INFORMATON, DEMAND AND THE GROWTH OF FIRMS: EVIDENCE FROM A NATURAL EXPERIMENT IN INDIA*

Robert Jensen
Wharton School
University of Pennsylvania and NBER

Nolan Miller
Department of Finance
University of Illinois at Urbana-Champaign and NBER

**Abstract**: In many developing countries, firms are on average small, do not grow and have low productivity. One potential contributing factor is firms' limited effective market size: due to information and search costs, consumers are often unaware of the prices and quality of non-local firms, and thus mostly buy locally. We explore this hypothesis using mobile phones as a natural experiment in the Kerala boat-building industry. As consumers learn more about non-local builders, high quality builders gain market share and grow, while low quality firms exit. Aggregate productivity increases, as does labor specialization. Finally, consumer prices (per year of boat-life) decline.

***JEL* Codes**: O10; O12.
**Keywords**: Economic development; small enterprises.

* We would like to thank Satish Babu, Peter Cherian, C.M. Jolly, X. Joseph, C.K. Muhammad, Prakash Nair, Mai Nguyen, M. Philip, P. Philip, V. Rajan, T.K. Sidhique, Joseph Thomas, and Jolly Thoms for helpful comments and discussion. Financial support was provided by the Dean's Research Fund at the Harvard Kennedy School.

# I. INTRODUCTION

Firms' growth and productivity are likely to be important determinants of income growth and economic development. Yet several observations about firms in developing countries reveal important challenges. First, the average firm is very small. For example, Hsieh and Klenow (2014) show that the typical manufacturing firm in India has only 2.6 employees, compared to 42 for the United States. Second, on average, firms often don't grow significantly as they age. Hsieh and Klenow (2014) also show that the average firm that is 40 years or older is only 40% larger by employment than the average firm under 5 years old. In the U.S., the older firms are on average 7 times greater. Thus, firms in developing countries generally start small and stay small.[1] Third, firms in low income countries appear to have low average productivity (see Tybout 2000 and Bloom et. al 2010). Finally, there is often significant productivity dispersion across firms, despite the fact that competition should drive less productive firms out of the market.[2] For example, Hsieh and Klenow (2009) find that in India and China, firms at the 90$^{th}$ percentile of the productivity distribution are five times more productive than firms at the 10$^{th}$ percentile.[3]

There are many possible explanations for these facts, including credit constraints, inadequate infrastructure, regulations, weak institutions or poor managerial ability. In this paper, we focus on the role of limited market size, or the limited demand for any given firm's output, arising from informational frictions. In particular, we argue that firms are often unable to sell beyond a fairly localized market because it is difficult for consumers to learn about the existence and quality of different firms' output. As a result, consumers often buy exclusively from a local producer, and producers sell mostly to local customers. The limited size of their potential customer base limits firms' ability to grow. The effective lack of competition also allows less productive firms to survive, lowering aggregate productivity and allowing cross-firm productivity dispersion to persist.

To test this hypothesis, we examine the artisanal fishing boat manufacturing industry in Kerala, India, using six years of semiannual censuses of boat builders and surveys of boat buyers

[1] McCaig and Pavcnik (2016) document similar patterns using a large, nationally representative longitudinal survey of microenterprises in Vietnam that followed firms for four years.

[2] Productivity dispersion is also found in rich countries. See Syverson (2004a, b, 2011).

[3] For the U.S. manufacturing sector, Syverson (2004b) finds that on average, within four-digit SIC industries, firms at the 90$^{th}$ percentile are twice as productive as those at the 10$^{th}$ percentile.

(fishermen). At baseline, the industry featured a large number of very small firms, each largely serving a highly localized market. There was also significant variation across firms in the lifespan of the boats produced (which we argue below is largely due to skill differences), with comparatively little variation in sales prices, resulting in large differences in prices per year of boat life purchased.[4] For example, despite similar specifications and charging very similar prices, the best builder in our data produced boats that lasted more than twice as long on average as those made by the worst builder. We also show that fishermen were initially poorly informed about these differences, and that nearly all fishermen bought their boats from the nearest builder, typically located in the same village.

Jensen (2007) documented that the spread of mobile phones in Kerala led fishermen to begin selling their catch outside their local markets for the first time. In the present paper, we use the same natural experiment to show that as fishermen began traveling to different markets to sell their fish, they learned more about the quality of non-local builders and began buying non-locally. Thus the arrival of mobile phones, by changing fishermen's behavior in the market for fish, provided an exogenous shock to potential market size in the market for boats.

We find that after the shock the highest quality (longest boat life expectancy) builders gained market share and grew in size, while the lowest quality builders lost market share, with many ultimately exiting. As a result, the industry transformed from a large number of very small firms to a much smaller number of larger firms. By the end of our sample period, the number of firms had decreased by almost 60 percent, and the average surviving firm was larger than the largest firm at baseline.

We also find evidence of aggregate productivity gains in the sector. For example, after the introduction of mobile phones, nearly the same number of boats was being produced with 10−25 percent fewer labor hours and 30−35 percent less capital (with no change in material inputs). We also show that firm growth was associated with significant labor specialization, which is one potential micro-foundation for the observed increase in productivity. The average worker

[4] Differences in the life span of boats are the primary source of variation in productivity across firms. There is, in fact, very little variation in (per-boat) labor, capital and material inputs across builders. However, with the same inputs, some builders produce much longer lasting boats and are thus more productive in producing a year of boat life. Thus, in our context, the question of how productivity dispersion can persist in equilibrium (Syverson 2004a, b, 2011) is equivalent to asking why low quality builders are not driven out of the market by high quality builders.

performed approximately 7 major job tasks (e.g., cutting wood, fastening, etc.) at baseline, but less than half as many (3) by endline. Finally, we also find evidence of gains for the industry's consumers (fishermen). Though the average raw sales price of boats increased slightly, the average estimated life span of a boat purchased increased to an even greater extent (1.29 years), so the price per year of boat-life purchased declined by approximately 15 percent.

Although we only study a single industry in a single country, we believe that the key underlying features of this industry, i.e., small manufacturers serving mostly a highly localized market, are common to many other industries in many other developing countries. In addition, the detailed, micro-level census data of firms in one industry (including detailed measures of the production process such as worker time allocation and specialization), with highly comparable data and production processes, coupled with a natural experiment that exogenously shifts the potential market size and number of competitors for each firm, provide a complement to studies with a wider range of industries or countries.

Our results contribute to the recent literature focusing on various size-related constraints on growth facing small firms in low-income countries (Fischer and Karlan 2015, Hsieh and Olken 2014). Among the themes examined in the literature are lack of managerial capital and business training (Bloom et al. 2013, Bruhn, Karlan and Schoar 2010, 2013, Karlan and Valdivia 2011, de Mel, McKenzie and Woodruff 2014), access to credit and capital (de Mel, McKenzie and Woodruff 2008, 2009, 2011, 2012, Fafchamps et al. 2014, Karlan and Zinman 2011, McKenzie and Woodruff 2008), and the quality of legal institutions (Laeven and Woodruff 2007). Using U.S. data, Foster, Haltwinger and Syverson (2016) model and explore the role of limited demand for new firms' products in slowing their growth. While Foster, Haltiwanger and Syverson (2016) also consider informational barriers as a constraint on firm growth, their focus is on the demand-side difference between new and old firms in a horizontally differentiated market where firms have idiosyncratic growth potential that accumulates over time. In contrast, our study focuses on supply-side differences, and on the way in which lifting market-wide barriers to trade (including informational barriers) differentially affects high- and low-quality firms in vertically differentiated markets.

Our results are also related to the large literature on the effects of trade on productivity (e.g., Hallward-Driemeier, Iarossi and Sokoloff 2002, Pack and Westphal 1986, Dollar and Sokoloff 1990, Pavcnik 2002, Melitz, 2003, Melitz and Ottaviano 2008, Topalova and Khandelwal

2011, De Loecker et. al 2016, Redding 2011 and Melitz and Redding 2014). In our study, improvements in information as mobile phones enter is akin to opening trade across areas that were previously *de facto* largely autarkic. This mechanism is discussed in greater detail in Section II, where we discuss the analogy between expanding market size through the introduction of mobile phones and expanding market size through the removal of barriers to trade.

Our study also connects to the literature on productivity dispersion across firms within industries (see Syverson 2011 for a summary). Such dispersion may be particularly important for welfare. For example, Hsieh and Klenow (2009) estimate that re-allocating capital across firms (to a level of efficiency achieved in the U.S.) would lead to dramatic gains in manufacturing TFP in China and India. Many explanations have been proposed for equilibrium cross-firm productivity dispersion (Syverson 2011); our paper suggests that in the present context, limited spatial competition due to barriers to trade likely played a key role. This proposed mechanism is related to those previous studies. For example, Syverson (2004a and 2004b) argue that the ability of consumers to substitute among different producers' output affects competition and can therefore impact minimum and average productivity, as well as productivity dispersion. These studies propose several potential barriers to substituting across firms' output, such as transportation costs, product differentiation, bundling or branding and advertising. Syverson (2004a) tests this argument by considering variation in spatial substitutability in output across firms created by the difficulty of transporting ready-mix concrete over long distances, whereas Syverson (2004b) considers a range of barriers to substitutability and a broad collection of industries. Related, Hallward-Driemeier, Iarossi and Sokoloff (2002) argue that transportation costs, along with product differentiation, in effect segment markets so that they are not integrated.

The remainder of this paper proceeds as follows. Section II discusses the background and related literature on market size and industry dynamics. Section III discusses the data and Section IV presents the empirical strategy. Section V presents the results and Section VI discusses alternative mechanisms. Finally, Section VII concludes.

## II. BACKGROUND

### *A. Informational Frictions and Market Fragmentation in Boat Markets*

Our analysis takes as its starting point the empirical observation (shown below) that despite very large cross-firm differences in quality (and, correspondingly, price per year of boat life), fishermen initially bought their boats almost exclusively from a local producer, typically the one in their own village. Correspondingly, since there was a near one-to-one mapping between villages and builders, with every fishing village having one, and typically only one, builder, sellers sold almost exclusively to fishermen in their own village. There are many potential explanations for why the market would be highly localized in this way. We argue that barriers to trade arising from the high costs of acquiring information about and trading with non-local producers play a large role.

Consider the case of a fisherman purchasing a boat. He might be able to easily acquire price information from many producers, but estimating how long each producer's boats will last (and thus, price per year of boat life) is more challenging, and producers are unlikely to be able to credibly signal quality to potential buyers.[5] Though it might be easy to tell the difference between a very poorly-made boat and a well-made one just by sight, it is much more difficult to distinguish between a boat that will last on average 4 years and one that will last 5. Boats are an experience good (Nelson 1970), where quality is revealed only after a number of years of use. If we assume that there is some random variation in boat durability even within a single builder, estimating average life expectancy would require experiencing a large number of boats from each builder, over a long period of time. If we start from an equilibrium where fishermen have repeatedly bought from a local builder, as have most of the other fishermen they know in the same village, each fishermen should be able to accurately estimate how long their local builder's boats last on average. However, they are likely to have significantly less information about the quality of non-local builders, for whom they may have few or no observations.[6]

---

[5] There are also no warranties or guarantees in this market. There are informal agreements that builders will provide refunds or replacements if an obvious construction problem leads to a failure very shortly after purchase. However, extending warranties beyond a short period could create moral hazard and the difficulty in establishing whether failure was due to construction or use. For similar reasons, there is no private boat insurance available. A well-functioning civil court system or other dispute resolution mechanism could also solve this problem, since builders who promise a certain life expectancy could be sued if their boats do not meet that promise, but such systems are not generally available or easily accessible.

[6] Fishermen could experiment and purchase from a non-local builder to learn about quality. However, if there are search or other transactions costs in dealing with non-local producers, they would only do so if they have strong priors that quality differences across builders are significant. Further, boats are an expensive and infrequent purchase, which might limit the desire to experiment. It would take many observations and many years before an estimate could be formed. Fishermen could engage in collective action, such as subsidizing members of their group to experiment; however, in practice, we do not observe such behavior, perhaps due to the fact that learning would still require many fishermen to experiment and quality would only be observed over a long period of time, or the difficulty of sustaining such cooperation.

As shown in Jensen (2007), at baseline most fishermen fish and sell their catch exclusively locally. This generates fewer opportunities to learn from fishermen in other villages.[7] We argue below that it was only when fishermen began to travel to other markets to sell their fish that they interacted with non-local fishermen regularly.[8] In the course of this interaction they acquired information about non-local builders, allowing them to form more accurate estimates of quality for a wider range of builders.

Though we will emphasize the role of information and learning, we note that there are other reasons why markets may be localized, and in particular, factors that mobile phones may also influence. For example, in our setting, before mobile phones, fishermen and builders would meet a few times in person prior to and during the course of boat construction. Mobile phones could reduce the number of in-person meetings required and thus lower the transaction costs of buying from a distant builder. However, we note that such costs (both time and travel costs) are very small relative to the cost of a boat, and many if not most of the visits cannot be eliminated by mobile phones (e.g., making an initial deposit to begin the process or picking up the boat at the end). Thus, for the purposes of interpretation of our results, reductions in transaction costs due to mobile phones are unlikely to affect the market appreciably.

In addition, imperfect contract enforcement may also limit transactions to local buyers and sellers. Buyers typically provide a down payment averaging about 10−15 percent when they first order a boat. They may worry that a builder that they don't know or have connections to will keep

[7] Problem such as this are the motivation for user review websites like Yelp or Angie's List, or expert review and testing companies like Consumer Reports or Zagat's. No such resources exist for this market.

[8] To understand the difficulties in acquiring information on non-local firms, imagine you live in a town with one or two firms providing a particular service, such as an auto mechanic or a plumber. Interactions with mechanics or plumbers is not very frequent, but you might over time, and through talking with friends, learn how often their work is successful in fixing the problem or how long their work lasts before the problem recurs. If there is more than one mechanic in your town, you might even have a sense of which is better. But you might not know whether a mechanic in a town 45 minutes away is better than your local mechanics (even with the greater inconvenience, for an important car repair (dental or medical procedure, etc.), and a high enough quality difference, you might still prefer this non-local provider if you knew about them). People in this other town however are likely to know how good their mechanic is. If you work with or know someone in this town, you might at some point exchange information. However, if you didn't, you might be reluctant to travel to the town, knock on a stranger's door and ask for information on their mechanic. We argue that the increased interaction of fishermen from different towns once they begin selling their fish non-locally lowers the costs of acquiring such information. And indeed, it is common to see fishermen talking about their boats when they are in other markets selling their fish.

their money and not deliver the boat.[9] Phones themselves may not make enforcement easier, but the greater connections that fishermen form with non-local fishermen when they sell in other markets may either help them determine which sellers are trustworthy, or provide a means of contract enforcement through greater mutual social connections. Qualitative interviews and survey data did not reveal any such concerns as a reason why fishermen did not use non-local builders at baseline, but we cannot rule out some role for such effects.

We will show that mobile phones led to more accurate information about the quality of non-local builders. And although we found no evidence consistent with the other two mechanisms, it won't be possible to formally test or completely rule out them out. However, even if these other mechanisms were operative, the unifying interpretation would still be that limited demand or effective market size are limitations on firm growth.

*B. Predictions and Analogy to Opening to Trade*

To motivate our predictions and empirical test, within this setting the transition brought about by the introduction of mobile phone service in Kerala can be thought of as analogous to the removal of barriers to trade between nearby markets. This is a problem that has been studied extensively in the trade literature. The most recent papers (Pavcnik 2002, Melitz 2003, Melitz and Ottaviano 2008, Topalova and Khandelwal 2011, De Loecker et. al 2016, Redding 2011, Melitz and Redding 2014 and Goldberg and Pavcnik 2016) establish that reductions in the cost of trading with outside producers leads to:[10] increased revenue productivity; decreased price-cost markups and prices; increased average productivity; exit by the least productive firms; expansion by the most productive firms; the most productive firms selling in both local and outside markets and less productive firms selling only to their local market (if they don't exit).

The intuition underlying these results follows from what Levinsohn (1993, p. 2) refers to as the "imports-as-market-discipline" hypothesis, which he notes Helpman and Krugman (1989) refer to as "the oldest insight in this area (of trade policy and imperfect competition)." The core of the hypothesis is that opening a market to trade introduces foreign firms as additional competitors. Faced with tougher competition, domestic industries will no longer be able to enjoy secure rents

[9] The builder is protected from untrustworthy buyers because of the down payment and the steady demand for boats. If the buyer doesn't return for delivery and to make the final payment, the builder can sell the boat to someone else.

[10] Similar results are also made in the industrial organization literature (see, for example, Syverson 2004a).

arising from barriers to entry in the local market and will be forced to respond by becoming more competitive, i.e., lowering prices and markups. Although Levinsohn referred to oligopoly models, recent studies of monopolistically competitive industries yield similar results.[11]

The model that most closely captures our case is that of Melitz and Ottaviano (2008), which considers the impact of trade liberalization in a monopolistically competitive market where firms differ in productivity and produce a differentiated product. Unlike previous approaches to the problem (e.g., Melitz, 2003), the Melitz-Ottaviano (hereafter MO) framework allows for endogenous firm markups and focuses on the imports-as-market-discipline channel.[12]

The key assumptions underlying the MO approach are monopolistic competition and heterogeneous productivity. While boats are quite similar, they differ in where they are produced (which entails travel costs associated with the purchase), which introduces a degree of horizontal differentiation in the market. Entry into the market is unrestricted, as is exit. Thus the market can be thought of as monopolistically competitive.

Productivity differences arise in the fact that while the boats are similar in specification and capability, producers differ in the longevity of the boats they produce. Since (as we show below) the amount of labor and other inputs used is similar across producers, differences in longevity translate into differences in the cost of producing a boat-year, i.e., productivity.

Finally, the introduction of mobile phone service can be seen as reducing the cost of trading across locations, as it makes it much easier to learn about the existence, prices and qualities of boats being offered for sale in outside markets.

Rather than reproduce the MO analysis here, we will focus on intuition and refer the interested reader to the original work. Consider two regions where, initially, fishermen buy boats only from their local sellers due to the cost of acquiring information on and purchasing from manufacturers in other regions. Potential firms face a fixed cost of entry and learn their productivity only after paying the cost. In such a model, only firms with sufficiently low cost (i.e., high productivity) will remain in the market. Low-cost firms will charge lower prices and produce higher output, and they will earn higher markups, revenue and profit than high-cost firms.

[11] Although we focus on the role of increased competition in increasing productivity, several other channels have been discussed, including exploiting increasing returns, reducing internal inefficiencies and taking advantage of previously unavailable or more-expensive imports (Topalova and Khandelwal 2011).
[12] By contrast, in Melitz (2003) the adjustments due to trade are driven primarily through increased competition in the labor market, which is less of a concern in our case.

As MO note, reducing costs of trading with nearby producers or converting from autarky to free trade is analogous to increasing the size of each of the markets. Faced with a larger market and more potential competitors, the residual demand curves facing existing firms become more elastic, which increases the intensity of competition. This increase in competition makes it difficult for high-cost firms to remain in the market, and the highest cost firms will exit. Those that remain will lower their prices and markups.

Since liberalization makes it more difficult for high-cost firms to survive, average productivity will rise, and average prices will fall both because of increased competition and selection. Even though selection of the lowest-cost firms implies that those firms that initially had the highest markups will remain in the market after trade liberalization, MO show that average markups decline after liberalization.

In situations where a cost of exporting remains after liberalization (i.e., it is still costly to trade with non-local producers), MO show that among those producers that continue to produce after liberalization, those with the lowest cost will produce for both the local and non-local markets, while the higher-cost firms will sell only locally. Due to the introduction of imports, the variety of products available for sale in any one location will increase, although the total number of producers operating in the integrated market will be less than the total number of producers in both markets before liberalization.[13]

As reviewed in Goldberg and Pavcnik (2016), the trade literature also suggests several possible channels through which the removal of barriers can reduce prices and increase revenue productivity. These include the pro-competitive effects discussed above, but also improved internal efficiency within the firm (i.e., reduced x-inefficiency) and increased investment in R&D and cost reduction. The literature also suggests that as market share is reallocated to the most productive firms, these firms may be able to exploit economies of scale, further reducing costs.[14]

Given our interest in understanding the barriers to firm growth in developing countries, rather than testing a complete trade model, we will focus on a subset of the predictions from this literature. In particular, our analysis will establish that following the reduction in trade barriers due to improved communication technology, the number of firms in the industry declined, driven

---

[13] This last result follows from the fact that the number of producers is concave in the size of the market, which MO do not emphasize but is easily verified.

[14] Although not relevant in our application, Melitz (2003) and others have argued that opening a market to competition can reduce imported input costs, which can also lead to lower prices and higher quantities.

primarily by the exit of low-productivity (quality) firms, average firm size and market share increased due to expansion by high-productivity firms, and that average productivity increased due both differential survival by high-productivity firms and increased productivity among surviving firms. In addition, we provide evidence for the mechanisms underlying the productivity gains.

## III. DATA AND SETTING

### *A. The Fisheries Sector in Kerala*

Fishing is a large industry in Kerala, employing over one million people and accounting for about 3 percent of the state's GDP. Discussions with builders, fishermen and NGOs suggest that the boat building sector tended to be fairly stable over time prior to the introduction of mobile phones, with little to no entry or exit. Most businesses pass from father to son, and have been in the same family for several generations. Further, there are no schools or other resources such as books for learning boat building. This, plus high upfront capital costs, makes entry into the sector difficult, and may help account for the fact that most villages typically had just one builder.[15]

### *B. Survey Information*

We conducted our study in two districts of Kerala: Kannur and Kasaragod (see Appendix Figure I).[16] These districts were chosen because they are commercial fishing regions that did not have mobile phones at the time our survey began, but which we knew from interviews and licensing permits would soon be adding phones.

Because all of the firms in this industry were unregistered, there was no official data available. We instead worked with local knowledgeable officials and NGOs to identify all boat landing spots (places where fishermen dock their boats when not in use) in the two districts. We then visited each of these landings and conducted brief surveys with the owners of every boat at the landing, including asking about the boat's builder (name, location and contact information). We also asked each boat owner the same information about the boat they owned prior to their current one, and whether they knew of any other builders. We used this information to create a complete list of all boat builders serving the study region. We cannot rule out that we missed some

[15] Most firms are based at the owner's home (typically in the same village they grew up in) and only two builders changed location during our sample period. We will therefore ignore the locational choice of firms.
[16] Jensen (2007) also examined a third district, Kozhikode. However, data collection for the present paper began after Kozhikode already had mobile phones, so we did not conduct our study there.

very small builders who sell just a few boats and may have been overlooked in our enumeration; however, any such builders would not constitute a large share of the market.

Using this list of builders, we conducted a complete census of all boat building firms, repeated every six months for a six year period from January, 1998 to January, 2004 (each census was proceeded by a survey at each landing, to capture any possible new builders, and to increase the chances of finding any builders that we may have previously missed). The census collected detailed information on the firm's activities, discussed in more detail below.

Finally, at each six month interval we also surveyed a random sample of 15 fishermen in each of the landing spots. The sample was drawn uniquely at each round, and is therefore not a panel. The survey gathered detailed information on boat purchase and use, and fishing behavior.

*C. Descriptive Statistics*

In our baseline census, we identified 143 boat building firms in these two districts. Though there are no hard geographic boundaries, in general at baseline there is close to a one-to-one correspondence between landing spots and firms, with most buyers in one landing buying boats from one builder, and each builder selling mostly to fishermen at just one landing. Table I provides baseline descriptive statistics for these firms. The average firm initially had only 2.2 workers. The largest firms in the industry had just 4 workers each (there were 3 such firms). Each firm is also small in terms of market share. If we consider the two districts combined as a single potential market, the average firm has a market share of 0.7%, and no firm supplies more than 1.3 percent of the market.[17]

We note by contrast, however, that firms capture a very large share of their local market, as measured by the landing spot closest to their business. On average, over 97% of boats in any given landing were purchased from the nearest builder at baseline. The sector as a whole therefore consists of something closer to a series of small, largely independent markets.[18]

[17] It is difficult to define what constitutes a market, if such a boundary even exists. However, we show later that even with this broad geographic definition, there are detectable changes in market share.
[18] This is akin to the findings in Syverson (2011), where high transportation costs for ready-mix concrete means that most areas can be treated as separate markets.

*D. Measuring Quality*

The key predictions outlined above suggest that as fishermen acquire greater information about different builders, high and low quality builders, i.e., firms with a high or low productivity in producing a year of boat life, will be affected differently.[19] Therefore, understanding and measuring boat life expectancy will be critical to our empirical analysis.

At baseline, boats are manufactured using only hand tools, and with the same underlying raw materials. Based on interviews with builders, fishermen, NGOs and a former insurance auditor, we argue that much of the variation in the life expectancy of boats built by different builders depends primarily on builder skill. Skill is particularly important in aspects of production such as treating and shaping the wood prior to construction and weaving and fastening planks of wood together in the final construction.[20] In fact, as we discuss below, there is almost no variation in capital, material inputs (including quality) or labor hours per boat across builders. If quality were for example a choice variable, we might expect these factors to differ across builders with high and low quality boats (i.e., builders with low quality boats might use lower quality inputs or spend less time working on the boat to get it just right).

We use four approaches to measuring boat quality or life expectancy. First, as noted, when we conducted our landing spot canvas, we asked all fishermen not just about their current boat, but their previous boat, including who built it, when they bought it and when they replaced it. Data on previous boats allow us to directly estimate the average life expectancy of the boats built by each builder.[21] This measure potentially suffers from a few limitations, however. First, because it is based on previously owned boats that have already been replaced by a newer boat, it measures quality with a lag, and builder quality may change over time.[22] Second, for any newer entrants, there will not be a long enough track record to assess their boats in this way.[23] Third, the life

[19] In focus groups with fishermen and builders, there was no suggestion that different builders' boats might vary by speed, fuel efficiency or other dimensions relevant for a fisherman's productivity. Thus, we treat durability or life expectancy as the sole aspect of quality or differentiation among different builders' boats.
[20] For example, planks must be fastened together tightly enough that they don't come apart, yet also left with enough flexibility to absorb and transfer shocks when larger waves are hit. The degree of tightening is something that builders describe as a feel rather than a precise tightness that can be described or taught.
[21] In principle, we could also use the distribution of ages of current boats (adjusting for right censoring) to estimate life expectancy for different builders.
[22] Though fishermen may also only have the same older data on previous boats for inferring quality, so this in principle may be the correct measure to use when examining how they choose builders.
[23] Ultimately, there was effectively no new entry during our sample, so this concern is not relevant (however, at the time we designed our study we did not want to ignore the possibility of entry).

expectancy of a boat may be affected by how it is used or the local fishing environment. For example, variation across areas in fishing intensity, the presence of biofouling organisms such as barnacles, the level of water salinity or the presence of rocks and other hazards can result in variation in boat life that is independent of the underlying skill or quality with which it was constructed. To the extent that fishermen are able to "control" for such factors in comparing builders and making their purchasing decisions, our estimates of the relevant life expectancy differentials across builders will contain errors.

As a second method for estimating quality, we asked an independent auditor who had worked for a short-lived, government boat insurance program to assess the quality of newly-built boats for all of our builders, both on a scale of 1 to 5 and in terms of estimated life span. This process involved inspecting the tension and spacing of fastenings (both visually and via calibrated stress tests) and checking for shape and defects or imperfections.[24] We did this every 6 months alongside our landing canvas and builder census. This measure overcomes some of the challenges with the first approach. For example, by examining newly built boats, the measure is a better reflection of more recent quality and can also be applied to new entrants. It also provides an assessment of quality that is independent of use or fishing conditions (e.g., since we can examine new or very recently built boats). However, this measure is more subjective than the first approach.

Our third approach relies on the survey of fishermen, where we asked them to estimate how long boats built by their local builder and any other builders they knew lasted on average. This measure, like the previous one, is also subjective. However, in principle this is the information that fishermen will later use in choosing among builders, as well as the basis for what information they later share with other fishermen. And as discussed above, since most fishermen have bought from the same builder repeatedly, as have most of the other fishermen in their village, we expect they might have fairly accurate information about how long their local builder's boats last.

One remaining problem with all three measures is that quality may be a choice variable. For example, in areas where fishermen are poor or credit constrained, they may not be able to afford a higher quality boat that lasts longer but costs more upfront. So some builders may intentionally build boats that don't last long, not because they lack the skill to produce better ones,

[24] The auditor had been trained to do this in his previous job as part of helping to price insurance.

but because of local demand conditions.[25] This suggests that some builders that we label as low quality may actually be able to build higher quality boats if their potential market size expands. Of course, it is possible that such builders will still be at a disadvantage when markets become less localized: if fishermen simply share raw, unadjusted information on life expectancy of different builders and are unable to control for (or are unaware of) endogenous quality, and if such builders are at least initially unable to credibly signal higher quality,[26] then this estimate should still be the relevant one for predicting changes in market share and other industry dynamics.

However, to at least account for the possibility of such mismeasurement, for our fourth measure we estimate a "skill residual." In particular, we regress estimated boat life expectancy at baseline (based on the fishermen's report of how long their previous boat lasted) on labor, material and capital inputs.[27] The residual from this regression is the variation in builder life expectancy that cannot be explained by these factors; in other words, holding constant the number of hours worked on a boat and the materials (including quality) and capital used, which are the main elements through which quality can be influenced by production choices, it indicates which builders' boats last longer or shorter than expected.[28]

None of these measures is perfect. However, any imperfections or measurement error in classifying builders by quality should bias against finding our expected results for whether firms will gain market share, grow or exit as a function of their baseline quality, unless there is a systematic negative correlation between our four measures of quality and actual quality (either true quality or the quality perceived by buyers), which seems unlikely.

[25] Though we in fact see little variation in the quality of inputs used or the amount of time or capital used across various builders, including when comparing the very best and very worst builders. For example, if we regress estimated life expectancy (using the previous boat estimates) on detailed capital, labor and material inputs, the $R^2$ at baseline is 0.03. The fact that variation in inputs explains almost none of the variation in life expectancy across builders suggests that quality variation is more likely to be driven by variation in builder skill than demand or other factors that may make quality endogenous.
[26] For example, a builder previously facing a demand for low quality boats would need to begin producing new boats and wait to show that they last 6 or 7 years rather than 4 years.
[27] Here we use estimated life expectancy from the first approach, but using any of the first three measures yields broadly similar results when used in our regressions below.
[28] Regression results below using the approach described in Levinsohn and Petrin (2003) are broadly similar to those obtained with the simple OLS residuals (the approach described in Olley and Pakes (1996) cannot be applied here because it can only be applied to observations where investment is non-zero, which causes us to drop many observations).

Table I shows that the average life expectancy of a boat based on estimates from previous boats is 4.8 years.[29] However, there is considerable variation across builders.[30] The best builder's boats last on average 8.1 years, whereas the worst's last on average less than half as long (3.6 years). The auditor's assessment yields a lower estimate of average life expectancy, at just 4.1 years. There is also less variation in these estimates across firms compared to those based on data from survival of previous boats. The difference between the best and worst builder is only 3 years, and the standard deviation is smaller, though both still reflect considerable variation in quality across builders. Finally, estimates of life expectancy reported by fishermen reporting on their local builder fall between the other two, with a mean of 4.5. Overall, all three measures suggest that there is considerable variation in boat life expectancy across builders.

The next-to-last row of the table shows that there is less variation in the price of boats, with only a 15 percent difference between the least and most expensive boats. However, given the large differences in life expectancy across builders, the price per year of boat life varies considerably, as shown in the last row of the table (note, the minimum and maximum prices do not correspond respectively to the shortest and longest lasting boats). For example, using life expectancy estimates from previous boats, the most expensive builder effectively charges 1,104 Rs. per boat*year, whereas the least expensive builder charges less than half of that (583 Rs.). These considerable price or quality differences are what we expect fishermen should respond to as they learn more about different builders.

## IV. EMPIRICAL STRATEGY

### *A. Mobile Phones in Kerala*

Prior to the arrival of mobile phones, few businesses or homes had landline phones in Kerala. Ownership of landlines was expensive, and waiting times for service often lasted years. Mobile phones were first introduced in the state in 1997. Service expanded gradually throughout the state via cell towers, concentrating first on the most populous cities (see Figure I). Each tower

---

[29] Table I excludes the TFP residual measure of quality, since as residuals the mean will be zero and the values will not be directly comparable to the three measures of life expectancy.

[30] There are also differences in the within-builder variance. However, there is a negative correlation between a builder's mean and their variance. The best builders (highest mean) also appear to be the most consistent (smallest variance) so buyers don't face a tradeoff between, say, higher mean/higher variance builders and lower mean/lower variance builders.

provides a service radius of approximately 25 km, though in practice range is more limited due to terrain, vegetation and man-made structures.

In the two districts we study, Kannur and Kasaragod, there was no mobile phone service at baseline (January 1998). In late July 1998, two towers were put into service in Kannur district, which we call Region I. No new service was added in the area until May of 2000, when two cities in Kasaragod district (Region II) received towers. New towers were added over the subsequent two years to fill in coverage gaps, so that by the end of 2002, most of the coast was covered. However, there are a number of fishing villages located inland or along major rivers that feed into the sea (Region III). Because they are further inland, and because of uneven terrain and dense tree cover, almost none of these villages had operational mobile phone coverage during our sample period. Inland fishing villages are not as directly comparable to those along the coast. For example, many of them fish exclusively on lakes or rivers. Because they also keep their boats in these areas, it is much more costly for them to travel to distant areas to sell their catch, even if they had mobile phones. However, these villages can be used as an additional, if limited, comparison group in our analysis because they can at least capture any common effects on boat markets, such as changes in technology, prices or regulations (provided such changes are equally distributed between coastal and more inland areas).

The timing and location of mobile phone introduction was certainly not random. The primary concern of the mobile phone companies was the size of the potential customer base, so both timing and placement are highly correlated with an area's population size and wealth. In Section VI, we address the resulting empirical challenges for our study.

*B. Empirical Specification*

The key predictions we will test are how changes in market share, probability of exit and firm size are affected by the effective "opening to trade" created by the introduction of mobile phones, as a function of baseline builder quality. In doing so, we take advantage of the staggered introduction of mobile phones across regions noted above. Thus, using builder-level data, we regress the outcomes of interest on indicators for whether the builder's region has mobile phones, the builder's baseline quality and the interaction of the two,

$$Y_{b,t} = \alpha_0 + \alpha_1 Phone_{b,t} + \alpha_2 Quality_b + \alpha_3 Phone_{b,t} * Quality_b + \varepsilon_{b,t}$$

where $Y_{b,t}$ is the outcome variable of interest for builder *b* at time *t*, $Phone_{b,t}$ is a dummy variable equal to one for all periods where the builder's region has mobile phone coverage (regardless of whether they own a phone) and $Quality_b$ is one of the measures of the builder's quality, measured in Round 1 before any regions in our sample have phones. The results we present below also include region fixed effects and region-specific time trends (none of which alter the results appreciably, since, as we show below, the market was extremely stable prior to the introduction of mobile phones). All regressions are estimated via least squares. Our identifying assumption is that had it not been for the introduction of mobile phones, there would have been no differential change in these outcomes across builders. We discuss potential challenges below.

Our discussion so far suggests a proposed causal chain that runs as follows: mobile phone introduction → fishermen begin selling their catch non-locally → fishermen learn about the quality of non-local builders → fishermen start to buy their boats non-locally → high quality builders gain market share and grow, and low quality builders lose market share and possibly exit (possibly followed by changes in productivity). We will show the correlation between mobile phones and each of these subsequent links, but this analysis alone won't establish the full causal chain from start to finish, or rule out other factors affecting any one of the links in this chain. However, after establishing the correspondence in timing between mobile phones and each of these links, we will also show that the other links were not changing appreciably prior to mobile phone introduction, and attempt to rule out other explanations outside of the proposed causal chain.

## V. RESULTS

### *A. Preliminary Visual Evidence*

We begin by providing visual evidence for most of the main results of the paper. Figure II provides data from our fisherman survey on the fraction of fishermen in each region who reported selling their catch exclusively in their local market during the week of the survey. The three panels of this figure correspond to the three regions in Figure I, and the vertical lines represent the dates when mobile phones were introduced. Confirming the results of Jensen (2007), we find that the spread of mobile phones induced fishermen for the first time to sell outside of their local market, as they sought out the best price for their catch. Before mobile phones, over 95 percent of fishermen in all three regions sold their catch in their local market. This rate declines in Regions I and II to just over 60 percent when they get mobile phones, but is largely unchanged in Region III, which never received coverage.

We argue that this greater search by fishermen in the fish market leads to greater learning in the market for boats. We provide evidence for this by examining data from our fisherman survey, which asked individuals to estimate how long on average they believed the boats built by their local builder lasted. The survey also asked if they knew of any other builders; if they said yes, we asked for the name and location of the one they were the most familiar with, and how long they believed that builder's boats lasted.[31] We can then match fishermen's estimates for each builder to our "previous boat" estimates for those builders. The first column of Table II shows that at Round 2,[32] when Regions II and III did not have phones (dark shading) and Region I had only just very recently acquired phones (light shading), fishermen have much more accurate estimates (or estimates closer to ours) for local than non-local builders across all three regions. The mean of the absolute value of the "errors" (fishermen's estimates minus our estimates) is around a half year for local builders. By contrast, there is considerably more error and/or uncertainty regarding non-local builders. First (not reported in the table), nearly 37 percent of fishermen across all regions reported that they didn't know of any non-local builders or reported "don't know" (or refused to answer) when asked to estimate the durability of any non-local builder's boats. And even among those who knew another builder, the average of the absolute value of the errors is about three to four times as large (1.47−1.90 years) as the estimates for local builders.[33] It is certainly possible that the question about non-local builders was not phrased well or that fishermen didn't give it much thought or take it seriously. However, the table also shows that over time, the average error declines when mobile phones are introduced in Regions I and II. For example, in Region I it declines from 1.78 years to 0.76 years and in Region II it declines from 1.47 years to 0.71. The accuracy never reaches the

[31] For fishermen reporting not knowing any other builders, we identified the nearest non-local builder and asked them to estimate how long they thought that builder's boats lasted. However, our analysis below excludes such cases.

[32] Unfortunately, we only started gathering these data in the second round of the fisherman survey.

[33] And the errors appear systematic in one direction. Most fishermen estimate that the non-local builder's boats last the same exact length as they report for their local builder or slightly below. Almost no fishermen report estimators for a non-local builder that exceed their local builder by more than half a year. This could account for the lack of search at baseline (though we should not interpret this result causally; the causality could even be reversed). The fact that fishermen's errors are not symmetric around the "true" mean for non-local builders would also imply that a fisherman could not solve the estimation problem when deciding whether to buy a boat non-locally by asking many people in their village and taking the mean.

level for locally producers, but the declines are very large.[34] We also note that there are no changes in average errors in Region III, which never got phones, and that there was no evident trend in Region II prior to mobile phones being introduced (we do not have enough pre-phone data to assess any possible pre-existing trend in Region I). Thus, though this method for eliciting estimated life expectancy may be imperfect, overall there is evidence of learning about the quality of non-local builders that corresponds to the timing of introduction of mobile phones and fish sales outside of local villages seen in Figure II.[35]

The final row of this table also provides evidence of information sharing or learning. This row shows the difference between the mean of what fishermen from a given village estimate as the life expectancy of the builder in that village and what fishermen from all other villages estimate as the life expectancy of that builder. As above, the results reveal a clear pattern. Over time, estimates of fishermen from different villages converge to the estimates of fishermen who live in the same village as the builder. To the extent that we believe fishermen have good estimates of those builders who they have long been familiar with, this again suggests that fishermen are getting more accurate estimates of non-local builders.

Our discussion above predicted that improved information about builders could affect market shares and, potentially, exit. Figure III shows the number of firms over time in the three regions. The solid red line in each panel plots the actual number of firms counted in each region in the semiannual canvas. Focusing just on these lines, the figure shows a large reduction in the number of builders within a few periods of mobile phones entering. In Region I, the number of builders declines from 59 in the baseline survey to just 23 by the end. Region II sees a similar decline, from 48 to 19. Both regions thus experience a nearly 60 percent decline in the number of firms over this period.[36]

Our baseline qualitative discussions with builders, fishermen and NGOs point to the boat building sector being very stable, with most businesses passing down through families from

[34] There is some evidence of a decrease in accuracy of estimates for local builders when phones are introduced. Since many firms exited over time, a fisherman's "local" builder may in fact be less familiar to them in later rounds. If we restrict the estimates for local builders to only fishermen whose local builder does not exit (third row of Table II) there is no evidence of a decrease in accuracy for local builders.

[35] The fact that fishermen's estimates of life expectancy move closer to our estimates is also in some sense a validation of our estimates. Neither fishermen nor builders were given information about our estimates, so there is no reason otherwise to have expected the discrepancy between our estimates and theirs to decline.

[36] These reductions are due to exit. None of the firms in our sample moved to different locations over this period. And our follow up surveys reveal that all builders we code as exiting are no longer producing boats.

generation to generation, with little to no exit or entry in recent history. To provide support for this observation, and further visual evidence of just how unusual the decline in the number of firms around the time of mobile phone introduction was, we can construct a "pre-sample" time series of builders. For every boat that we find in our canvas of all boat landings at baseline[37] in January 1998, we know who built it and when. So we can for example look at all boats we find in January 1998 that were built around July 1997 and count up the number of unique builders of those boats. Provided there was no builder in the industry in July 1997 who had no boats surviving to January 1998, we should get a reasonable estimate of the number of builders who were building boats in the pre-sample period 6 months before our baseline survey.[38] We can then do the same for all boats we find in our canvas that were built in January 1997, and further back. In Figure III, the dotted line traces back our estimates of the number of builders in the 3 years prior to our baseline.[39]

With these constructed pre-sample data, the evidence becomes more compelling, showing that in both regions, large declines in the number of builders follow 12 to 18 months after phones are introduced, with no evidence of any changes at all before mobile phones are present.[40] In the case of Region II, this lack of any trend is evident even from the actual counts of firms from the canvas, but becomes even more striking when we also include the pre-sample estimates of the number of firms. And notably, in Region III, which did not receive phones, the number of firms is very stable over the whole survey period. Overall, the figures indicate that there was no evidence of any major changes in the number of firms other than when and where mobile phones are present.

Figure IV provides additional evidence to support our proposed interpretation by splitting the sample into firms above vs. below the region-specific median life expectancy at baseline, using

[37] Recall, this was a canvas of every boat landing throughout the two districts, and we gathered data on every boat at the landing, so we have what we believe to be an exhaustive canvas of every fishing boat in these two districts with which we should be able to identify every builder.
[38] We verify the accuracy of this method by using our final landing canvas in January 2004 to perform a similar "back-estimate" of the number of builders in the three years prior to that canvas, since for each of those years we also have a direct count of the actual number of firms. Despite this period featuring much more exit, we find a perfect correspondence between the actual and back-estimated number of firms.
[39] Aside from concerns about the accuracy of respondents' recall of purchase dates further in the past, going back more than 3 years might cause us to miss low quality builders. For example, a builder whose boats last less than 4 years and who has since gone out of business would not have any surviving boats as of our baseline survey, so we would underestimate the number of active builders 4 years ago, which might bias us against finding a pre-existing downward trend in the number of builders over time.
[40] The fact that the number of firms is stable over time of course does not suggest there was no entry or exit, only that the two were balanced. However, all but three cases of entry or exit in Region III, or in Regions I and II prior to mobile phones, were firms that exited temporarily and returned later.

the previous-boat measure of life expectancy. The two top panels reveal that the decline in the number of firms seen in Figure III was heavily concentrated among those below the median baseline life expectancy (within their region). Some above-median firms do exit, and some below-median firms continue to produce, but overall it is clear that the decline is largest among lower quality builders. And the longer pre-phone series available in Region II shows that prior to mobile phones, there was no evident differential trend in exit or entry for high and low quality builders.[41] Similarly, Region III, though again perhaps not as comparable, shows no differential trends in exit or entry by quality over this entire period. Thus overall, between the two figures we find that there was a large decline in the number of firms, which was much more pronounced among lower quality firms. These declines correspond in both regions to having recently received mobile phones, and there is otherwise no evidence of any decline in the number of firms, overall or by quality, before phones were available (or in Region III, which never received phones). These two graphs, alongside Table II, provide supportive evidence of the proposed causal chain discussed above, namely that greater learning about non-local firm quality drove out low quality builders (though this evidence so far does not rule out that mobile phones may have affected firm exit through other channels, which we explore below).

Figure V provides data on the average number of employees among firms (computed excluding firms once they have exited). As with the number of firms, the timing of mobile phone introduction does not correspond to an immediate and evident change. However, there is a noticeable increase in the mean number of employees after the introduction of mobile phones. At baseline, the average firm in all three regions has just over two workers. For both Regions I and II, the mean is near five by the end of our sample period, an increase of 150 percent. Even more notable is that at the end of our sample, the average number of workers per firm in these two regions is greater than the biggest firms (4 workers) we observed at baseline (Table I). Region II, which, again, has a longer series of data before phones are introduced, shows there is no general

[41] We do not provide pre-sample estimates of the number of firms based on baseline quality, since we would be unable to classify the few firms that exited (even if only temporarily) in the pre-sample period. However, if we just confine ourselves to firms that were in business at our baseline survey, we see no evidence of any pre-existing differential trend in the number of firms based on baseline quality (since in general there was very little exit at all prior to the introduction of mobile phones).

trend in firm size prior to mobile phones being introduced.[42] Similarly, there is no trend in firm size over the whole period in Region III, which never got phones.

Together, Figures III through V reveal broad changes to the industry over the period when mobile phones were added: namely, the industry moved from a large number of very small firms, to a much smaller number of larger firms.

*B. Regressions: Exit, Market Share and Firm Size*

Table III provides the regression results for exit, market share and number of employees, using all four measures of builder quality. Consistent with Figures III and IV, Column 1 of Panel A shows that getting phone coverage was associated with a large and statistically significant increase in the likelihood of exit. However, exit is a function of baseline quality when phones enter, as each additional year of baseline life expectancy reduces the likelihood of exit by 5.9 percentage points. Panels B − D show that using the auditor's assessment, fishermen's estimates or skill residuals for baseline quality yield very similar conclusions. The results are all statistically significant at the 1 percent level, and do not differ appreciably across the various measures of quality.

Column 2 shows the effects of phones on market share, where the market is defined as the total number of boats sold in the prior 6 months across all three districts. Again, phones have a large effect, differentiated by baseline quality. To give a sense of magnitudes, a firm at the 75th percentile of the life span distribution gains on average almost 2 percentage points in market share after phones enter. This is particularly striking when we note that at baseline, no firm had greater than a 1.3 percent market share. By the final survey round, many firms had between 4 and 7 percent shares of the total market. As with the regressions for exit, these results are robust to alternate measures of baseline quality, and all coefficients for the interaction term are statistically significant at the one percent level.

Finally, Column 3 shows the results for firm size, as measured by the number of employees. Again consistent with the visual evidence, we find that once mobile phones are introduced, firms with the highest baseline quality grow. As above, the results are all significant at the 1 percent level, and are consistent across the different measures of baseline quality.

[42] We did not collect retrospective data on firm size, and thus cannot provide any pre-sample data here.

*C. Productivity*

There are many channels through which these dramatic changes in the industry may result in gains in aggregate productivity, such as reallocations in output across firms (including through exit) and gains in productivity among surviving firms (such as due to the pressure of increased competition, or just due to scale economies). Table IV shows data on output, labor, capital and materials, aggregated across all firms within each region, drawn from our firm censuses (for ease of presentation, we present data from every other round).[43] For labor, we asked firms to report all workers, and the number of hours they worked in a typical week and typical month. For material inputs, we asked firms about the amount of materials, the quality of the materials (primarily, wood and coir) and their prices. For capital, we took an inventory of every tool and piece of equipment used by the firm. However, we do not have measures of their quality or estimates of value.[44] We create an index of a firm's stock of capital by valuing each tool at average market prices (collected from a separate survey). However, this measure will miss any quality variation in tools and equipment.

Many of these variables may be noisily measured or just naturally fluctuate considerably from year to year. However, some clear patterns can be discerned. The first rows of each panel of Table IV show that the total number of boats produced in each region was fairly constant over time. Again, output does vary from year to year, but there is no evidence of any trend.[45] Similarly, material inputs vary across years, but do not appear to change in any clear way over time. By contrast, both labor and capital noticeably declined in Regions I and II, in both cases occurring after phones became available (unshaded cells), while remaining largely unchanged in Region III. Thus, by the final period, the sector is producing nearly the same number of boats (if not slightly

[43] In this section, we discuss productivity via descriptive analysis rather than by first estimating productions functions as in the approaches of Olley and Pakes (1996) or Levinsohn and Petrin (2003). As noted above, the Olley-Pakes approach is not suitable for our purposes, since it can only be applied to firms in rounds where they have non-zero investment, which causes us to drop many observations. And perhaps because of our smaller samples, particularly in the later rounds, the results of applying the Levinsohn-Petrin approach are very sensitive to the way we construct our key variables and implement the approach (constructing changes in aggregate productivity, we find gains ranging from 15 to nearly 60 percent).

[44] Beginning in Round 6, we did collect information on the purchase value of tools and equipment in every other round. However, this information was not gathered at initial rounds due to a need to limit the length of the interview (most firms own more than 100 tools or pieces of equipment, so asking the price of each one would have been prohibitively time consuming for the large number of firms we had).

[45] If we measure output as boat*years produced, output increased significantly over this period, since many of the lowest quality builders lost market share and exited.

more), but with about 40 percent fewer workers, 25 percent fewer worker hours and 35 percent less capital in Region I, and 28 percent fewer workers, 10 percent fewer worker hours and 34 percent less capital in Region II. Appendix Table II expresses capital, labor hours and material inputs per boat produced in the region for a clearer comparison of productivity changes. Again, we find there were dramatic declines in capital and labor hours used per boat produced in both Regions II and III. However, one caveat to our analysis in both tables is that if firms upgraded the quality of their capital, we will overstate the productivity gains.[46]

Almost all of the gains in productivity are attributable to gains in productivity within firms. Rather than provide a formal decomposition, we instead note that there was no entry over this time period and neither exit nor changes in market share are a function of baseline TFP (where the number of boats produced is used as the output measure). As noted above, at baseline there is in fact little difference in raw productivity, the average labor, capital or material inputs used in producing a boat, across firms at baseline. Thus, exit and changes in market share on their own contribute little to the aggregate change in productivity.

We note however that the productivity changes we observe are relatively short run; Region I can be followed for five years following mobile phone introduction, whereas we only have data for Region II up to three years after phones were added. We of course cannot rule out that the gains in productivity may increase or decrease over time.

*D. Potential Sources of Productivity Gains*

The productivity gains shown above could come arise through many channels. In this subsection, we discuss two possibilities.

Labor Specialization: One possible explanation is gains from increased specialization of labor within firms, as in the classic case of the pin factory described by Adam Smith (1776). The primary time-intensive tasks in these firms are: obtaining inputs; cutting; shaping; drilling; sanding; fastening; finishing/treating; customer relations; cleanup; and management and supervision. We asked questions on the allocation of each worker's time to each of these tasks as part of our boat builder survey (though beginning only in the second round).

[46] Changes in the type of capital used, however, will be captured in our data. For example, by the last two rounds of the survey, a small number of firms had for the first time adopted some power tools.

The data in Table V reveal that as firms grew, labor specialization increased dramatically. Across all three regions, at baseline, the average worker in a firm performed about $7 - 8$ of the measured tasks. In essence, in the small, two person firms common at baseline, both workers performed almost all tasks, with only a few exceptions (e.g., the owner typically conducted all customer relations, as well as management and supervision). However, in Region I, within two years of phones entering, the average worker is performing only about three tasks, less than half of the baseline number. In Region II, again, because there is a longer period before phones are in place, we see more clearly that there was no change in the number of tasks performed by workers before mobiles phones were in place, but the decline is evident after mobile phones become available. By contrast, in Region III, there is essentially no change in the number of tasks performed per worker.

Breaking down the data further (not shown in table), we find that as firms grow, the owner tends to focus more on finishing and fastening, the two most skill-intensive tasks, as well as continuing with customer relations and management and supervision. Newer employees (typically, relatives) tend to specialize in less skilled tasks, such as cutting, obtaining inputs and cleaning up. Given the skill intensity of some key aspects of boat production, this division of labor likely also helps the firm increase output, particularly in the short run when there is not enough time to find or train workers for skilled tasks. However, the ability of the firm to further grow may eventually hit limits; once the skilled builder is devoting all of their time to just the highest skill tasks, and is working at their maximum capacity, the firm will not be able to expand output without other workers also being able to perform the high skill tasks.

Capital: From our observation of these builders, a possible explanation for the reduced aggregate need for capital in the sector is the fact that in small firms, most capital is often sitting idle. Imagine a simplified boat building process with three steps: first, the wood is cut using a saw; second, holes are drilled in the wood using a hand drill; third, planks are mounted on stands and woven together. In a one person firm, the builder does each of these steps in sequence. So while he is cutting the wood, the hand drill and stands are idle; while he is drilling the holes, the saw and stands are idle; and during weaving for final assembly, the saw and drill are idle. If all three tasks take the same amount of time per boat, adding a second and third worker to the firm could potentially triple output without increasing capital needs, either by having the three workers operate independent production lines with staggered timing so that tools can be passed from one worker to the next, or with labor specialization and a single assembly line where each worker has one tool and focuses on one of the three tasks exclusively. In either case, capital would be idle for less time during the day. With production involving even more steps, specialization could lead to even bigger gains in output without additional capital.[47]

This description does however raise an additional consideration in identifying productivity gains, namely depreciation. For example, if depreciation were perfectly linear in use, then capital requirements, properly accounted for, would vary only with the number of boats produced, with no resulting productivity gains.[48] However, we believe that depreciation is not linear in use and further, that in general depreciation of the hand tools used in this type of production is fairly low. First, most of the capital used is extremely durable and unlikely to be replaced over any reasonable time frame, even with extensive use. For example, vises, mallets, pry bars, rulers, punches, squares, sanding blocks, work benches or levels may last decades. In fact, for many of these tools, depreciation often will be more a function of age rather than use, as items with metal parts rust in the high salt environment or wood parts rot when exposed to fungi (dry rot) or the high humidity of the region. Other tools have very long lifespans but require some maintenance such as sharpening or lubricating (e.g., chisels) or have some parts that are durable and some that depreciate with use but are less expensive and easy to replace (e.g., a hand drill with replaceable bits). Of all the capital used in boat production, saws depreciate the most with use. However, even saws have some attributes like those mentioned above, such as how maintenance can make a long life possible even with extensive use (they can be repeatedly filed and sharpened) or replaceable parts (e.g., hacksaws with replaceable blades). Further, even under full depreciation, saws are only a very small share of the total capital stock for builders.

Since our survey collected information on both capital stock and new capital purchases at each round, we can provide some suggestive evidence that depreciation does not scale significantly with use (in doing so, we also include estimates of maintenance costs such as materials like

[47] Different tasks may take different amounts of time, which could lead some workers to be idle while they wait for someone downstream in the assembly line; however, more than one worker could be assigned to the lengthier task, or idle workers could be assigned second tasks. A second limitation is that at some point, capital may be fully employed and firms may need to acquire enough new capital to set up a second production line to further increase output (and indeed, in our data we see growing firms add capital slowly during most periods, but then in a few instances add a lot of capital all at one time).

[48] In other words, we might see the capital stock appear to be almost constant over many periods, whereas in fact the increased intensity of use has caused capital to be replaced every few periods.

lubricants and the value of time). First, we exploit the fact that even at baseline, some firms produce far more boats than others (as noted in Table I). We find that new capital expenditures in the past year are less than 5 percent greater for firms in the top quartile of the distribution of baseline production compared to those in the bottom quartile, despite the fact that they produce 2.5 times as many boats per year (20 vs. 8) and are using the same capital and essentially identical production processes. Second, we can examine annual capital purchases over time in Region III, where firms did not grow (in the other two regions, it is difficult to distinguish capital purchases designed to increase production from purchases to replace depreciated capital). Overall, across the 6 years of data we collected, new spending on capital was on average only 18 percent of the value of firms' capital stock at baseline (and again, some of the implied depreciation may be due to age (rot or rust), or loss or theft, rather than as a result of usage). The qualitative arguments above and both pieces of evidence suggest that depreciation will not increase dramatically as firms increase in scale, suggesting that the gains in output relative to capital will remain significant.

*E. Gains for Consumers*

Table VI shows estimates of changes for consumers (fishermen). We regress changes in price, life expectancy and price per boat*year on a dummy variable equal to one in all periods in which the fisherman's region has mobile phones (we include region fixed effects and region-specific time trends).

The introduction of mobile phones is associated with a statistically significant 413 Rs. increase in the price of boats on average. This represents about a 12 percent increase over the baseline average. However, the average life expectancy of a boat also increased by 1.3 years (column 2), which is a 31 percent improvement (using estimated life expectancy from the assessor in order to capture more newly built boats). As a result, the cost per boat* year dropped 117 Rs., or 14 percent. For fishermen, boats are by far the largest business expenditure, so this price decline is likely to represent a substantial welfare improvement. However, these are just short-run effects. As production grows more concentrated into fewer firms, it is possible that firms will exercise greater market power, potentially eroding consumer gains.

## VI. ALTERNATIVE EXPLANATIONS AND MECHANISMS

We argue that increased potential market size due to fishermen learning about heterogeneous builder quality led to the observed changes in the industry. In this section, we consider several potential empirical challenges or alternative mechanisms.

We first note again that Figure III shows that there were large declines in the number of firms after the introduction of mobile phones in Regions I and II, and that these changes occurred at two distinct points in time. In addition, there is no evidence of any changes or general trends prior to mobile phones being introduced in these two regions, nor any evident changes in Region III, which never received phones. Further, in Regions I and II, the changes disproportionately affected firms producing the lowest quality boats. Of course, any fixed differences across the regions, or any common or state-level changes (laws or regulations, input prices, new technologies, etc.) that affected all regions equally, could not explain the results. Challenges to our identifying assumption would have to come from factors that changed around the same two points in time as phones arrived in Regions I and II, and in a way that would differentially affect high and low quality firms, but that did not affect Region III and were not evident in any earlier periods. It is of course difficult to rule out every possible factor that might change. However, we will consider a few of the most significant possibilities. Additionally, we need to consider whether mobiles phones might have affected the sector through mechanisms other than those proposed in our proposed causal chain. Some of the discussion that follows draws on Jensen (2007), which explored similar challenges because the same natural experiment was used.

Other infrastructure: Although the construction of mobile phone towers represented a major investment in telecommunications infrastructure, there is no evidence that this was accompanied by any other changes in infrastructure. Mobile phone towers were constructed entirely by private companies. And as discussed in Jensen (2007), the sequencing of when different towers were constructed was driven largely by licensing and technical factors (the availability of equipment and engineers). Further, the big cities where the towers were located already had adequate power supply for the towers, so there was no upgrading of the public electricity infrastructure. Finally, the boat builder and fishermen surveys asked about access to electricity. Column 1 of Appendix Table I shows that there was no change in access to power associated with the timing of mobile phone introduction across the regions.

Push vs. pull factors. Another possibility to consider is whether other businesses became more attractive to boat builders, pulling them to other industries (as opposed to decreased demand for boats pushing some builders away from boat building). For example, Jensen (2007) shows that the profitability of fishing itself increased when mobile phones were introduced (by 6 percent), and perhaps this pulled in some builders. However, we believe that it is unlikely that exit was driven more by the increased attractiveness of outside opportunities. First, both at baseline and throughout the survey, boat building remains a profitable industry. For example, the average boat builder earns approximately 41 percent greater net income than the average fisherman. Further, in follow-up surveys tracking exited builders, the average ex-builder suffered an income loss of approximately 36 percent.[49] Further, we find no difference in profits at baseline between low- and high-quality builders (the point estimates suggest slightly greater profits for the low quality builders, though the difference is not statistically significant); thus, it is not clear why the low quality builders would have been more likely to choose to exit boat building (unless we assume that low quality builders had higher expected profits in the alternative employment opportunity than high quality builders, though there is no obvious reason why that might be the case).

Change in demand for boats. As noted, over this time period, fishing became more profitable. This in turn could have led to increased demand for boats, corresponding exactly to where and when mobile phones were introduced across the three regions. However, any such increase in demand would be unlikely to lead to consolidation in the builder market; if anything, it might allow lower quality firms within a region to remain in business. A decrease in demand could lead to increased exit, which could occur for example if phones increased expected incomes from some other economic activity more than it increased them for fishing, causing some fishermen to exit. However, as shown in Table IV, there is no evidence that the total number of boats produced changed over this period (again, if anything there is perhaps a slight increase). This result is consistent with Jensen (2007), who finds no evidence of significant increases in entry or exit from fishing.[50] There is also no evidence of a spatial shift in demand, such as increased fishing

---

[49] Though it is certainly possible that builders expected greater profits when making the decision to switch industries, or that the lower income is temporary and will soon catch up and overtake their previous earnings, or that there was some non-wage amenity to these alternative jobs that, perhaps in conjunction with a decreased income gap between the two jobs, was enough to induce some builders to switch.

[50] We might eventually expect a decreased demand for boats even with a stable number of fishermen due to the longer life span of boats being sold once low quality builders exit. However, any such effects would not yet have influenced boat demand during our sample period.

in some areas (those with high quality builders) and decreased fishing in others (those with low quality builders), or fishermen moving from some villages to others. In Column 2 of Appendix Table I, we present regressions like those above but where the dependent variable is the number of active fishing boats in each village (from our landing canvas), based on the baseline quality of the builder originally located in that village. The coefficient on the interaction of phone and baseline quality is small, and not statistically significant. Thus, there does not appear to have been any differential change in the demand for boats in villages with high and low quality builders; all that changed is where fishermen in those villages bought their boats.

Demand for quality. A related possibility is that the demand for quality increased following mobile phone introduction, perhaps due to the greater travel now involved in selling fish (and thus more rapid depreciation of boats).[51] Table II showed that fishermen had much less accurate information at baseline about the quality of non-local producers, so it can't be that fishermen already knew about quality differences but those differences were not important enough to them. However, quality might matter more when boats are being used more intensively, and this may have led fishermen to search for more information about builders. We first note that this would be consistent with our broader interpretation that markets are highly localized, and the lack of firm growth and the dispersion in quality arise from the limited ability of firms to sell outside of their immediate area. However, we also believe that it is unlikely that increased demand for quality is what drives our results. First, it would seem like even at baseline, before there was extensive travel for arbitrage, most fishermen should still have preferred to buy the boats that last longer, holding fixed the price of the boat. Further, even at baseline, fishermen from some villages traveled considerably longer on an average day than fishermen in other villages;[52] yet, again, these fishermen were no more likely to buy their boats from a non-local producer before mobile phones.

Input markets: Another factor to consider is the price and availability of inputs, such as wood. For example, mobile phones might allow builders to search for and find better prices for

[51] Another possibility is that the increased income from fishing once there are mobile phones led to an increase in the demand for higher quality boats. However, we find that income had no effect on the likelihood of buying boats non-locally at baseline (since in fact almost everyone purchased boats locally at baseline). Further, higher quality boats were not more highly priced at baseline, so credit constraints were not previously limiting the demand for higher quality boats.

[52] Though most fishermen at baseline fish and sell their catch locally, there are still moderate differences in the average distance travelled by fishermen in different villages due to natural variation in coastline geography, fish density and the distance between home landing spots and common fishing locations.

inputs. And if high-quality firms are better able to acquire inputs at lower prices (or to more easily secure a reliable supply of inputs), this could lead to differential exit by low-quality firms. However, perhaps because wood, the primary input, is non-perishable, in general there is very little price variation in input purchases even in the absence of mobile phones. Further, in regressions like those above (Column 3 of Appendix Table I) we find no statistically significant change in input prices paid by boat builders in response to adding mobile phones, based on baseline quality. Finally, our surveys asked builders whether they ever had to wait or were unable to find inputs, and there is no evidence that such problems are common, much less correlated with either the pattern of mobile phone introduction or the baseline quality of builders. In general, inputs appear to be readily available in the market throughout our sample period.

Credit Markets. If mobile phones increased access to credit for builders (e.g., by lowering search and transactions costs), this could have allowed some firms to expand and potentially push others out of business. However, even at the time of our final survey, we find that only three firms borrowed money or received formal or informal loans for their business from a bank, government program, friends, family or any other source of credit. Most firms appear to grow via savings or retained earnings. The fact that firms were able to grow without access to credit is of interest in itself, given that credit access is often cited as a key limitation to firm growth.

Advertising, marketing or technical knowledge. Finally, we believe that is it unlikely that phones had effects on the sector through their use in advertising or marketing. Since there was no directory or phonebook of fishermen that firms could take advantage of, mobile phones were not a useful means for advertising or marketing their goods, and anecdotally, no builders reported doing so. Similarly, phones would not have helped fishermen gain technical knowledge from others, since there were no resources available for learning about boat building through phones.[53]

## VII. DISCUSSION AND CONCLUSION

We find that the introduction of mobile phones led to consumer learning, causing them to switch from low quality to high quality producers. This led to increases in market share for high quality/more productive firms, the exit of less productive or lower quality firms and reductions in

[53] Whether for the potential purposes of advertising and marketing or learning about boat building, access to the internet is not a relevant consideration during this period. Mobile phones were not internet capable and access to or use of the internet in general was very low in India, particularly among the poor.

productivity/quality dispersion across firms. Aggregate productivity for the sector increased and consumer prices, per year of boat-life, decreased. We attribute this to mobile phones reducing barriers to trade across regions, increasing each builder's effective market size and the intensity of competition, as in the imports-as-market discipline hypothesis.

Though this sector is a small industry in a small region, we believe that the fundamental attributes of this industry (small firms largely serving a local customer base) are found in many other industries and in many other developing countries. The key insight we wish to emphasize is that factors such as imperfect information that limit the ability of businesses to get customers outside of their local area are an important constraint on firm growth. Further, in the present setting, once information on quality became available, firms were able to grow without greater access to credit, improved infrastructure or changes in any of the other factors that are often thought to limit firm growth. Of course, we would not argue that these other factors are irrelevant for firm growth. In fact, credit constraints or managerial skill may become more important in our setting beyond an early stage of growth, since although firms in our sample grow considerably, they still remain fairly small by the last round of our survey (with no firm having more than 10 employees). However, the results here demonstrate a clear role for constraints on effective market size as one potential constraint on growth.

REFERENCES

Bloom, Nicholas, Aprajit Mahajan, David McKenzie and John Roberts (2010). "Why Do Firms in Developing Countries Have Low Productivity," *American Economic Review*, 100(2), p. 619-623.

Bloom, Nicholas, Benn Eifert, Aprajit Mahajan, David McKenzie, and John Roberts (2013_. "Does Management Matter? Evidence from India," *Quarterly Journal of Economics*, 128 (1), p. 1 – 51.

Bruhn, Miriam, Dean Karlan and Antoinette Schoar (2010). "What Capital is Missing in Developing Countries?" *American Economic Review Papers & Proceedings*, 100 (2), p. 629 – 33.

- -, - - and - - (2013). "The Impact of Consulting Services on Small and Medium Enterprises: Evidence from a Randomized Trial in Mexico." WPS 6508, Impact Evaluation Series no. IE 95. Washington, DC: World Bank.

de Loecker, Jan, Pinelopi Goldberg, Amit Khandelwal and Nina Pavcnik (2016). "Prices, Markups and Trade Reform," *Econometrica*, 84(2), p. 445-510.

de Mel, Suresh, David McKenzie and Christopher Woodruff (2008). "Returns to Capital in Microenterprises: Evidence from a Field Experiment", *Quarterly Journal of Economics,* 123(4), p. 1329-1372.

- -, - - and - - (2009). "Are Women more credit Constrained? Experimental Evidence on Gender and Microenterprise Returns," *American Economic Journal: Applied Economics*, 1(3), p. 1-32.

- -, - - and - - (2011). "Getting Credit to High Return Microentrepreneurs: The Results of an Information Intervention," *World Bank Economic Review*, 25(2), p. 456-485.

- -, - - and - - (2012). "One time Transfers of Cash and Capital Have Long-Lasting Effects on Microenterprises in Sri Lanka," *Science***,** 335 (6071), p. 962-966.

- -, - - and - - (2014). “Business Training and Female Enterprise Start-up, Growth, and Dynamics: Experimental evidence from Sri Lanka,” *Journal of Development Economics***,** 106, p. 199-210.
Dollar, David and Kenneth Sokoloff. (1990) "Patterns of Productivity Growth in South Korean Manufacturing Industries, 1963-1979", *Journal of Development Economics*, 33 (4), p. 309-327.
Fafchamps, Marcel, David McKenzie, Simon Quinn and Christopher Woodruff (2014). “Microenterprise Growth and the Fly-paper Effect: Evidence from a Randomized Experiment in Ghana,” *Journal of Development Economics***,** 106: 211-226, 2014.
Fischer, Greg and Dean Karlan (2015). “The Catch-22 of External Validity in the Context of Constraints to Firm Growth,” *American Economic Review Papers & Proceedings***,** 105(5), p. 295-299.
Foster, Lucia, John Haltiwanger and Chad Syverson (2016). “The Slow Growth of New Plants: Learning about Demand,” *Economica*, 83(329), p. 92-129.
Goldberg, Pinelopi and Nina Pavcnik (2016). “The Effects of Trade Policy,” in Bagwell, Kyle and Robert W. Staiger, eds., Handbook of Commercial Policy, Volume 1A, p. 161−206.
Hallward-Driemeier, Mary, Giuseppe Iarossi and Kenneth L. Sokoloff (2002). "Exports and Manufacturing Productivity in East Asia: A Comparative Analysis with Firm-Level Data," NBER Working Paper No. 8894.
Helpman, Elhanan and Paul Krugman (1989). *Trade Policy and Market Structure*. MIT Press.
Hsieh, Chang-Tai and Peter J. Klenow (2009), “Misallocation and Manufacturing TFP in China and India,” *Quarterly Journal of Economics*, 124(4), p. 1403-1448.
- - and - - (2014). "The Life Cycle of Plants in India and Mexico," *Quarterly Journal of Economics*, 129(3), p. 1035-1084.
Hsieh, Chang-Tai and Benjamin A. Olken (2014). “The Missing ‘Missing Middle’ ,” *Journal of Economic Perspectives*, 28(3), p. 89–108.
Jensen, Robert T. (2007). “The Digital Provide: Information (Technology), Market Performance and Welfare in the South Indian Fisheries Sector,” *Quarterly Journal of Economics*, 122(3), p. 879 − 924.
Karlan, Dean and Jonathan Zinman (2011). “Microcredit in Theory and Practice: Using Randomized Credit Scoring for Impact Evaluation,” *Science***,** 322(6035), p. 1278-1284.
- - and Martin Valdivia (2011). “Teaching Entrepreneurship: Impact of Business Training On Microfinance Clients and Institutions,” *Review of Economics and Statistics***,** 93(2), p. 510-527.
Laeven, Luc and Christopher Woodruff (2007). “The Quality of the Legal System, Firm Ownership, and Firm Size,” *Review of Economics and Statistics*, 89(4), p. 601-614.
Levinsohn, James (1993). “Testing the Imports-as-market-discipline Hypothesis,” *Journal of International Economics*, 35(1), p. 1-22.
-- and Amil Petrin (2003). “Estimating Production Functions Using Inputs to Control for Unobservables,” *Review of Economic Studies*, 70, p. 317-341.
McCaig, Brian and Nina Pavcnik (2016). “Out with the Old and Unproductive, in with the New and Similarly Unproductive: Microenterprise Dynamics in a Growing Low-Income Economy,” *manuscript*.
McKenzie, David and Chris Woodruff (2008). “Experimental Evidence on Returns to Capital and Access to Finance in Mexico,” *World Bank Economic Review*, 22(3), p. 457-82.
- - and - - (2013). “What are we learning from business training and entrepreneurship evaluations around the developing world?” *World Bank Research Observer*, 31(2), p. 1-35.
- - and - - (forthcoming). “Business Practices in Small Firms in Developing Countries,” *Management Science*.
Melitz, Mark (2003). “The Impact of Trade on Intra-industry Reallocations and Aggregate Industry Productivity,” *Econometrica*, 71(6), p. 1695-1725.
- - and Gianmarco Ottaviano (2008). “Market Size, Trade, and Productivity,” *The Review of Economic Studies*, 75(1), p. 295-316.
- - and Stephen Redding (2014). “Heterogeneous Firms and Trade,” in Gopinath, Gita, Elhanan Helpman and Kenneth Rogoff , eds., Handbook of International Economics, Volume 4, p. 1-54. Elsevier.
Nelson, Phillip. (1970). "Information and Consumer Behavior," *Journal of Political Economy*, 78 (2), p. 311–329.

Olley, Steven G., and Ariel Pakes (1996). "The Dynamics of Productivity in the Telecommunications Equipment Industry," *Econometrica*, 64(6), p. 1263–1297.
Pack, Howard and Larry Westphal (1986). "Industrial Strategy and Technological Change: Theory versus Reality," *Journal of Development Economics*, 22(1), p. 87-128.
Pavcnik, Nina (2002). "Trade Liberalization, Exit, and Productivity Improvements: Evidence from Chilean Plants," *Review of Economic Studies,* 69, p. 245-76.
Redding, Stephen (2011). "Theories of Heterogeneous Firms and Trade," *Annual Review of Economics,* 3, p. 77-105.
Smith, Adam (1776). An Inquiry into the Nature and Causes of the Wealth of Nations. London: W. Strahan.
Syverson, Chad (2004a). "Market Structure and Productivity: A Concrete Example." *Journal of Political Economy*, 112(6), p. 1181-1222.
- - (2004b). "Product Substitutability and Productivity Dispersion." *Review of Economics and Statistics*, 86(2), p. 534-550.
- - (2007). "Prices, Spatial Competition, and Heterogeneous Producers: An Empirical Test," *Journal of Industrial Economics*, 55(2), p. 197-222.
- - (2008). "Markets: Ready-Mixed Concrete," *Journal of Economic Perspectives*, 22(1), p. 217-33.
- - (2011). "What Determines Productivity?" *Journal of Economic Literature*, 49(2), p. 326-65.
Topalova, Petia and Amit Khandelwal (2011). "Trade Liberalization and Firm Productivity: The Case of India," *Review of Economics and Statistics,* 93(3), p. 995-1009.
Tybout, James R. (2000). "Manufacturing Firms in Developing Countries: How Well Do They Do, and Why?" *Journal of Economic Literature*, 38(1), p. 11–44.

TABLE I. SUMMARY STATISTICS FOR KEY VARIABLES AT BASELINE

| | Mean | Standard Deviation | Min | Max |
|---|---|---|---|---|
| Number of employees | 2.2 | 0.72 | 1 | 4 |
| Boats produced per year | 14.2 | 5.8 | 4 | 27 |
| Market share (total market) | 0.007 | 0.003 | 0.001 | 0.013 |
| Life expectancy (years) | | | | |
| Previous boat | 4.76 | 0.89 | 3.56 | 8.1 |
| Auditor | 4.13 | 0.63 | 4.0 | 7.0 |
| Fishermen's perceptions | 4.53 | 1.22 | 4.13 | 7.79 |
| Price (Rupees) | 3,930 | 270 | 3,550 | 4,150 |
| Price/year (Rupees) | 841 | 122 | 583 | 1,104 |

Notes: Baseline values for key variables, collected in the Round 1 survey. Market share (total market) refers to the number of boats sold by a firm in the past 6 months as a percent of the total boats sold across all firms in the two sample districts.

TABLE II.ABSOLUTE ERRORS IN ESTIMATES OF BOAT LIFE-YEARS FOR OWN AND NON-LOCAL BUILDERS

| | REGION I | | | | | |
|---|---|---|---|---|---|---|
| | 1999 (Round 2) | 2000 (Round 4) | 2001 (Round 6) | 2002 (Round 8) | 2003 (Round 10) | 2004 (Round 12) |
| Own Builder | 0.53 | 0.56 | 0.52 | 0.52 | 0.59 | 0.59 |
| | (0.056) | (0.053) | (0.057) | (0.065) | (0.069) | (0.061) |
| Other Builder | 1.68 | 1.53 | 0.94 | 0.84 | 0.81 | 0.76 |
| | (0.28) | (0.26) | (0.16) | (0.073) | (0.077) | (0.082) |
| Own Builder: Retained | 0.53 | 0.55 | 0.58 | 0.47 | 0.51 | 0.54 |
| | (0.056) | (0.053) | (0.058) | (0.061) | (0.059) | (0.055) |
| Perception gaps | 2.15 | 1.99 | 1.50 | 0.65 | 0.54 | 0.58 |
| | (0.37) | (0.42) | (0.17) | (0.087) | (0.092) | (0.094) |
| | REGION II | | | | | |
| | 1999 (Round 2) | 2000 (Round 4) | 2001 (Round 6) | 2002 (Round 8) | 2003 (Round 10) | 2004 (Round 12) |
| Own Builder | 0.47 | 0.50 | 0.51 | 0.55 | 0.62 | 0.57 |
| | (0.045) | (0.042) | (0.047) | (0.044) | (0.049) | (0.057) |
| Other Builder | 1.47 | 1.55 | 1.38 | 1.04 | 0.78 | 0.71 |
| | (0.25) | (0.26) | (0.18) | (0.068) | (0.077) | (0.068) |
| Own Builder: Retained | 0.47 | 0.50 | 0.52 | 0.52 | 0.49 | 0.52 |
| | (0.045) | (0.042) | (0.047) | (0.043) | (0.040) | (0.036) |
| Perception gaps | 1.86 | 1.83 | 1.60 | 1.05 | 0.64 | 0.61 |
| | (0.31) | (0.38) | (0.31) | (0.22) | (0.073) | (0.080) |
| | REGION III | | | | | |
| | 1999 (Round 2) | 2000 (Round 4) | 2001 (Round 6) | 2002 (Round 8) | 2003 (Round 10) | 2004 (Round 12) |
| Own Builder | 0.45 | 0.50 | 0.47 | 0.46 | 0.42 | 0.49 |
| | (0.072) | (0.070) | (0.71) | (0.078) | (0.76) | (0.72) |
| Other Builder | 1.90 | 1.83 | 1.99 | 1.94 | 1.76 | 1.99 |
| | (0.31) | (0.32) | (0.33) | (0.31) | (0.28) | (0.34) |
| Own Builder: Retained | 0.45 | 0.50 | 0.47 | 0.46 | 0.42 | 0.49 |
| | (0.072) | (0.070) | (0.71) | (0.078) | (0.76) | (0.72) |
| Perception gaps | 2.33 | 2.28 | 2.44 | 2.46 | 2.38 | 2.30 |
| | (0.46) | (0.49) | (0.52) | (0.41) | (0.38) | (0.49) |

Numbers in the first three rows of each panel represent the average of the absolute value of the difference between our estimates of life expectancy for boats (based on “previous boat” estimates) and fishermen’s estimates. “Own builder” refers to a builder in one’s village, and “other builder” is any other builder the fisherman is aware of. “Own builder: Retained” refers to estimates for the builder in one’s own village, restricting the sample to those fishermen whose original local builder does not exit. The fourth row in each panel, “perception gaps” contains differences between what individuals from a particular village estimate for the life span of their local builder and what individuals from other villages estimate about that same builder. Dark shading indicates the region did not have phones during this period, light shading indicates the region received phones during this period.

TABLE III: REGRESSION RESULTS: EXIT, MARKET SHARE AND EMPLOYMENT

| A. "Previous Boat" Life Expectancy (years) | (1) Exit | (2) Market Share | (3) # Workers |
|---|---|---|---|
| Phone*Baseline Quality | -0.059 | 0.0033 | 0.37 |
| | (0.022) | (0.0009) | (0.11) |
| Phone | 0.48 | -0.018 | -2.02 |
| | (0.077) | (0.0055) | (0.68) |
| Baseline Quality | 0.001 | -0.0001 | -0.0032 |
| | (0.002) | (0.0002) | (0.022) |
| Observations | 1,522 | 1,522 | 1,522 |
| **B. Auditor's Assessment (years)** | **Exit** | **Market Share** | **# Workers** |
| Phone*Baseline Quality | -0.015 | 0.0012 | 0.17 |
| | (0.006) | (0.00045) | (0.06) |
| Phone | 0.20 | -0.0055 | -0.80 |
| | (0.043) | (0.0029) | (0.36) |
| Baseline Quality | -0.001 | -0.00001 | -0.023 |
| | (0.001) | (0.0001) | (0.014) |
| Observations | 1,522 | 1,522 | 1,522 |
| **C. Fishermen's Estimates (years)** | **Exit** | **Market Share** | **# Workers** |
| Phone*Baseline Quality | -0.067 | 0.0050 | 0.54 |
| | (0.029) | (0.0010) | (0.12) |
| Phone | 0.38 | -0.028 | -3.0 |
| | (0.058) | (0.005) | (0.69) |
| Baseline Quality | 0.001 | -0.0002 | -0.029 |
| | (0.002) | (0.0002) | (0.031) |
| Observations | 1,522 | 1,522 | 1,522 |
| **D. TFP Residuals** | **Exit** | **Market Share** | **# Workers** |
| Phone*Baseline Quality | -0.060 | 0.0032 | 0.37 |
| | (0.012) | (0.0009) | (0.11) |
| Phone | 0.12 | 0.016 | -0.18 |
| | (0.015) | (0.0008) | (0.10) |
| Baseline Quality | 0.002 | 0.0001 | 0.011 |
| | (0.002) | (0.0002) | (0.023) |
| Observations | 1,509 | 1,509 | 1,509 |

Dependent variable listed at the top of each column. Each panel represents the primary regression specifications using a different measure of builder quality, indicated at the top of the first column. Regressions include region fixed effects and region-specific time trends. Standard errors in parentheses.

TABLE IV. OUTPUT AND INPUTS OVER TIME

| | 1999 (Round 2) | 2000 (Round 4) | 2001 (Round 6) | 2002 (Round 8) | 2003 (Round 10) | 2004 (Round 12) |
|---|---|---|---|---|---|---|
| **REGION I** | | | | | | |
| Boats Produced | 665 | 681 | 651 | 678 | 642 | 694 |
| Boat*Years Produced | 2,667 | 2,852 | 2,734 | 3,092 | 3,141 | 3,615 |
| Number of Workers | 96 | 95 | 74 | 65 | 60 | 57 |
| Labor Hours (x1,000) | 272 | 248 | 215 | 206 | 202 | 206 |
| Value of Capital | 655 | 684 | 680 | 507 | 438 | 439 |
| Value of Materials | 138 | 146 | 118 | 123 | 129 | 138 |
| **REGION II** | | | | | | |
| Boats Produced | 758 | 740 | 791 | 773 | 825 | 801 |
| Boat*Years Produced | 3,206 | 3,059 | 3,409 | 3,583 | 4,208 | 4,277 |
| Number of Workers | 111 | 108 | 113 | 95 | 78 | 80 |
| Labor Hours (x1,000) | 297 | 305 | 330 | 288 | 261 | 268 |
| Value of Capital | 777 | 832 | 750 | 572 | 544 | 518 |
| Value of Materials | 147 | 143 | 159 | 166 | 183 | 167 |
| **REGION III** | | | | | | |
| Boats Produced | 538 | 564 | 512 | 509 | 493 | 537 |
| Boat*Years Produced | 2,572 | 2,600 | 2,381 | 2,428 | 2,436 | 2,637 |
| Number of Workers | 72 | 70 | 68 | 68 | 71 | 69 |
| Labor Hours (x1,000) | 234 | 211 | 214 | 218 | 220 | 228 |
| Value of Capital | 490 | 520 | 538 | 544 | 508 | 532 |
| Value of Materials | 103 | 118 | 99 | 98 | 101 | 120 |

Value of capital and materials measured using constant, 1999 market prices in thousands of Rupees. Dark shading indicates the region did not have phones during this period, light shading indicates the region received phones during this period.

TABLE V. NUMBER OF TASKS PERFORMED PER WORKER

| Region | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---|---|---|---|---|---|---|
| I | 7.2 | 5.6 | 3.3 | 2.9 | 3.1 | 2.7 |
| | (0.26) | (0.34) | (0.68) | (0.72) | (0.65) | (0.66) |
| II | 7.4 | 7.3 | 5.8 | 3.5 | 3.2 | 3.0 |
| | (0.21) | (0.24) | (0.56) | (0.82) | (0.85) | (0.87) |
| III | 8.0 | 8.1 | 7.7 | 7.9 | 7.5 | 7.7 |
| | (0.19) | (0.18) | (0.20) | (0.23) | (0.29) | (0.27) |

Table shows the average number of tasks performed per worker in firms (excluding firms that have exited). Dark shading indicates that the region did not have phones during this period, light shading indicates the region received phones during this period.

TABLE VI: POOLED TREATMENT REGRESSIONS: CONSUMERS

| | (1)<br>Price | (2)<br>Assessed Life Expectancy | (3)<br>Price per boat*year |
|---|---|---|---|
| Region Has Phone | 413<br>(182) | 1.33<br>(0.54) | -117<br>(45.0) |
| Region III mean | 3,930 | 4.76 | 841 |
| Number of Observations | 1,871 | 1,871 | 1,871 |

Regressions include region fixed effects and region-specific time trends. Standard errors in parentheses.

FIGURE I. SPREAD OF MOBILE PHONES, JANUARY 1998−JANUARY 2003

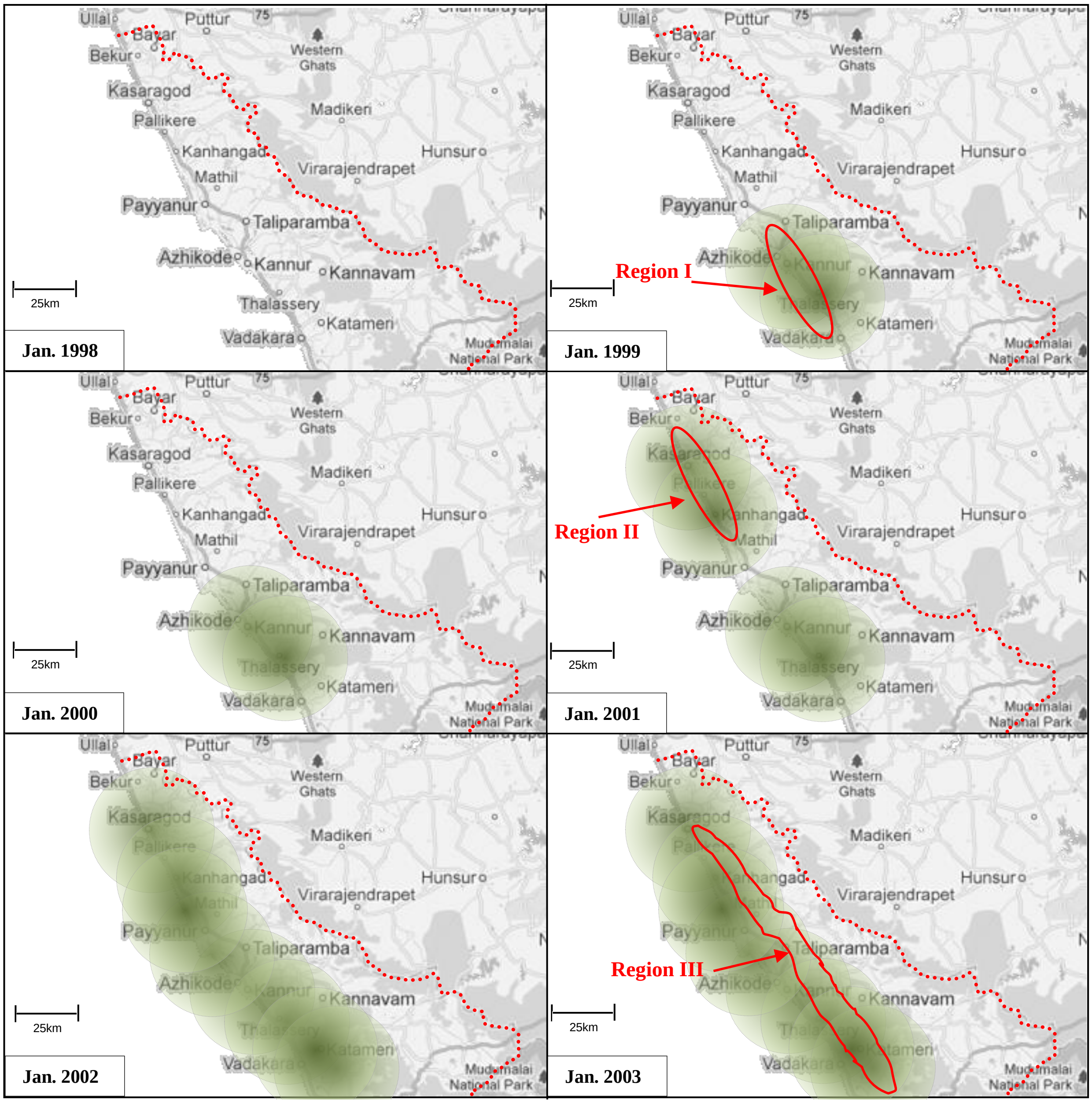
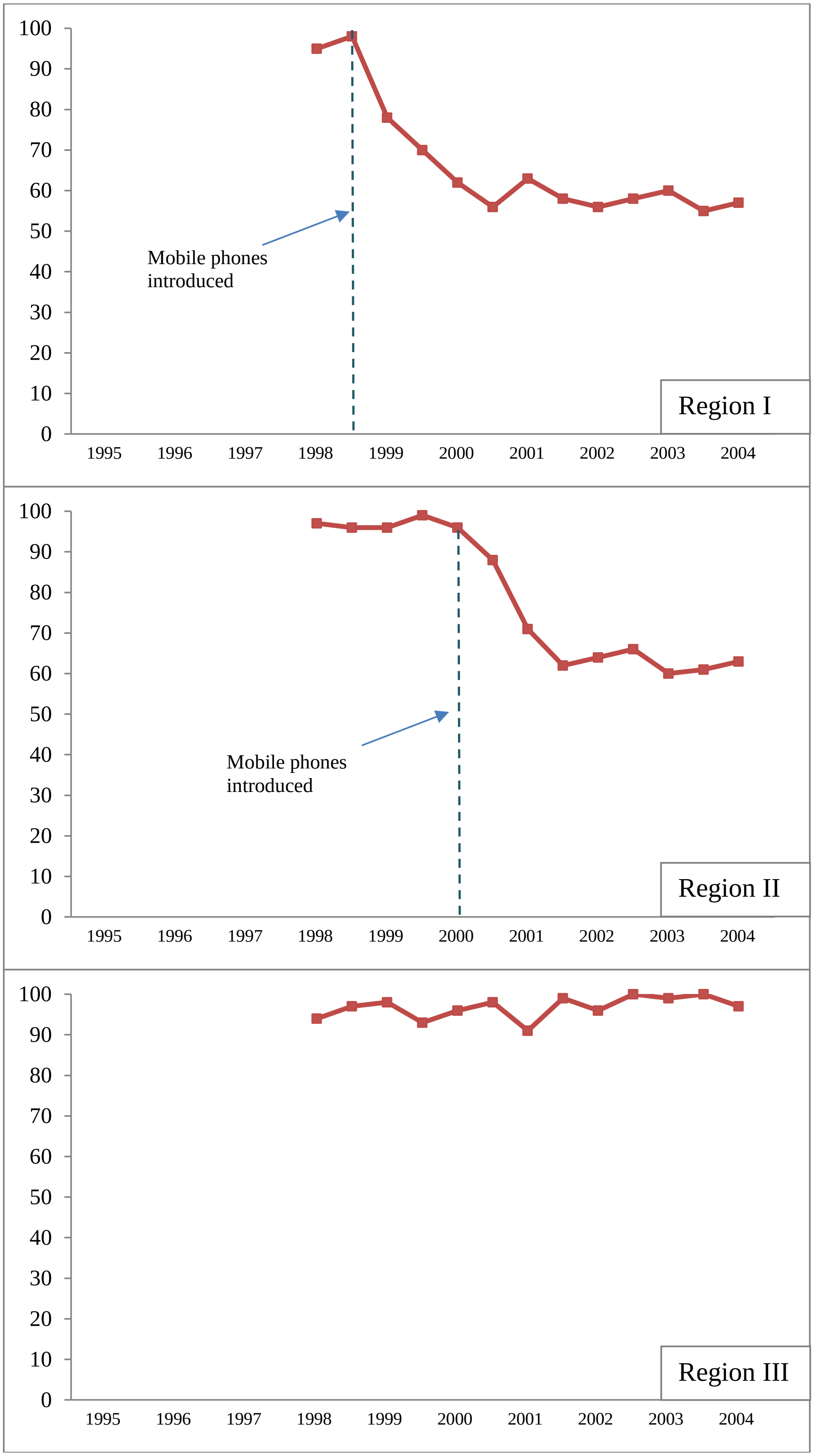


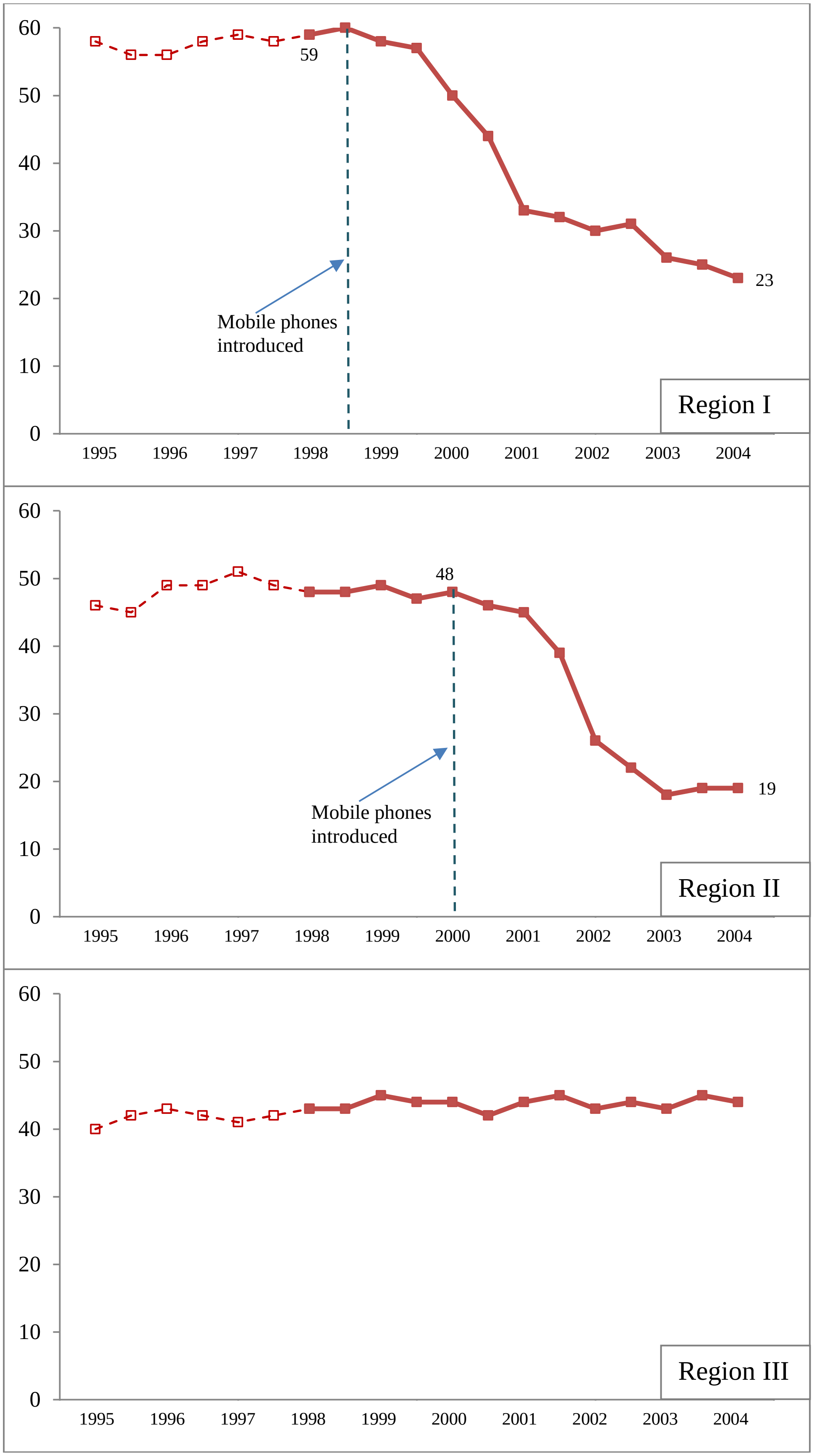

Figure shows the spread of mobile phones in two districts of Kerala between 1998 and 2003. Circles represent mobile phone towers (center point) and their service radius. Region designations are created by the authors to reflect when various geographic areas received mobile phones and do not represent any actual administrative unit.

FIGURE II. PERCENT OF FISHERMEN SELLING FISH LOCALLY, BY REGION



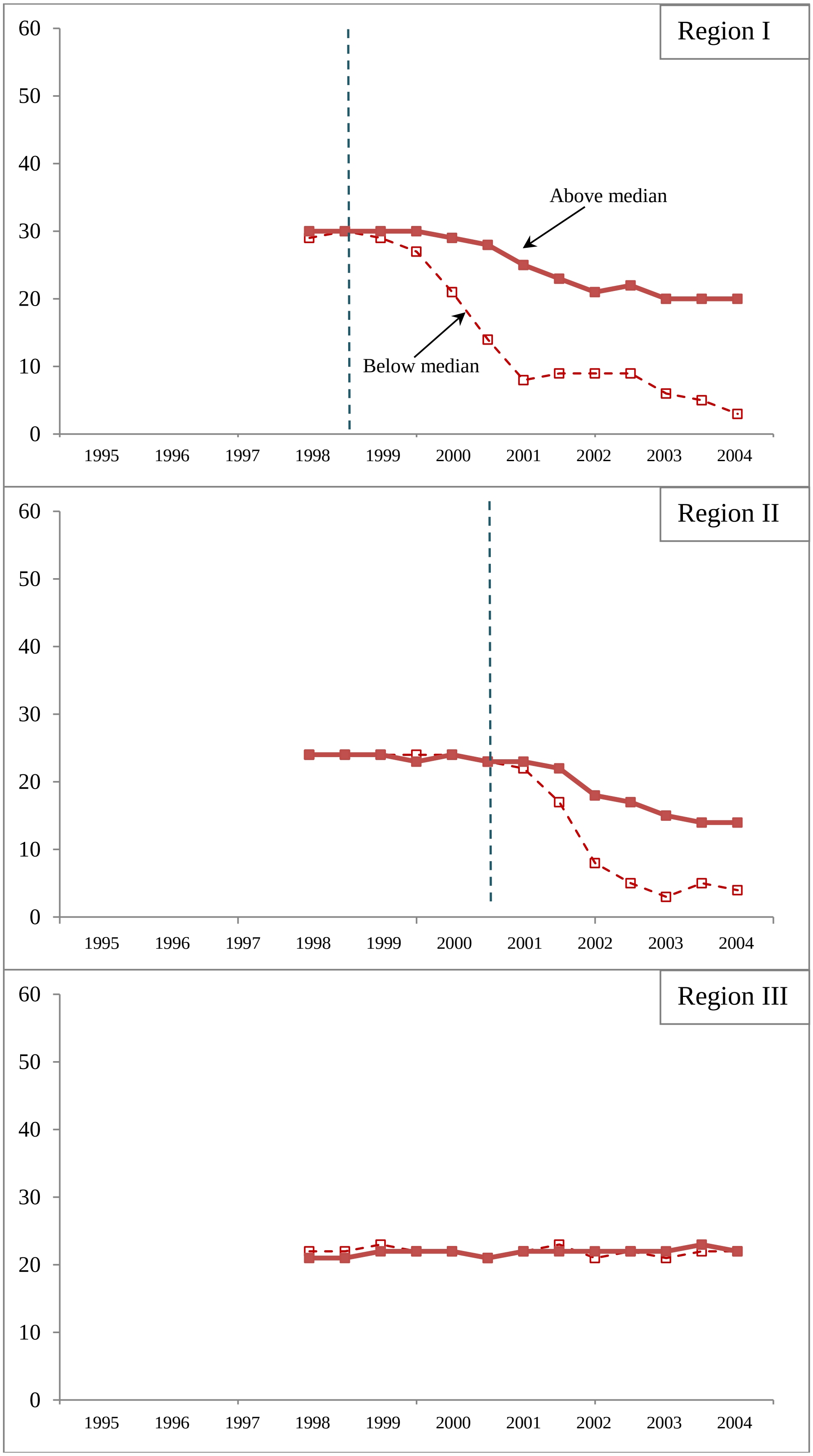

Notes: Figure represents the fraction of fishermen in each round of our fishermen survey who report selling their catch in their local market.

FIGURE III. THE NUMBER OF FIRMS, BY REGION



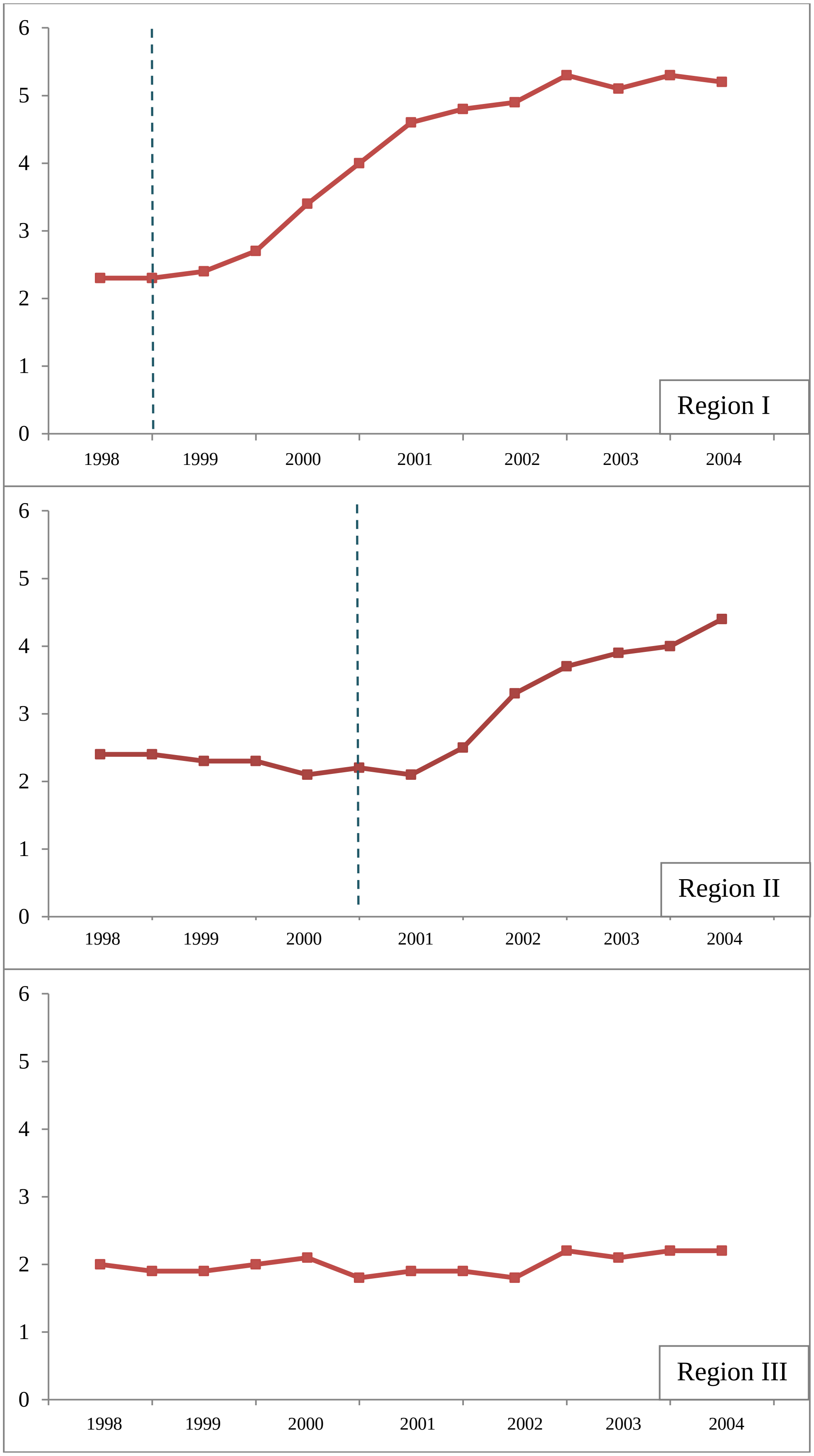

Notes: The solid line is a count of the number of firms in each round obtained from our builder census. The dashed line is a "pre-sample" estimate of the number of firms, using the purchase dates and builder names from all boats observed in our canvas of landings.

FIGURE IV. THE NUMBER OF FIRMS, BY REGION AND BASELINE QUALITY




Notes: The solid line is a count of the number of firms in each round that were above the median within-region life expectancy at baseline (using "previous boat" estimates of life expectancy. The dashed line is the number of firms in each round that were below this median at baseline.

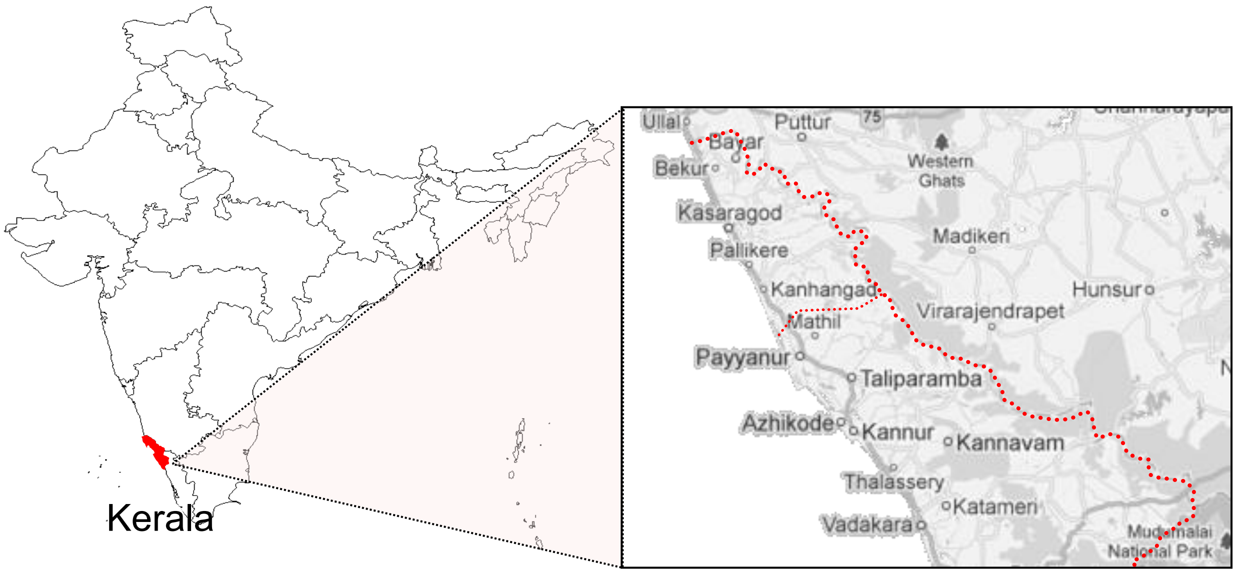
FIGURE V. AVERAGE NUMBER OF EMPLOYEES PER FIRM, BY REGION




Notes: The lines represent the average number of employees of boat builders, among surviving firms in each round. Data are from the builder census.

APPENDIX
[NOT TO BE PUBLISHED]

APPENDIX FIGURE I. STUDY REGION



APPENDIX TABLE I. INPUTS PER BOAT PRODUCED OVER TIME

| | 1999 (Round 2) | 2000 (Round 4) | 2001 (Round 6) | 2002 (Round 8) | 2003 (Round 10) | 2004 (Round 12) | % Change 2004 vs. 1999 |
|---|---|---|---|---|---|---|---|
| Boats Produced | 665 | 681 | 651 | 678 | 642 | 694 | 4 |
| Labor Hours/boat | 409 | 364 | 330 | 304 | 315 | 297 | -27 |
| Value of Capital/boat | 0.98 | 1.00 | 1.04 | 0.75 | 0.68 | 0.63 | -36 |
| Value of Materials/boat | 0.21 | 0.21 | 0.18 | 0.18 | 0.20 | 0.20 | -4 |
| | 1999 (Round 2) | 2000 (Round 4) | 2001 (Round 6) | 2002 (Round 8) | 2003 (Round 10) | 2004 (Round 12) | |
| Boats Produced | 758 | 740 | 791 | 773 | 825 | 801 | 6 |
| Labor Hours/boat | 392 | 412 | 417 | 373 | 316 | 335 | -15 |
| Value of Capital/boat | 1.03 | 1.12 | 0.95 | 0.74 | 0.66 | 0.65 | -37 |
| Value of Materials/boat | 0.19 | 0.19 | 0.20 | 0.21 | 0.22 | 0.21 | 8 |
| | 1999 (Round 2) | 2000 (Round 4) | 2001 (Round 6) | 2002 (Round 8) | 2003 (Round 10) | 2004 (Round 12) | |
| Boats Produced | 538 | 564 | 512 | 509 | 493 | 537 | 0 |
| Labor Hours/boat | 435 | 374 | 418 | 428 | 446 | 425 | -2 |
| Value of Capital/boat | 0.91 | 0.92 | 1.05 | 1.07 | 1.03 | 0.99 | 9 |
| Value of Materials/boat | 0.19 | 0.21 | 0.19 | 0.19 | 0.20 | 0.22 | 17 |

Value of capital and materials measured using constant, 1999 market prices in thousands of Rupees. Dark shading indicates the region did not have phones during this period, light shading indicates the region received phones during this period.

APPENDIX TABLE II: REGRESSION RESULTS FOR ALTERNATIVE EXPLANATIONS

| | (1)<br>Electricity | (2)<br># fishing boats | (3)<br>Input price index |
|---|---|---|---|
| Phone*Baseline Quality | -0.0035 | -0.011 | -1.2 |
| | (0.010) | (0.026) | (1.2) |
| Phone | 0.017 | -0.053 | 6.5 |
| | (0.064) | (0.17) | (7.2) |
| Baseline Quality | 0.001 | -0.014 | 0.40 |
| | (0.005) | (0.015) | (0.67) |
| Observations | 1,859 | 1,859 | 1,522 |

Dependent variable listed at the top of each column. Baseline quality is measured using our "previous boat" estimates of life expectancy. Regressions include region fixed effects and region-specific time trends. Standard errors in parentheses.