Does Better Information Increase Fishery Profits?

Gabriel Englander, Larry Karp, and Leo Simon

In the world's largest fishery, we find that better information about the location and size of fish populations would decrease fishery profits. This counterintuitive result occurs because the congestion costs arising from vessels fishing in the same places and times are large.

Increased information sharing among Peruvian fishing vessels would lower fishery profits.

Photo Credit: iStock.

Like cars on the highway, vessels can cause congestion at sea when too many of them fish in the same place at the same time. They also leave fewer fish in the water for others to catch, further lowering profits. Better information enables vessels to fish in more productive locations. But it may also increase congestion costs by causing vessels to converge on the same location. We develop a theoretical model to determine whether the benefits of better information—fishing in more productive locations—exceed the increased congestion costs. We estimate our model with data from Peru's anchoveta fishery, which accounts for 8% of global marine fish catch and is the world's largest fishery.

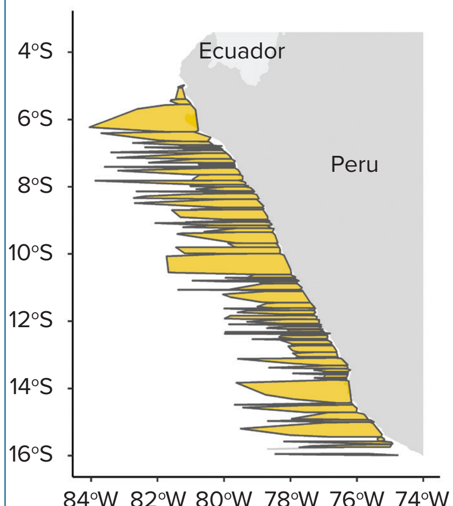
Governments have the ability to improve the information available to fishers. For example, Peru's fisheries ministry has the ability to publish near real-time data on catch by all industrial anchoveta fishing vessels. But if doing so would decrease industry profits, then regulators should maintain their current policy of not publishing these data.

Peruvian anchoveta fishers use public and private information to choose where to fish. Public information includes satellite data on chlorophyll and sea surface temperature, which fishers use to predict the locations of anchoveta. Private information includes the catch of vessels that belong to the same firm. Improvements in both types of information help fishers find better fishing locations but also increase congestion. Improved public information is particularly likely to increase congestion because it is shared with everyone, while private information stays within the firm. For this reason, improvements in private information are more likely to increase profits than improvements in public information. In general, both types of information might raise or lower profits.

Our data include the location, time, and tons that vessels catch each time they "set" their net in the water (see Figure 1 for a map of the fishing zones). There are 246,920 sets reported by 806 unique vessels in the data. We adjust tons caught by vessel characteristics to create a measure called Catch Per Unit Effort (CPUE). CPUE accounts for the fact that fishing by larger and more powerful vessels requires more energy than fishing by smaller and less powerful vessels.

Figure 2 plots CPUE by location. We use CPUE as a proxy for vessel profits and for the productivity of different fishing locations each day. We do so by regressing tons per set on the length (in meters), engine horsepower, and gross tonnage of each vessel. The residuals from this regression are our preferred measure of CPUE because they are catch conditional on effort.

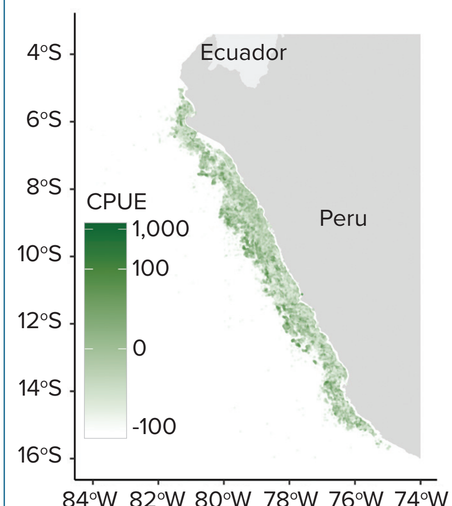
Figure 1. Anchoveta Fishing Zones



Note: The distinct regions show the different fishing zones in our data set; all vessels are prohibited from fishing within 5 nautical miles (9.3 km) of the coast.

Source: Englander, Karp, and Simon. 2022.

Figure 2. Peruvian Anchoveta Fishery Data, 2017–2019



Notes: Each point is a vessel-level fishing operation, called a set. The color of each point is the catch per unit effort (CPUE) of that set, which we calculate by adjusting tons caught by vessel characteristics.
Source: Englander, Karp, and Simon. 2022.

A fisher's payoff—their CPUE—increases when they fish closer to the "ideal location," where the stock is densest. The payoff also increases with the dispersion of vessels, as this lowers congestion. A fisher's expected payoff in our model depends on three parameters: the relative precision of public versus private information about the ideal location; the correlation between the public and the private information; and the importance of being close to the ideal location, relative to the importance of being far from other vessels.

The first parameter is a measure of the relative quality of the two types of information. The second parameter, which is not present in earlier models, further describes the relation between the two types of information, and is critical to our empirical results. The third parameter measures the importance of congestion. Our model allows for the possibility that there are "negative congestion costs," i.e., vessels benefit from the proximity to other vessels, possibly because of improved safety. However, our data imply that congestion costs are positive and large.

We determine whether better public or private information would increase profits in two steps. First, we estimate the relative precision of public and private information and the correlation between public and private information. Then we estimate the benefit of fishing closer to the most productive location relative to the cost of congestion.

Relative Precision and Correlation of Public and Private Information

The relative precision of public and private information and the correlation between public and private information determine how fishers translate public and private information into decisions on where to fish. If information is more precise, it is more likely to guide fishers to the most productive fishing location. Relative precision refers to a comparison between the precision of public information and the precision of private information. If public information is more precise than private information, then fishers know that it is a stronger predictor of the most productive fishing location. The correlation between public and private information informs how fishers anticipate each other's decisions. If they are highly correlated, then private information is effectively less private. Fishers still have private information, but it is similar to the public information that all fishers receive. An improvement in private information, in this case, is less likely to increase profits because it will cause more congestion than if the correlation was lower.

We identify the best fishing location each day with CPUE data, and we estimate how well public and private information predict this location. We find that public information is slightly more predictive than private information; it is relatively more precise. We also estimate a high degree of correlation between public and private information.

Benefit of Fishing Closer to the Best Location Relative to the Cost of Congestion

We estimate the relationship between CPUE, our proxy for profit, and two variables: the distance to that day's best location and congestion. We measure congestion as the distance to all other sets (vessel-level fishing operations) that day. Congestion is lower when the distance to all other sets increases. We find that a one standard deviation increase in congestion decreases CPUE by 2.37 tons (0.05 standard deviations of CPUE), while a one standard deviation decrease in distance to that day's best location increases CPUE by 4.23 tons (0.08 standard deviations). These results demonstrate quantitatively the countervailing effects of better information: higher profits from vessels fishing in better locations but lower profits from more vessels fishing in the same locations.

A Negative Value of Public and Private Information

If we simply ignored the correlation between public and private information, then our point estimates for the cost of congestion relative to the benefit of being close to the ideal location, and of the relative precision of public versus private information, would imply that improved public information lowers profits, but improved private information raises profits. Our estimates would then imply that congestion costs are in an intermediate range, high enough that the value of improved public information is negative, but low enough that the value of improved private information is positive.

However, we find that public and private information are highly correlated. Including this correction, our estimates imply that greater precision of both public and private information would reduce profits. If Peru's fisheries ministry continuously published their near real-time catch data, fisher's profits would decrease. Improvements to private information, e.g., due to subsidizing onboard fish finder technology, would also reduce fisher's profits, but by a lower amount. Additional information-sharing among vessels, converting private to semi-public information, would also likely lower profits.

Discussion

These counterintuitive results occur because our model and statistical analysis emphasize the possibilities of congestion, distinguish between public and private information, and allow correlation between public and private information. Our paper demonstrates the surprising result that better public or private information reduces profits in the world's largest fishery.

A large body of empirical literature documents circumstances where better information enables a decision-maker to increase profits or welfare. However (to the best of our knowledge) all of these papers consider situations where better information enables a decision-maker to adopt better plans, but without otherwise affecting the environment in which that agent operates. In contrast, we consider the equilibrium effect of better information, which takes into account the effect of better information on all vessels' behavior.

A single vessel in our setting would certainly be able to improve its payoff if it were the only vessel receiving the improved information. However, when all (or more generally, many) vessels receive better information, their collective decisions change. Each vessel responds optimally to maximize its own profits. When congestion is important, vessels create a "negative externality," i.e., their individually rational actions reduce collective welfare. Better information increases that negative externality.

An example helps to clarify the distinction between individual and equilibrium effects. Suppose that a regulator attempts to control firms' pollution emissions, but can observe the firms' decisions only imperfectly. If the regulator is suddenly able to observe firms' decisions more precisely, and if there is no change in firms' behavior, then the more precise information certainly benefits the regulator. In that example, the better information changes the regulator's decisions, but not the environment in which she operates.

However, firms might change their behavior once they recognize that the regulator has better information; in that case, we would be interested in the equilibrium (i.e., "overall") effect of the better information. If the regulator's improved information makes firms decide to follow emissions rules more carefully, because firms now think that there is little chance that they will be able to get away with breaking the rules, then the equilibrium effect of the better information amplifies the direct benefit that takes into account only changes in the regulator's behavior. Alternatively, if firms decide to increase their anti-regulation lobbying or engage in other individually rational, but socially costly, means of evading the rules, then the equilibrium effects would reduce or might even overturn the apparent benefits of better information.

This example illustrates the important point that sometimes we know neither the direction nor the magnitude of the equilibrium effects of a change that (at first blush) seems to improve welfare. It is analytically convenient, but possibly quite misleading, to simply ignore these potential equilibrium effects. The example also illustrates the difficulty of using results from one context to inform policy in another setting.

Our empirical results for the Peruvian anchoveta fishery provide a high level of confidence in the conclusions that better public or private information would lower fishery profits, and that increased information sharing among vessels (converting private to semi-public information) would also lower profits. Our model and estimation procedure can be useful for other fisheries, and other natural resource settings where congestion may be important. However, we do not recommend applying our policy conclusions to other settings, without context-specific analysis of those settings.

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For additional information, the authors recommend:

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