of personal relationships that might confound our interpretation that stated loyalty is the basis on which retailers prioritize customers. In columns (1) - (5), we find our baseline estimates of the mitigating impact of loyalty on outside demand shocks leading to lateness are robust to including levels and interactions for other aspects of the relationship, such as length of relationship, friendship, shared ethnicity, along with the More Ice $(=1)_j$ indicator variable for reliance on ice as discussed above. In column (6), we add controls

for the Order Size$_i$ (in kilograms), the Order Rank$_i$ (the sequence in which orders were placed), a squared term for the order rank, and an indicator variable for if the order involved trade credit, which are factors retailers reported as influencing their prioritization decisions in addition to loyalty. None of these specifications substantially change the magnitude or significance of our main interaction effect of outside sales with loyalty. The persistent and dominant effect of the "Loyal Client" designation across these specifications is consistent with the retailers' self-expressed objective of maintaining a regular demand through loyal customer relationships.

4.1.2 Ice manufacturer entry reduces risk that ice is unavailable.

In order to show that reduction in supply risk dissolves loyalty in relationships, we must have a source of variation in supply risk that is exogenous to fishermen's demand for ice. That source of variation, we argue, can be found in the entry of additional ice manufacturers, the timing of which as discussed above was unexpected. In this sense, we follow the approach of an event study across the three wharves, exploiting idiosyncratic variation in entry timing. In this subsection, we show that entry by new ice manufacturers leads to sizable improvements in the price and timeliness of ice deliveries to customers. We also show that downstream this entry had substantial welfare implications for consumers of fish, consistent with fishermen becoming more productive once their key input became cheaper and more readily available.

In Figure 6, we show decreases in the incumbent manufacturer's price of ice corresponding to the entry of new manufacturers. Table 5 documents the effect of manufacturer entry on changes in prices and late deliveries for fishermen purchasing from the original five retailers who served the incumbent manufacturer. We include data on all fishermen purchases recorded by these retailers, including orders sourced from competitor manufacturers. As above, we use retailer records of each order i by fisherman j from retailer k on date t to measure the log price for ice, Log Price$_{ijkt}$, and an indicator for whether the order was delivered late, Late$_{ijkt}$. We then exploit the timing of manufacturer entry into each wharf to

estimate the effect of entry on our two dependent variables by regressing each on an indicator variable, Manufacturer Entry $(=1)_{w(k)t}$, which equals 1 following the entry of the first new manufacturer into wharf, w, on day, t. As above, we include time-varying weather controls, X_t, retailer fixed effects, η_k and calendar month fixed effects, $\tau_{m(t)}$ to address seasonality. The specification is:

$$\mathrm{Y}_{ijkt} = \theta_2 \text{Manufacturer Entry } (=1)_{w(k)t} + \eta_k + \tau_{m(t)} + X_t'\beta + \epsilon_{ijkt}. \tag{2}$$

The identifying assumption here, and in the regressions below, is that $\mathbf{E}[\epsilon_{ijkt}|\eta_k, \tau_{m(t)}, X_t] = 0$, or that after accounting for retailer fixed effects, month fixed effects and daily weather conditions, no unobserved factors are correlated with both manufacturer entry and the outcome variable Y_{ijkt}. We discuss our basis for this assumption in detail in Section 2 above, noting that (a) entry was triggered by the emergence of entrepreneurs with cash to investment and the lowering of procurement and financing barriers for industrial ice machines, (b) that the exact timing when each manufacturer entered a market was determined by idiosyncratic delays involving equipment, staff and production processes, and (c) that the incumbent manufacturer did not anticipate entry by its competitors. Furthermore, in our interviews we found no qualitative evidence that other unspecified factors may have been influencing both the entry of manufacturers and outcome variables such as prices, lateness, switching or credit.

Following manufacturer entry, we find that prices fall on average by 8% in column (1), and lateness falls on average by 17 percentage points in column (5).[28] In columns (2) and (6), we estimate the intensive margin of competition by replacing Manufacturer Entry with # Manufacturers, the count of ice manufacturers serving a wharf, and find that on average each new manufacturer is associated with a 4% price decrease and 5 percentage point decrease

[28]By using the full 18 months of data, which include the less active rainy season from July-September, these lateness results understate the magnitude of the decrease in year on year terms. In a specification using only the first two quarters of each year, the share of orders delivered late falls from 21.6% in the first half of 2013, to 1.4% of orders during the first half of 2014.

in the share of late deliveries.[29]

In columns (3) and (7), we explore competition spillovers across wharves by including # Manufacturers and # Outside Manufacturers, where the latter is the count of manufacturers active only in other wharves. We find that about 1/4 of the reduction in price, and all of the reduction in lateness is associated with generalized competition effects from outside the specific wharf. The former observation is consistent with the fact that the incumbent manufacturer maintained a single pricing scheme across all three wharves (as shown in Figure A2), and the latter point suggests that retailers were readily able to source additional supply from manufacturers in other wharves in order to reduce lateness.[30] Finally, we estimate a triple-difference specification to explore heterogeneity in Goderich wharf and for loyal customers. In column (8), we find that the reduction in lateness was concentrated primarily among non-loyal clients and customers outside of Goderich, who were previously those most exposed to late orders as shown in Table 3.

Returning to Figure 5, it is striking to note the visual decrease in the propensity for late deliveries as sales by manufacturers other than the incumbent M1 expand. While there is a major decrease in lateness during the rainy season from July-September when overall production decreases at the factory, lateness returns again as orders pick up after the rainy season. Late orders then drop dramatically following manufacturer entry and competition, and do not return to their previous levels when comparing January 2014 - July 2014 to the same half of the prior year.

[29] We can use the quantity data, shown Table A2, along with these estimates of the price effect to estimate a price elasticity of demand. Comparing the first half of 2013 to the first half of 2014, aggregate ice quantity sold to fishing firms across all manufacturers—including sales by retailers and those directly from the factory—increased by about 15%, and the increase in Goderich alone was 21%. Using the price effect estimated in column (1) of Table 5 we thus estimate an arc price elasticity of demand of approximately 1.9, which is consistent with the characterization of the fishermen customers as highly price sensitive.

[30] Consistent with this, in interviews the retailers report using their relationships with competing manufacturers to smooth shocks to supply and demand, often checking the capacity of each manufacturer to supply orders on a given day and threatening to redirect orders to a competitor if deliveries arrived late.

4.1.3 Ice manufacturer entry causes relational contracts to be redrawn, shifting the balance of benefits from retailers to their customers.

Having established a reduced form relationship between manufacturer entry and a reduction in supply risk, we now show that, in the same time series, entry also dissolves loyalty in relationships and leads trade credit to expand. Both results are being consistent with more intensive competition among retailers, and more value captured by customers.

Using data on retailer and customer identities, we document a large increase in the previously infrequent patterns of customer-retailer switching after manufacturer entry, which we interpret as the breakdown of "loyalty" in relationships. This result can be seen graphically in Figure 7, in which we plot the weekly count of customer-retailer switches - when a fisherman orders from a different retailer than the previous order - and the cumulative share of fishermen who have made at least one switch in our data. The visual results are stark: before new manufacturer entry, about 5% of fishing firms completed less than 20 switches; after entry, 50% of fishing firms made over 200 switches.[31] The cumulative probability of switches rises sharply after manufacturer entry into Goderich (W3), where multiple agents compete directly for customers at baseline.[32] We only observe 12 new fishermen (an 8.5% increase) in the transaction data after new manufacturer entry, so the increase in switching cannot be solely due to the entry of new customers without pre-existing retailer relationships.

We now examine visually effects on credit provision by retailers. Figure 8, shows that the aggregate credit supply in Goderich spikes after new manufacturer entry, but not in the other two wharves. It is also important to note the sequencing of this credit increase in Goderich, as it starts not shortly after manufacturer entry in October 2013, but rather after customer-retailer switches started to rise in early 2014, and peaks in the 2nd quarter of 2014 (April-June). This observation supports the interpretation that improvements in the availability of ice sourced from other wharves induced more vigorous competition between

[31] Switching retailers is not significnatly correlated with prior "Loyal Client" status, relationship length or close friendship, underlining the major transformation of economic relationships.

[32] Appendix Figure A3 shows switching for Goderich only, where 80% of fishermen switched retailers.

retailers in Goderich. Credit was used for competition as, given fixed retail prices, it was the only margin available. Because the retailers in Aberdeen and Tombo were legacy monopolists and served smaller markets, they did not have to compete as vigorously to maintain their supply relationships and thus did not extend credit increases.

In Table 6, we quantify the effects of manufacturer entry on customer-retailer switching and increased credit provision. As earlier, we use retailer records of each order i by fisherman j from retailer k on date t to construct an indicator for whether the order was made with a different retailer than the most recent previous order, Switch Retailer $(=1)_{ijkt}$, and if the order involved trade credit, Credit Order $(=1)_{ijkt}$. We then run the same specification as in Equation 2 on these two dependent variables, including retailer fixed effects, η_k, month fixed effects, $\tau_{m(t)}$, and time-varying weather controls, X_t, as above.

Column (1) of Table 6 shows that the likelihood of switching retailers increased by 9 percentage points overall after manufacturer entry. In column (2), the entry dummy is interacted with an indicator variable for Goderich (W3), and show that while switching increases by 2 percentage points in the remaining two wharfs, the effect is six times larger in Goderich. This positive interaction effect provides a confidence check to show that this effect is largest in markets where switching was easiest given the presence of multiple retailers. In Tombo and Aberdeen, the alternative, except for a brief period in which an additional retailer enters, the alternative was generally to buy from another wharf or from a manufacturer directly. [33] Column (3) adds an additional triple interaction term for whether the customer had previously been identified as loyal. Here we see that loyal customers in Goderich are 8 percentage points less likely to switch than their non-loyal counterparts (p=.03), consistent with the observation that where switching is less costly, loyalty dampens switching effects. This indicates that after uncertainty is reduced, the ensuing retailer competition does not fully transition the market to anonymous exchange; loyalty still plays a role. As an additional check to ensure that our results are not driven by selection of months into the sample, column

[33]Indeed, note that this switching estimate is a lower bound given that we do not have data on the fishermen orders from other retailers who entered Goderich after the onset of manufacturer competition.

(4) restricts the sample to only Q2 of 2013 and 2014. While we now do not have statistical power to detect whether the triple interaction coefficient is different from zero, it is of similar size to that observed in column (3), with a magnitude of 6 percentage points.[34]

To understand how and why relationships were preserved—or restored—in the absence of supply uncertainty, we explore the effects of manufacturer entry on retailer credit provision. Columns 5-8 report estimates of 2 with a binary outcome variable for whether trade credit was provided with the order. Column (5) shows a 9 percentage point increase in the likelihood of credit provision, and columns (6) demonstrates that, similar to the effects on switching, the effect is strongest in Goderich wharf where we had preexisting competition among retailers. The triple interaction-term in column (7) is positive but not significant due to a large standard error, suggesting that loyal customers in Goderich may have received more credit than their non-loyal counterparts in the same wharf, but not significantly so. Here we also see that loyal customers outside of Goderich are slightly more likely to receive credit, potentially a tradeoff relative to relatively more late orders observed in 3. In column (8), we restrict the time period to only the 2nd quarters of 2013 and 2014 (April-June), which was the period in which credit supply spiked as noted in Figure 8 above. Here we find that the likelihood of receiving credit increased by 21 percentage points for non-loyal customers year on year, and 12 additional percentage points for loyal customers (SE=.06, p=.06) - a more than 50% increase in credit provision to loyal customers. We interpret this heterogeneity as suggestive evidence that after manufacturer entry retailers continued to invest in their most valued customers, but substituted from the margin of prioritizing late deliveries to expanding trade credit. Once the rent retailers could charge for controlling supply risk disappeared, they were forced to compete for loyalty by providing services.

Overall, we interpret the results in Table 6 as evidence of an aggregate decline in loyalty, and an increase in competition among retailers concurrent with the entry of manufacturers and the reduction of supply risk. Field interviews provide further detail as to what the

[34]Unfortunately, we cannot comment on the persistence of this credit increase as the ebola virus reached Freetown in July 2014, disrupting data collection and economic activity.

mechanisms behind this effect were. Informants identified three. First, the reduction in lateness effectively removed a margin by which loyalty was previously rewarded through prioritization. Second, retailers gained access to new supply sources at different times, creating variation in the availability and price across retailers that increased short-term benefits to customers from switching. Third, the potential arrival of new retailers placed pressure on existing horizontal relationships through which retailers avoided competing for each other's customers, triggering a competition for market share and a fresh effort to secure the loyalty of valued customers.

4.2 Reduced supply risk and increased competition in input production leads to improvements in consumer welfare

In our second result, we estimate the downstream effects of ice manufacturer entry on the final good market for fish. In Table 7, we explore how the price effects of manufacturer entry propagate downstream to affect the quantity and price of fish. This provides evidence that the improved availability of ice increased the productivity of the fishing sector, leading to substantial benefits for consumers. In Panel A, we exploit 22 high frequency waves of survey data covering May 2013-July 2014 in which we asked fishermen to report on their total catch for each trip in the previous two weeks. Specifically, we calculate the average number of fish caught per fishing firm in each wharf-wave, separating fish caught far from shore, which we call "Ice fish," and those caught close by called "Non-Ice fish," and estimate the following regresssion:

$$\text{Average Fish Caught}_{fwt} = \theta_3 \text{Manufacturer Entry } (=1)_{wt} + \mu_f + \eta_w + \tau_{m(t)} + \epsilon_{fxt} \qquad (3)$$

Equation 3 includes fixed effects for whether the total reflects whether the fish is "Ice fish" or not, μ_f, wharf, η_w, and calendar month of survey, $\tau_{m(t)}$. In column (1) we estimate an increase of 17,341 in the average number of fish caught (45% of the mean value) following

manufacturer entry without fixed effects. This estimate decreases in column (2) to 10,953 (29% of the mean value) when including all fixed effects—part of this difference is due to the fact that different magnitudes of ice fish are caught relative to non-ice fish. In column (3), we present a difference in difference test of the impact of entry on productivity. We interact the indicator variable for Manufacturer Entry with an indicator variable for fish caught with ice, and find that the quantity of fish caught with ice increased more in absolute terms than fish caught without ice. Here we find that the effect of entry on productivity is concentrated in Ice fish, with the a large and highly significant coefficient on the interaction term. In columns (4) and (5) we provide another version of this test and show the separately estimated regresions on the subsample of non-ice fish and ice fish, respectively. We observe increases in both fish categories (56% of the mean value in non-ice fish, and 25% in ice fish), though the mean level of fish caught with ice is 7.8 times larger than fish caught without ice. Figure 9 provides a visual representation of these regression results, where following manufacturer entry we observe a sharp and sustained increase in the average fish caught per fisherman for ice fish, and a more modest increase for non-ice fish from a far lower base that is not sustained.[35]

One concern about this result is that ice fish and non-ice fish may be of different sizes. If ice fish were systematically smaller in weight (in this case by a factor of roughly 4), our results could be consistent with a differential effect of entry on productivity of fishing in terms of kilogram yield. Unfortunately, given that our survey was due to logistical constraints only able to capture numbers of fish and not their weights, we cannot directly test whether this is true. It is highly unlikely, however, given the nature of the fishing ecology. An independent fishing supply analysis commissioned by M1 observed that fish caught farther from shore are systematically larger, as is typical globally. In this case, our results with counts of fish systematically understate the difference in differences in terms of weight.

In Panel B of Table 7, we conduct a similar difference in difference analysis on impact of

[35]Recall that our fishermen sample was constructed based on the universe of customers who fish with ice.

entry on the consumer price of fish with the following regression using two years of official microdata from the monthly consumer price index (CPI) at six markets in Freetown, where we include fixed effects for all 12 fish types, μ_f, market, η_x, and month of the CPI, $\tau_{m(t)}$.[36]

$$\text{Log Price Fish}_{fxt} = \theta_4 \text{Manufacturer Entry } (=1)_t + \mu_f + \eta_x + \tau_{m(t)} + \epsilon_{fxt} \tag{4}$$

In column (1), we find a 5% average decrease in the price of 12 different varieties of fish sold in the Freetown markets following manufacturer entry, and this result is robust to including fixed effects for market, fish type and month in column (2). In column (3), we interact the indicator variable for Manufacturer Entry with an indicator variable for fish caught with ice, and find that the price of fish caught with ice decreased by more, and this result is significant at the 10% level. In columns (4) and (5), we show this result in another way by splitting our sample into ice fish and non-ice fish. Those fish that do not require ice show no significant price decrease in column (4), while those that do show a 10% price decrease in column (5). This result is consistent with increased supply of fish requiring ice as a consequence of the increased fishermen productivity observed in panel A.

We can provide a rough estimate the aggregate benefit to of this price decline to consumers. To do this we multiply the percentage price reduction by an estimate of the value of fish consumed. Specifically, we multiply the 10% price decrease by 50% of the types of fish that require fish to be caught, the share of fish overall in the CPI consumption basket (5.49%), the consumption share of GDP (100.8% in 2014) and GDP PPP in constant 2011 dollars ($11.98bn), resulting in a total of $33.15 million in PPP 2011 constant dollars. Dividing by the total population of approximately 6.35 million results in $5.22 per capita, which is roughly 0.3% of GDP PPP per capita for that year.[37] The effect is modest, but non-negligible in a low-income country like Sierra Leone and given the comparatively small capital investments by new manufacturers. Overall, we interpret these results as showing

[36]Because CPI data is only collected in Freetown and not in Tombo, we use the month of the first new manufacturer entry into the Goderich and Aberdeen wharves to estimate our coefficient of interest, θ_4.

[37]GDP numbers are taken from the World Development Indicators.

that market structure, in this case for an intermediate input such as ice, can have substantial implications for welfare in low-income countries.

5 Conclusion

Ongoing relationships allow buyers and sellers to smooth uncertainty over supply and demand, to share information and build trust, and to privately enforce agreements when formal institutions are weak. Our findings highlight the endogeneity of relationships to local market structure and specifically how a shift in supply uncertainty in a market can spur the reformulation of well-established contractual norms. While previous literature has focused on how existing relationships affect contractual and market outcomes, our analysis highlights how relationships may emerge, or dissolve, as a function of market structure.

The onset of ice manufacturer competition, and its concomitant reduction in uncertainty over ice supply, contributes to the dissolution of loyalty in downstream relationships between retailers and customers, as evidenced in the sharp onset of buyer-retailer switching despite their previous unwillingness to switch. Without the ability to reward loyalty through prioritized deliveries, retailers had to compete instead for buyer relationships using increased trade credit. We find that previously labeled loyal customers are less likely to switch and more likely to receive credit increases. Thus, we observe a transition in the distribution of trade surplus that rewards the "long side of the market" (MacLeod and Malcomson, 1989), as benefits from trade move from the monopolistic manufacturer to the downstream retailers, fishermen customers, and ultimately fish consumers after the onset of competition. In particular, we observe that while average prices and lateness decrease everywhere following new manufacturer entry, credit provision only increases in the wharf where multiple existing retailers also compete.

Our findings are also informative about the function of market competition in developing economies. We demonstrate sizable improvements in contractual terms following competi-

tion, suggesting externalities from market power that may serve to constrain firm growth. We also find that market power matters at each level of the supply chain, with variation in retailer competition appearing just as important as manufacturer competition in explaining why credit provision increases. Given the high concentration of market power in upstream industries in low-income countries, our results suggest that policymakers should pay close attention to promoting entry and competition.

Finally, our results that loyalty remains somewhat important in determining trade credit provision suggest that informal institutions are resilient and do adapt to market changes. Firms entering emerging economies must account for informal institutions that govern who does business with whom before engaging in competition. Further, incumbents may find it advantageous to integrate valued retailer networks in order to deter entry. In the case of M1, integrating the retailers, who kept their same market shares after competition, may have established a barrier to entry of the other vendors, as they lacked their own retailers to access the fishermen. In the absence of such strategic responses, upstream market competition is likely to result in the reallocation of value to downstream retailers, customers and consumers.

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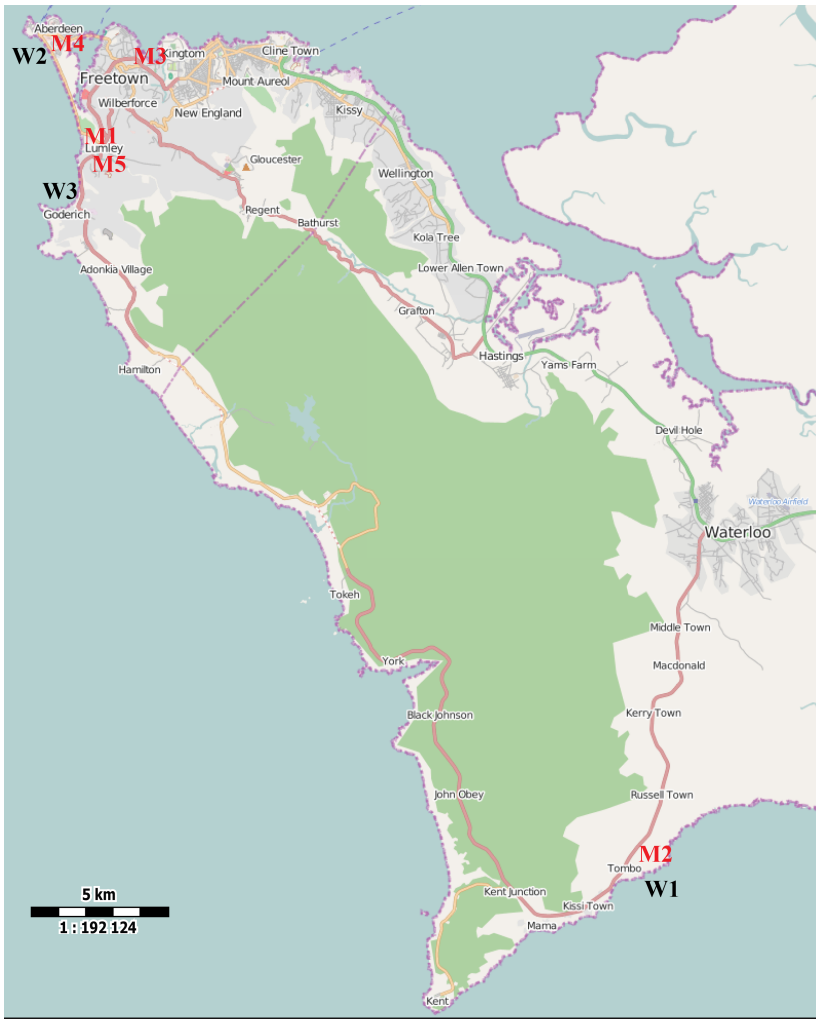
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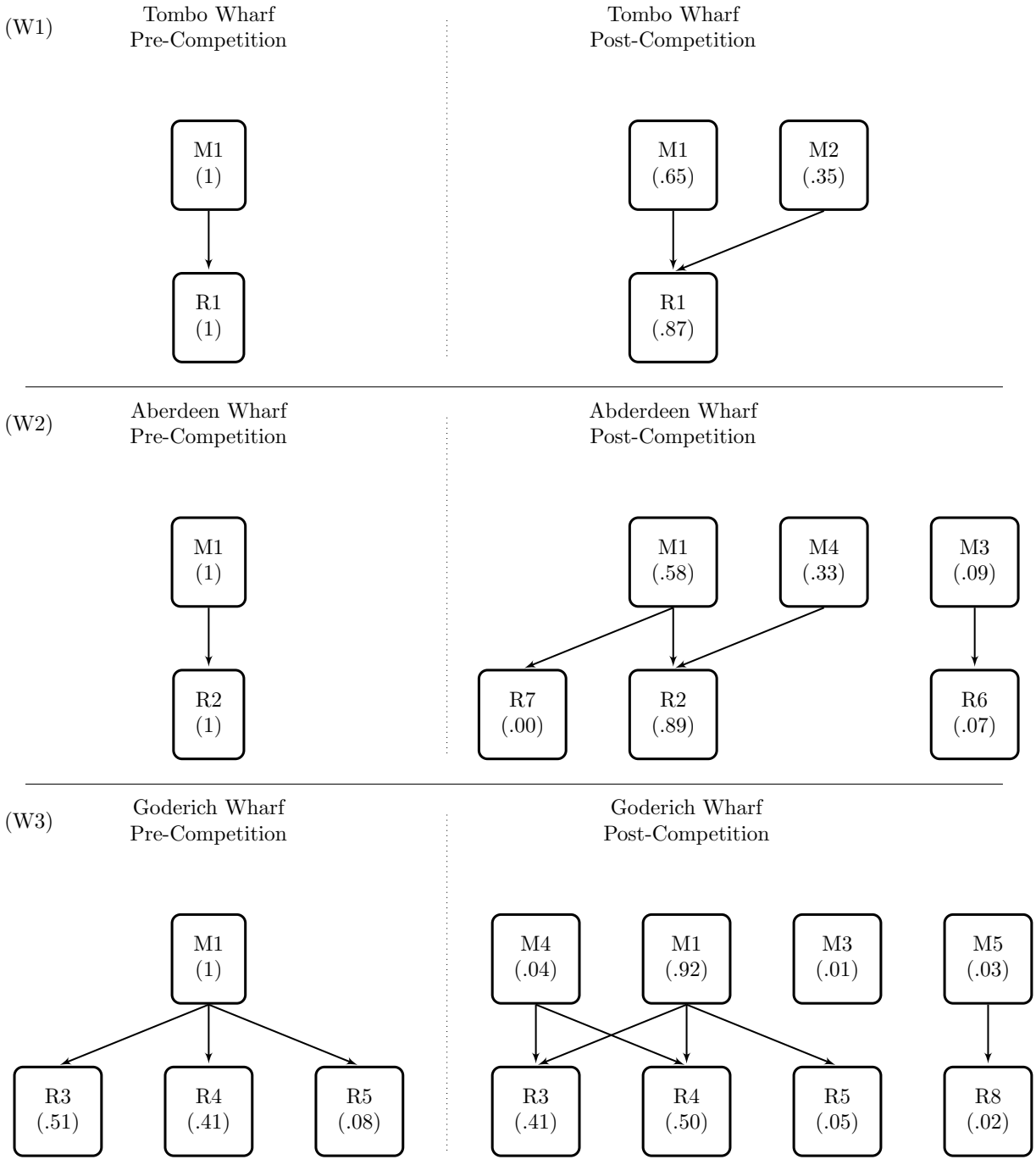
Figures and Tables

Figure 1: Map of Freetown Peninsula, Sierra Leone



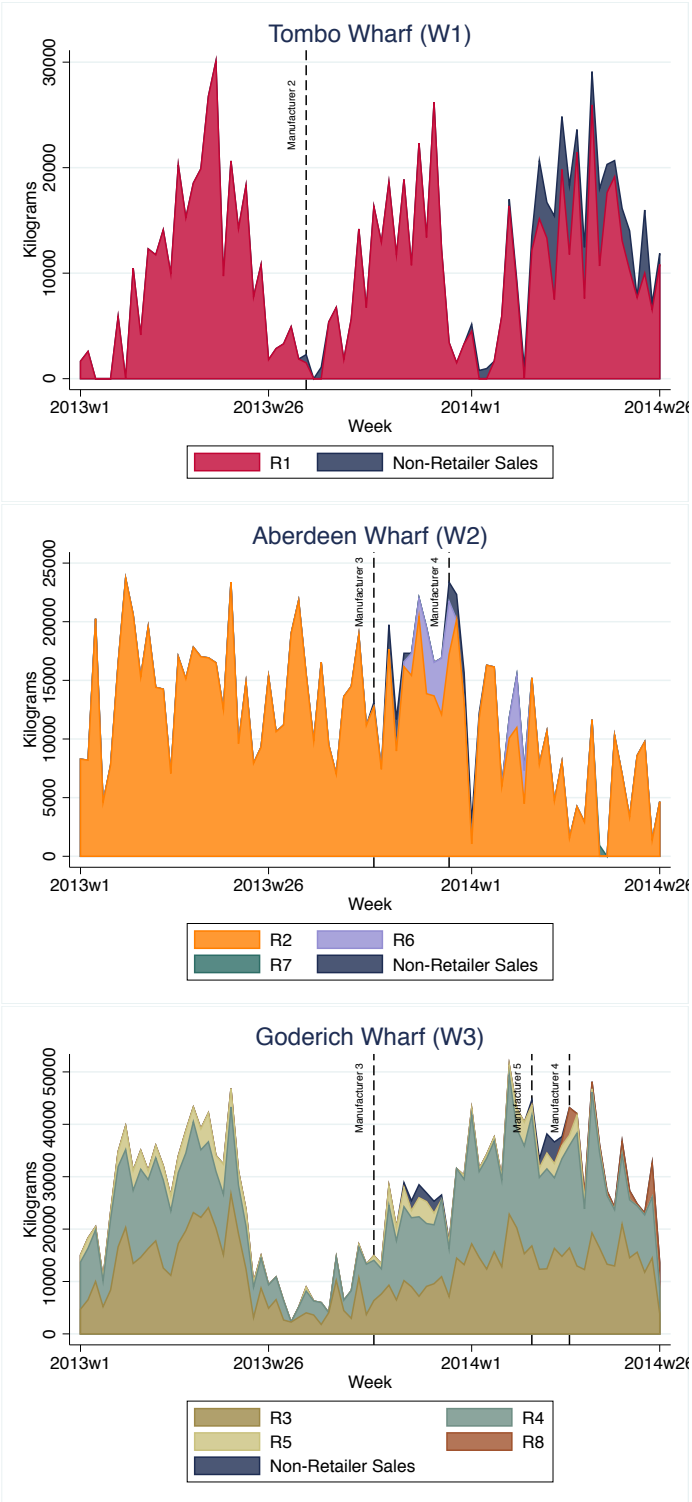
Notes: Map shows the approximate location of three major fishing wharves served by the ice factories: Tombo (W1), Aberdeen (W2) and Goderich (W3). It also shows the factory locations of the incumbent manufacturer IIB (M1), and the new entrant manufacturers (M2, M3, M4, M5), which are highlighted in red and numbered by entry order.

Figure 2: Market Structure Pre- and Post-Competition



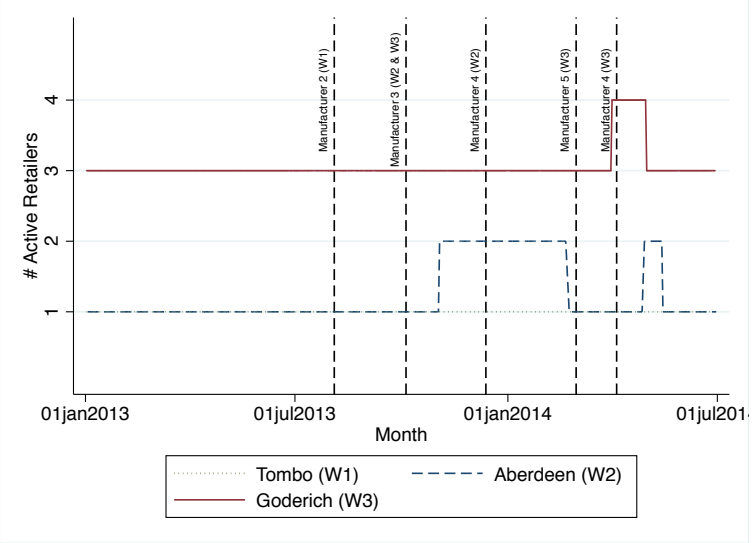
Notes: This figure presents the market structure of manufacturers (designated by M) and retailers (designated by R) in each of the three wharves before and after the onset of new manufacturer entry. Manufacturer and retailer market shares are reported in parentheses, corresponding to January 2013 until the onset of competition in the left panels, and from competition to July 2014 in the right panels. Retailer market shares do not always sum to 1 due to direct customer sales by Manufacturers 2 and 3. See paper text for details.

Figure 3: Retailer and Non-Retailer Sales, Partitioned by Wharf



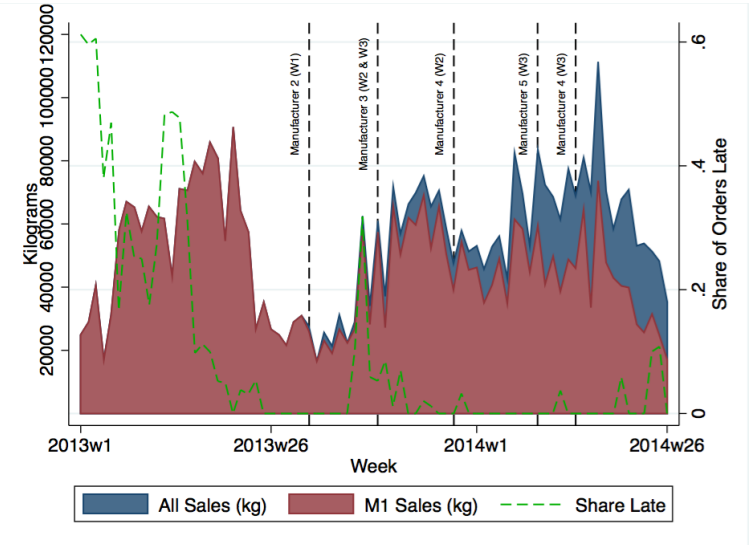
Notes: Y-axis shows the weekly total sales (in kilograms) for each retailer, or in the case of "Non-Retailer Sales," the remaining sales made directly by manufacturers to fishermen customers in each wharf. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Figure 4: Number of Active Retailers over Time



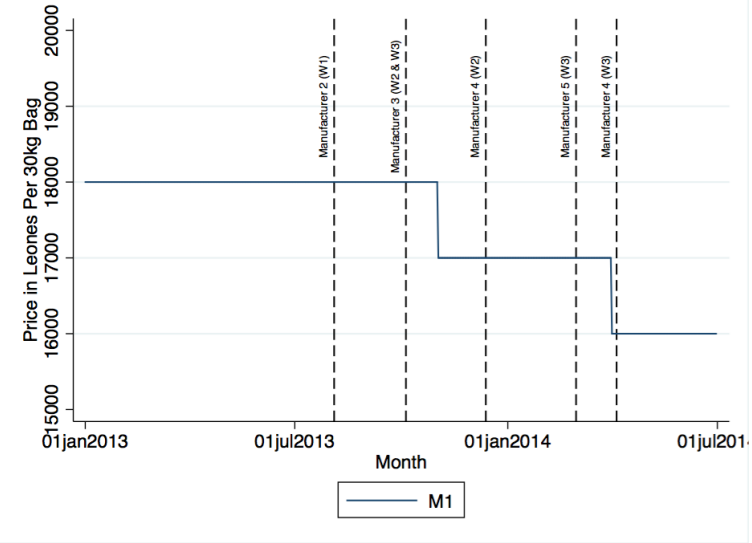
Notes: This figure presents the number of active retailers in each of the three wharves. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Figure 5: Total Fishermen Ice Sales and Lateness



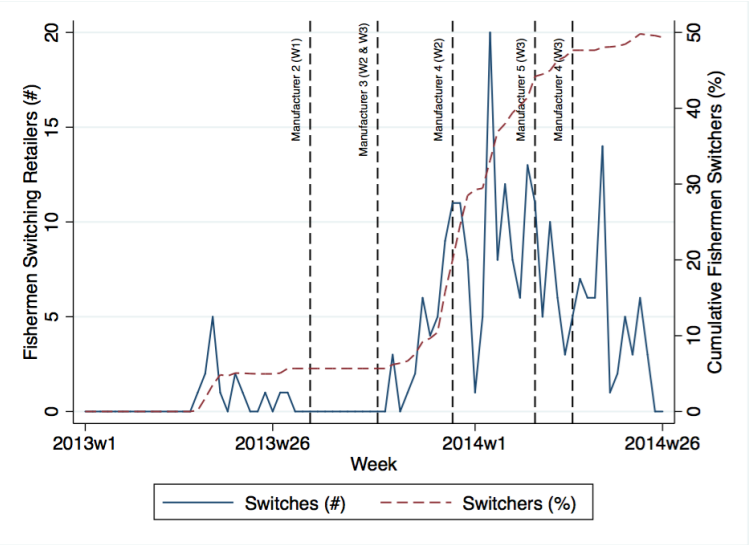
Notes: This figure presents weekly total sales (in kilograms) to all fishing buyers (separated into Manufacturer 1 "M1" sales and all sales) and share of orders delivered late. There is an unknown quantity of missing data until February 2013, so some sales up until that point have been censored. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Figure 6: Entry and Price Competition



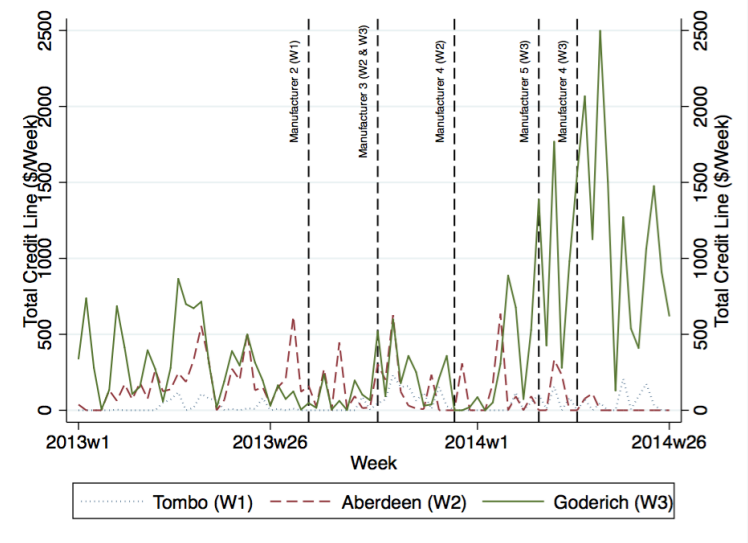
Notes: Y-axis shows the incumbent manufacturer's retail price per 30 kilogram bag of ice sold in all three wharves (Tombo, Aberdeen and Goderich). Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves. See paper text for more details.

Figure 7: Customer Switching



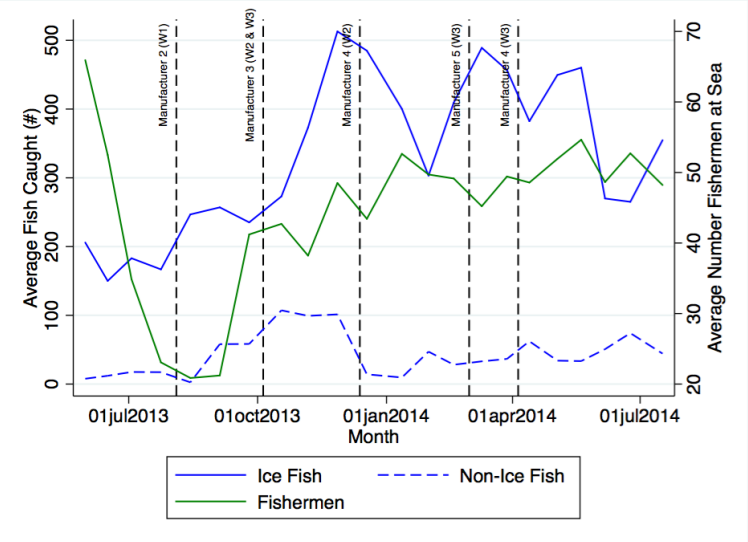
Notes: This figure presents the count of weekly customer-retailer switches and the cumulative percentage of fishing customers who are observed switching retailers across all wharves during the 18-month data collection period with the 5 incumbent retailers. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Figure 8: Credit Provision



Notes: This figure presents the aggregate weekly credit provision provided by the five incumbent retailers in each of the three wharves during the 18-month data collection period. We convert credit totals to US dollars with the average exchange rate of 4200 Leones during this period. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Figure 9: Fishing Intensity



Notes: This figure presents the average number of fish caught per fisherman and the average number of fishermen at sea during the previous two weeks over a 22 high frequency survey waves from May 2013 - July 2014. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Table 1: Baseline Summary Statistics

		By Wharf				
	All	W1	W2	W3	Min	Max
Age	40.23 (9.35)	39.11 (9.71)	41.68 (11.48)	40.20 (8.42)	24.00	82.00
Years Fishing Experience	17.31 (8.70)	15.70 (11.19)	18.06 (8.82)	17.73 (7.34v	1.00	47.00
Own Fishing Boat (=1)	0.61 (0.49)	0.68 (0.47)	0.90 (0.30)	0.48 (0.50)	0.00	1.00
Captain Fishing Boat (=1)	0.81 (0.39)	0.65 (0.48)	0.90 (0.30)	0.85 (0.36)	0.00	1.00
Fishing Trips Per Month	9.57 (10.61)	15.22 (17.03)	7.42 (6.19)	7.96 (7.06)	2.00	86.00
Major Fishing Assets ($)	9,107.34 (7,492.56)	11,646.70 (8,901.26)	8,130.65 (8,539.43)	8,318.85 (6,109.30)	1,035	45,195
Standard Trip Expenses ($)	375.76 (167.83)	311.74 (132.68)	382.30 (198.94)	402.26 (163.93)	54.42	941.39
Ice as Share of Trip Expenses	0.26 (0.12)	0.26 (0.07)	0.33 (0.07)	0.24 (0.14)	0.00	0.76
Relationship Years	4.22 (3.11)	3.97 (2.88)	3.42 (2.54)	4.65 (3.36)	0.00	20.00
Retailer Survey: Loyal Client (=1)	0.73 (0.45)	0.68 (0.47)	0.90 (0.30)	0.68 (0.47)	0.00	1.00
Retailer Survey: Close Friend (=1)	0.73 (0.45)	0.76 (0.43)	0.55 (0.51)	0.78 (0.42)	0.00	1.00
Retailer Survey: Coethnic (=1)	0.33 (0.47)	0.73 (0.45)	0.65 (0.49)	0.04 (0.19)	0.00	1.00
Observations (Firms)	153	37	31	85		

Notes: Standard deviations reported in parentheses. W1 refers to Tombo, W2 refers to Aberdeen, and W3 refers to Goderich.

Table 2: Correlates of Ex-Ante Loyalty

	Loyal Client (=1)						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Relationship Years	0.01	0.14***					
	(0.02)	(0.04)					
Relationship Years Squared		-0.01***					
		(0.00)					
Bought Longer (=1)			-0.08				
			(0.09)				
Close Friend (=1)				0.51***			
				(0.08)			
Coethnic (=1)					0.20***		
					(0.07)		
More Ice (=1)						0.22***	
						(0.07)	
Fishing Risk Tolerance							0.15
							(0.18)
Constant	0.69***	0.47***	0.75***	0.36***	0.66***	0.65***	0.65***
	(0.07)	(0.09)	(0.04)	(0.07)	(0.05)	(0.05)	(0.10)
# Observations (Firms)	153	153	153	153	153	153	149
R-Squared	0.00	0.08	0.01	0.26	0.04	0.05	0.00

Notes: Loyal Client (=1) is an indicator variable that equals one if the retailer reported that this fisherman customer would only buy from him even if other ice supply was available, using the primary retailer from the baseline data. Relationship Years is the length of a fisherman's retailer relationship. Bought Longer (=1) is an indicator for if that fisherman was in the top tercile of relationship length. Close Friend (=1) is a indicator that equals one if a retailer indicated this buyer was a close friend. Coethnic (=1) is a indicator that equals one if a retailer indicated the buyer shared his ethnicity. More Ice (=1) is a indicator for if that fisherman was in the top tercile of self-reported ice expenditures as a share of trip expenses. Fishing Risk Tolerance is the average of three risk tolerance questions about dangerous fishing practices rescaled on a 0-1 continuous scale. Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: Outside Ice Sales, Lateness and Loyalty

	Late Ice Delivery (=1)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Outside Sales	0.11***	0.06***	0.09***	0.09***	0.07**	0.01*	0.01*	0.02
	(0.01)	(0.02)	(0.03)	(0.03)	(0.03)	(0.01)	(0.01)	(0.01)
Outside Sales X Loyal (=1)			-0.03**	-0.03*	-0.01	-0.01*	-0.01*	-0.02**
			(0.02)	(0.01)	(0.02)	(0.00)	(0.00)	(0.01)
Loyal Client (=1)			-0.01	0.05**	0.05**	0.01	0.02**	0.02*
			(0.01)	(0.02)	(0.02)	(0.00)	(0.01)	(0.01)
Goderich X Loyal (=1)				-0.12***	-0.12***		-0.02*	-0.02*
				(0.04)	(0.04)		(0.01)	(0.01)
Outside Sales X Goderich (=1)					0.03			-0.02
					(0.04)			(0.01)
Outside Sales X Goderich X Loyal (=1)					-0.03			0.02*
					(0.04)			(0.01)
Time Period	Pre-Entry	Pre-Entry	Pre-Entry	Pre-Entry	Pre-Entry	Post-Entry	Post-Entry	Post-Entry
Mean Dep Var	0.18	0.18	0.18	0.18	0.18	0.03	0.03	0.03
# Firms	142	142	142	142	142	154	154	154
# Observations	2649	2649	2649	2649	2649	2603	2603	2603
R-Squared	0.09	0.21	0.21	0.21	0.21	0.25	0.25	0.25
Weather Controls	NO	YES	YES	YES	YES	YES	YES	YES
Month FE	NO	YES	YES	YES	YES	YES	YES	YES
Retailer FE	NO	YES	YES	YES	YES	YES	YES	YES

Notes: Late Ice Delivery (=1) is an indicator variable for whether an order was delivered late, and an observation is an order. Data includes purchases from the original five retailers serving the incumbent manufacturer. Outside Sales is the total kilograms of all non-fishing ice sales made by the incumbent manufacturer (M1) on that day, normalized by sutracting the population mean and dividing by the standard deviation. Loyal Client (=1) is an indicator variable that equals one if the retailer reported this buyer would only buy from him even if other ice supply was available. Goderich (=1) is an indicator variable for an order in Goderich wharf. Weather controls include average daily temperature, hours of rain, and average windspeed. Time period is prior to the entry of the first competitor manufacturer in each wharf in columns (1) - (5) and following entry in columns (6) - (8). Regressions include weather controls, retailer fixed effects, and month fixed effects as noted. Robust standard errors, two-way clustered by fishing firm and delivery date, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4: Lateness and Loyalty - Robustness

	Late Ice Delivery (=1)					
	(1)	(2)	(3)	(4)	(5)	(6)
Outside Sales	0.10***	0.09***	0.09***	0.09***	0.10***	0.10***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Outside Sales X Loyal (=1)	-0.03**	-0.03**	-0.04*	-0.03**	-0.03**	-0.04**
	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Loyal Client (=1)	-0.00	-0.01	0.01	-0.01	-0.01	-0.00
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)
Outside Sales X Relationship Years	-0.00					
	(0.00)					
Relationship Years	-0.00					
	(0.00)					
Outside Sales X Bought Longer (=1)		0.00				
		(0.02)				
Bought Longer (=1)		-0.01				
		(0.02)				
Outside Sales X Close Friend (=1)			0.01			
			(0.02)			
Close Friend (=1)			-0.02			
			(0.02)			
Outside Sales X Coethnic (=1)				0.00		
				(0.02)		
Coethnic (=1)				0.02		
				(0.01)		
Outside Sales X More Ice (=1)					-0.02	
					(0.02)	
More Ice (=1)					-0.01	
					(0.01)	
Order Size						0.01
						(0.01)
Order Rank (#)						0.01
						(0.01)
Order Rank Squared						-0.00
						(0.00)
Credit Order (=1)						0.02
						(0.02)
Time Period			Pre-Entry			
Mean Dep Var	0.18	0.18	0.18	0.18	0.18	0.18
# Firms	142	142	142	142	142	142
# Observations	2649	2649	2649	2649	2649	2649
R-Squared	0.21	0.21	0.21	0.21	0.21	0.21
Weather Controls	YES	YES	YES	YES	YES	YES
Retailer FE	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES

Notes: See Table 3 notes. Order Rank measures the sequence in which a buyer's orders were submited to a given retailer on a given day. Order Size is the quantity of ice demanded in kilograms, subtracting the population mean and dividing by the standard deviation. Credit Order (=1) is an indicator for if a buyer paid less than the full cost for the order upfront. All regressions include weather controls, retailer fixed effects, and calendar month fixed effects. Robust standard errors, two-way clustered by fishing firm and delivery date, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 5: Effect of Competition on Ice Prices and Lateness

	Log Ice Price (Leones)				Late Ice Delivery (=1)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manufacturer Entry (=1)	-0.08***			-0.07***	-0.17***			-0.10**
	(0.00)			(0.01)	(0.02)			(0.04)
# Manufacturers		-0.04***	-0.03***			-0.05***	-0.00	
		(0.00)	(0.00)			(0.01)	(0.01)	
# Outside Manufacturers			-0.01***				-0.10***	
			(0.00)				(0.01)	
Entry X Goderich (=1)				-0.02*				-0.13***
				(0.01)				(0.04)
Entry X Loyal Client (=1)				0.00				-0.08**
				(0.01)				(0.04)
Loyal Client (=1)				0.00				0.10***
				(0.00)				(0.03)
Goderich X Loyal (=1)				-0.00				-0.17***
				(0.00)				(0.03)
Entry X Goderich X Loyal (=1)				-0.00				0.16***
				(0.01)				(0.04)
Time Period	All Months							
Wharf Sample	All	All	All	All	All	All	All	All
Mean Dep Var	9.77	9.77	9.77	9.77	0.11	0.11	0.11	0.11
# Firms	155	155	155	155	155	155	155	155
# Observations	5281	5281	5281	5281	5281	5281	5281	5281
R-Squared	0.66	0.68	0.71	0.67	0.17	0.14	0.20	0.17
Weather Controls	YES	YES	YES	YES	YES	YES	YES	YES
Retailer FE	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Log Ice Price (Leones) is the natural logarithm of the average price paid for a 30kg bag of ice, Late Ice Delivery (=1) is an indicator variable for whether an order was delivered late, and an observation is an order. Manufacturer Entry (=1) is a indicator that equals one after the entry of the first new ice manufacturer in a wharf, # Manufacturers is the count of ice manufacturers serving a wharf, # Outside Manufacturers is the count of ice manufacturers active only in other wharves, and Goderich (=1) is an indicator for an order in Goderich wharf. Data includes purchases from the original five retailers serving the incumbent manufacturer, and does include sales by these retailers on behalf of other manufacturers. Time period covers January 2013 to June 2014. All regressions include weather controls, retailer fixed effects and calendar month fixed effects. Robust standard errors, two-way clustered by fishing firm and delivery date, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Effect of Competition on Retailer Switching and Credit Provision

	Switch Ice Retailer (=1)				Ice Credit Order (=1)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Manufacturer Entry (=1)	0.09***	0.02**	0.01	-0.00	0.09***	0.04*	0.06**	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.03)	(0.02)
Entry X Goderich (=1)		0.12***	0.14***	0.08*		0.09***	0.06	0.22***
		(0.01)	(0.03)	(0.05)		(0.03)	(0.04)	(0.06)
Entry X Loyal Client (=1)			0.00	0.02**			-0.03	-0.07**
			(0.01)	(0.01)			(0.03)	(0.03)
Loyal Client (=1)			-0.01**	-0.01**			0.03*	0.02
			(0.01)	(0.00)			(0.02)	(0.03)
Goderich X Loyal (=1)			-0.06**	-0.07*			-0.02	-0.03
			(0.03)	(0.04)			(0.03)	(0.04)
Entry X Goderich X Loyal (=1)			-0.08**	-0.06			0.05	0.12*
			(0.04)	(0.05)			(0.04)	(0.06)
Time Period	All Months			Q2	All Months			Q2
Mean Dep Var	0.05	0.05	0.05	0.03	0.16	0.16	0.16	0.18
# Firms	154	154	154	151	155	155	155	152
# Observations	4934	4934	4934	2197	5281	5281	5281	2276
R-Squared	0.10	0.12	0.15	0.09	0.07	0.07	0.07	0.15
Weather Controls	YES	YES	YES	YES	YES	YES	YES	YES
Retailer FE	YES	YES	YES	YES	YES	YES	YES	YES
Month FE	YES	YES	YES	YES	YES	YES	YES	YES

Notes: Switch Ice Retailer (=1) is a dummy variable for whether a buyer switched to a new retailer relative to their last recorded purchase, Ice Credit Order (=1) is a dummy that equals one if a buyer paid less than the full cost for their order upfront, and an observation is an order. Data includes purchases from the original five retailers serving the incumbent manufacturer, and does include sales by these retailers on behalf of other manufacturers. Time period covers April 2013-June 2013 and April 2014 to June 2014 when noted as "Q2", and otherwise from January 2013 - June 2014 when noted as "All". All regressions include weather controls, retailer fixed effects and month fixed effects. Robust standard errors, two-way clustered by fishing firm and delivery date, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 7: Effect of Competition on Fish Quantity and Prices

Panel A: Fish Quantity

	Average Fish Caught (#)				
	(1)	(2)	(3)	(4)	(5)
Manufacturer Entry (=1)	17341.53***	10953.64***	-981.29	4820.72***	17086.55***
	(3493.78)	(2143.50)	(3694.42)	(1033.96)	(4732.82)
Manufacturer Entry * Ice Fish (=1)			23869.86***		
			(7471.67)		
Fish Sample	All Fish	All Fish	All Fish	Non-Ice Fish	Ice Fish
Mean Dep Var	38096.29	38096.29	38096.29	8656.01	67536.58
# Survey Waves	22	22	22	22	22
# Observations	132	132	132	66	66
R-Squared	0.05	0.84	0.87	0.87	0.72
Wharf FE	NO	YES	YES	YES	YES
Ice Fish FE	NO	YES	YES	-	-
Month FE	NO	YES	YES	YES	YES

Panel B: Fish Price

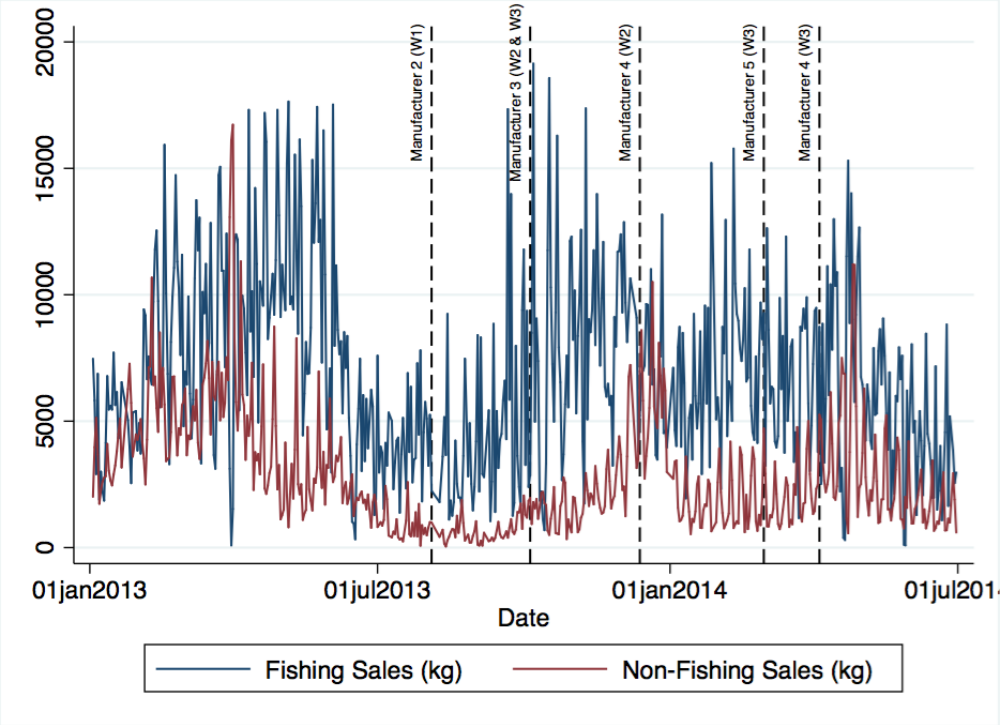
	Log Fish Price Per Kg				
	(1)	(2)	(3)	(4)	(5)
Manufacturer Entry (=1)	-0.05**	-0.05***	-0.01	-0.01	-0.10***
	(0.02)	(0.01)	(0.02)	(0.03)	(0.03)
Manufacturer Entry * Ice Fish (=1)			-0.09*		
			(0.05)		
Fish Sample	All Fish	All Fish	All Fish	Non-Ice Fish	Ice Fish
Mean Dep Var	9.25	9.25	9.25	8.92	9.58
# Months	24	24	24	24	24
# Observations	1728	1728	1728	864	864
R-Squared	0.00	0.67	0.68	0.61	0.17
Market FE	NO	YES	YES	YES	YES
Fish Type FE	NO	YES	YES	YES	YES
Month FE	NO	YES	YES	YES	YES

Notes: Dependent variable in top panel is the number of fish reported caught per fisherman surveyed from May 2013-July 2014, where quantity is aggregated over all trips in the last two weeks by each wharf, survey wave and by if fish type is caught with ice or not. Dependent variable in bottom panel is the log price of different types of fish per kilogram, as measured in monthly micro-data collected for Sierra Leone's Consumer Price Index at 6 markets in Freetown from January 2013 until December 2014. Robust standard errors, clustered at the year-month level, in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Online Appendix - Not for Publication

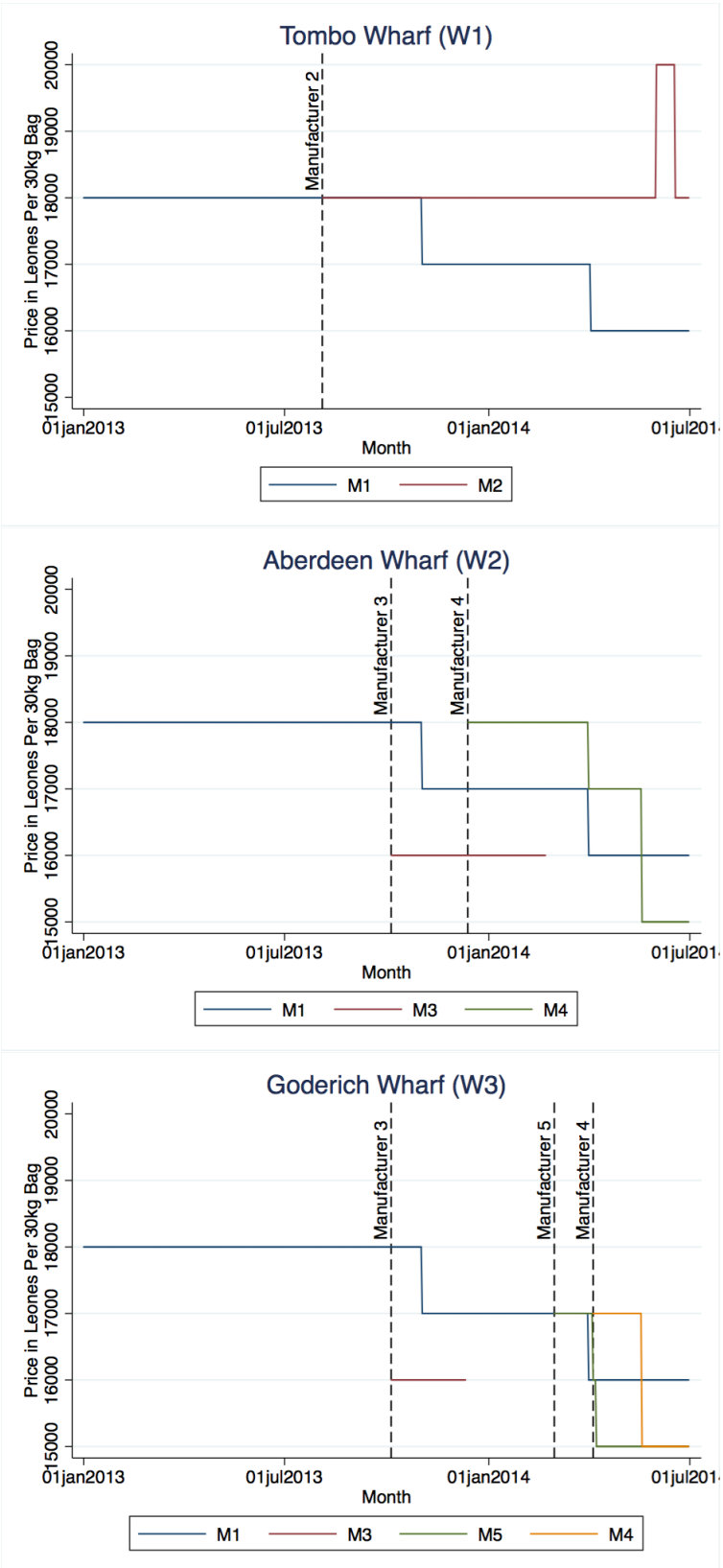
Appendix Figures and Tables

Figure A1: M1 Sources of Ice Demand (kg)



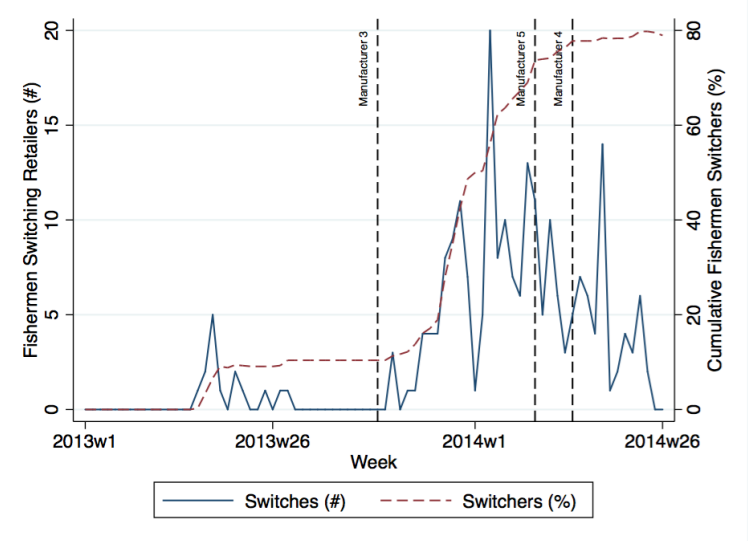
Notes: This figure presents the aggregate ice sales in kilograms by the incumbent manufacturer, M1 (Ice Ice Baby), to two sources of demand: fishermen and non-fishermen sources. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Figure A2: Entry and Price Competition, Partitioned by Wharf



Notes: Y-axis shows the retail price per 30 kilogram bag of ice. Vertical lines mark the first date of ice sales by a competitor manufacturer in that wharf.

Figure A3: Customer Switching - Goderich (W3) only



Notes: This figure presents the count of weekly customer-retailer switches and the cumulative percentage of fishing customers who are observed switching retailers within Goderich wharf during the 18-month data collection period with the 5 incumbent retailers. Vertical lines mark the first date of ice sales by a competitor manufacturer in one or more wharves.

Table A1: High Frequency Summary Statistics

		Before Manufacturer Entry			After Manufacturer Entry		
	All	W1	W2	W3	W1	W2	W3
Trip Length (Days)	2.87	2.44	2.83	1.85	2.78	3.33	3.44
	1.24	0.95	1.28	0.92	0.80	1.19	1.23
Trip Without Ice (=1)	0.24	0.24	0.26	0.45	0.10	0.17	0.22
	0.43	0.43	0.44	0.50	0.31	0.37	0.41
Ice Purchase (kg)	461.08	447.65	602.23	262.28	623.68	718.47	396.86
	353.22	275.05	472.73	299.82	265.59	486.56	275.30
Late Ice (=1)	0.07	0.16	0.01	0.08	0.14	0.03	0.02
	0.25	0.37	0.10	0.28	0.34	0.16	0.15
Trip Profits($)	110.75	33.59	126.81	135.29	115.90	128.81	100.81
	152.01	75.03	167.49	150.19	193.89	98.76	141.51
Observations (Trips)	4559	307	269	936	893	452	1702
Ice Ordered (kg)	714.63	652.89	832.11	644.18	779.51	822.72	699.56
	470.54	226.55	364.02	332.95	533.19	440.67	622.87
Ice Delivered (kg)	690.94	494.03	818.52	629.79	779.51	822.72	699.56
	481.61	306.37	371.05	334.40	533.19	440.67	622.87
Late Delivery (=1)	0.11	0.28	0.16	0.16	0.09	0.00	0.01
	0.31	0.45	0.36	0.37	0.28	0.00	0.09
Price per 30kg (Leones)	17447.26	18000.00	18000.00	18000.00	17235.68	16852.87	16747.96
	822.46	0.00	0.00	0.00	1148.10	812.89	681.25
Paid Upfront ($)	85.87	85.72	104.70	81.47	98.74	97.81	74.07
	62.46	34.47	55.67	47.66	65.54	59.44	79.12
Total Credit ($)	9.14	1.06	10.13	7.43	3.64	8.21	15.67
	29.92	7.99	30.04	25.20	16.54	29.38	40.07
Credit Order (=1)	0.16	0.04	0.16	0.15	0.09	0.12	0.25
	0.37	0.19	0.37	0.35	0.29	0.32	0.43
Share on Credit	0.10	0.01	0.09	0.08	0.04	0.07	0.19
	0.28	0.08	0.25	0.25	0.15	0.24	0.37
Switch Agent (=1)	0.05	0.00	0.00	0.01	0.01	0.03	0.15
	0.22	0.00	0.00	0.10	0.08	0.17	0.36
Observations (Orders)	5281	603	662	1413	611	401	1591

Notes: Standard deviations reported in parentheses. W1 refers to Tombo wharf, W2 refers to Aberdeen wharf, and W3 refers to Goderich wharf. Data above the midline is from surveys of fishing trip outcomes, and below the midline from ice retailer order and delivery records. Before (After) Manufacter Entry period refers to prior (before) to the entry of new manufacturers in each fishing wharf (see paper text for details).

Table A2: Total Ice Sales to Fishermen and Percent Change

	M1 Only Pre-Entry	M1 Only Pre-Entry	ALL Post-Entry	M1 Only % Change	ALL % Change
Wharf 1 Sales (thousand kg)	286.77	201.87	348.18	-29.61	21.41
Wharf 2 Sales (thousand kg)	369.90	61.68	199.59	-83.33	-46.04
Wharf 3 Sales (thousand kg)	749.19	814.44	906.93	8.71	21.05
Wharves Total (thousand kg)	1405.86	1077.99	1454.70	-23.32	3.47
All Fishing Total (thousand kg)	1436.37	1123.95	1659.96	-21.75	15.57
Wharf 1 Sales (million leones)	172.06	109.23	203.78	-36.52	18.44
Wharf 2 Sales (million leones)	221.94	34.61	112.51	-84.41	-49.31
Wharf 3 Sales (million leones)	449.48	450.55	498.72	0.24	10.95
Wharves Total (million leones)	843.48	594.39	815.00	-29.53	-3.38
All Fishing Total (million leones)	860.88	621.41	948.78	-27.82	10.21

Notes: Total ice sales to fishing firms in thousand kilogram or milliion leone units, where the exchange rate during this period was 4200 leones to the dollar. Pre- and Post-Entry time periods are restricted to January-June 2013 and January-June 2014 to allow for direct comparison. M1 refers only to sales by the original manufacturer, while ALL refers to sales by the collection of all five manufacturers. Wharf 1 refers to Tombo wharf, Wharf 2 refers to Aberdeen wharf, and Wharf 3 refers to Goderich wharf. "Wharves Total" includes all sales made at the three original wharves, and "Fishing Total" includes sales to fishing buyers at these three wharves, at other wharves, and directly at the factory locations.