***Data Repository***

*In a nutshell*:

a) **Estimates of total unreported catch**: how we got the 67-88% is illegal number

b**) Legal landings data**: all reported catches by fisher’s data

c) **Enforcement records**: number of enforcement activities government did

d) **Price data**: the price at which legal fish is sold at ports

e) **Findings from fieldwork**: rough notes of what I founded doing fieldwork

f) **Framework manuscript**: manuscript in which we describe in great detail how the hake market operates.

1. **Estimates of total unreported catch**

Using sensitive questioning methods (the Randomised Response Technique) and direct questions, we estimated under-reporting per trip to be 548.37 [SE = 66.42], and 594.54 [SE = 33.75] kg for RRT and direct questions, respectively. To extrapolate the per boat/per trip unreported catch rates from to an overall yearly estimate, we first fitted a linear model with unreported catch rates as the response variable and a binomial predictor of whether boats had high or low quota. Since these estimates were per trip, the second step was to calculate yearly rates of unreported catch. For this, we built two scenarios of the number of trips per boat in a year. The "high" scenario considered a 3-day local rule (high scenario), and therefore that fishers’ fish three days a week for 11 months (because of a reproductive ban in September). For the "low" scenario, we obtained data from SERNAPESCA on the number of registered trips for the region in 2015-2018. From this, we calculated an average per boat number of trips a year. Estimates from these two scenarios were compared to the annual quota limit for the VII region.

Quantitative estimates of unreported catch and comparison to assigned quota in 2018 (in tons)

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| --- | --- | --- |
|  | **High Scenario** | **Low Scenario** |
| Low Quota Boats/trip (Std. Error) | *0.73 (0.046)* | |
| High Quota Boats/trip (Std. Error) | *0.41 (0.063)* | |
| Per year Region | 24204 | 6658 |
| Quota | 3267 | |
| Total Catch | 27471 | 9925 |
| **Unreported Catch (%)** | **88** | **67** |

1. **Legal landings data**

Legal landings data includes anonymised legal transactions (reporting) from fishers to intermediaries **per day** for the 2014-2019 period in the VII region. This data is called [dataland.csv](https://github.com/emilemathieu/illegal_fishing/blob/master/data/dataland.csv) in the data folder in github. This data includes data of transaction and quantity (kg). The code in [datasources.r](https://github.com/emilemathieu/illegal_fishing/blob/master/data/datasources.R) just aggregates these data into weeks/months. Good thing of this data set is that it’s quite big and consistent throughout years, so we know for sure how reporting of hake changes by day. I have been using this data just to compare the simulations in the graph. But, for “filtering” the simulations I just use the overall yearly quota, so basically, I have not been using this data in the model

1. **Enforcement records**

Data on enforcement effort by government authorities includes all enforcement activities done **per day** for the 2014-2019 period, including date, species and a code for each enforcement action. The data is called EnforcementData, but it’s too big to uploaded to github, so I’ll have to send it by email. The code in [datasources.r](https://github.com/emilemathieu/illegal_fishing/blob/master/data/datasources.R) just aggregates these data into weeks/months. Also a very big dataset, but not as complete as legal landings, just because there isn’t enforcement activity every day or week. Its important to note that I have not really been using this data either, since my Detectability min and max are not coming from this data, but from a calculation of what would be the detectability at a specific level of illegality (88%).

1. **Price data**

Data on price comes from surveys at ports. These data is only aggregated at the month level. It includes date, species, place and price. Data is in [AllPrices.csv](https://github.com/emilemathieu/illegal_fishing/blob/master/data/AllPrices.csv) and then in [datasources.r](https://github.com/emilemathieu/illegal_fishing/blob/master/data/datasources.R) I just aggregate that into monthly averages. This is the least complete data set, as people only go to survey prices at the port from time to time, so there’s lots of unfilled data points, and its only aggregable at the month level, cause government does not provide day when it was measured, only month and year. Same than above, I have not been using this data at all, I just used data on average prices from my fieldwork.

1. **Findings from fieldwork**

- Price formation

           When asked about what determined price formation in the common hake fishery, respondents of the key-informant survey consistently pointed out that price, both at the market and port level, depended on quantities landed. Respondents that belong to fisher or the trader sector pointed out that price was determined at the fishing terminal level, but that it depended, ultimately, on landings across the country.

           While variable, respondents consistently identified prices within a range. At the port, prices varied between $3,000 and $15,000 pesos for a box of 27-30 kg. Over this price, a visa or permit value was charged by fishers for reported (legal) boxes. Respondent consistently identified the value of this permit at $3,000 per box. However, fishers mentioned that this permit's value can go down by the end of the year when fishers have an excess of permit and rush to sell catch with a permit.

When fishers and traders were asked whether the amount of fish landed depended on prices, they indicated that most of the times fishers do not even know the prices they will sell for before going out fishing (some fishers indicated that they would not go when price is very low, but this was not often and did not sustain over time). As such, respondents implied that fishers do not respond to prices. Fishers indicated that demand drives price and affects fishing behaviour only in preparation for and during eastern (March).

           Market operators and traders indicated that demand is constant across the year (except eastern) because the main markets where common hake is sold (open-air markets) maintain prices relatively stable. Market operators indicated that this stability is caused by an upper limit at which common hake can be sold before consumer shift to other animal-protein based products such as pork or chicken. The lower limit is set by a constant demand for common hake as the cheapest fresh fish product available. Respondents indicated that prices at the fishing terminal vary between $17,000 and $30,000 pesos per box.

- Trader – fisher relationship characterisation

           We then asked respondents to characterise the relationship between fishers and traders. Respondents overwhelmingly pointed out to the excessive power of traders to manipulate prices and reporting/unreporting dynamics. Fishers indicated that traders are a highly organised group, with a fixed set of trucks (around 25-30) that operate in the region. These trucks have different capacities but gather around three types: small (~60 box capacity), medium (100-120 box capacity) and large (~300 box capacity).

Fishers characterised traders as a "mafia" which set prices and prevent negotiation. However, fishers do recognise that traders take the most significant risk by transporting unreported products from the port to the fishing terminal in Santiago. Moreover, fishers indicated that traders generally respect the fact that they have to pay more for legal boxes. Finally, they mentioned the need for these traders as a crucial actor to trade both legal and unreported catch. As such, there is a synergic relationship between fishers and traders for the reported/unreported trading market to operate.

            Responses were consistent in indicating that the number of traders in the region is fixed, with high barriers to new entries. Because current traders are highly organised and manage prices, fishers indicated that traders could temporarily drive prices down to prevent newcomers. Moreover, fishers indicated that traders have a fluid relationship with enforcement agents so that in case a new trader comes into the region, they coordinate and bribe enforcers to direct their activities to the incoming traders. As such, it is not often for new traders to come into the fishery.

- Trader decision for purchase legal or unreported catch

Traders surveys provided essential insights into their decision to purchase legal or unreported catch. Traders indicated that the amount legally traded works as an operation "licence" in the sense that they need to transport some amount of legal common hake to justify their operation for taxes and regulation purposes. Further, they do need to show "some" legal permits to get into the fishing terminal in Santiago. As such, they always trade some legal boxes, but then depending on landings they carry more or less unreported catch. This does vary, however, when there is more enforcement or when prices are higher. From the surveys, we could not assess ranges of increases in trading of reported catch due to enforcement or price raises. Fishers also indicated that traders communicate to share information on when SERNAPESCA (enforcement agency) is operating, and during those periods, they trade more legal common hake than usual.

- Fishing terminal and open-air markets operation

Market operators indicated that there is a small market for legal boxes at the fishing terminal, for some restaurants or risk-averse consumers that prefer fully licensed products. As such, there is product differentiation at the market, because of a "price premium" that is paid to traders for legal products. We could not, from the survey, determine the "price premium" value at the terminal for legal boxes. Responses on this question were too spread or unclear to determine a credible range of values. The product in itself cannot be distinguished, but for instance, a trader could sell a certain number of boxes and a lower number of permits. No particular box can be differentiated, but the buyer will pay a price premium for those permits to the trader. Traders as well indicated the existence of a differentiated demand for legal products at the fishing terminal, although it was small and filled rapidly. Similar to traders, open-air markets operators needed a constant amount of legal (permitted) boxes to justify their operations, and therefore are willing to pay more for some legal boxes.

* Stages

Results from the surveys and enforcement analysis indicated that trading dynamics in this fishery can be categorised in four stages within a year. These stages are when peaks in official landings data are found, which reflect increases in reporting rates. These stages are:

1. *Eastern month*: due to an increase in demand in preparation for eastern, price elasticity diminishes. Moreover, enforcement increases during this period, which lasts for a month. Price and enforcement increases, then, increase reporting rates.
2. *Pre/post ban*: Increases in enforcement activity prior (August) and past (October) the September ban result in higher reporting rates
3. *End of year*: because the quota is not transferable across years, fishers who still have quota permits by December, rush to sell it, lowering the permit value, increasing reporting rates.
4. *Primary stage*: This is how the fishery and trade operate in the times outside of the three previous stages.
5. **Framework manuscript**

A detailed description of the system is provided in the manuscript [here](https://github.com/emilemathieu/illegal_fishing/blob/master/data/STOTEN-S-20-38734.pdf), and in case you need the supplementary material they are [here](https://github.com/emilemathieu/illegal_fishing/blob/master/data/STOTEM%20Supplementary%20Material%20.pdf).