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The Economic Effects of the Covid-19 Pandemic on Swedish Shrimp Fishers

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The Economic Effects of the Covid-19 Pandemic on Swedish Shrimp Fishers

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Abstract:

This paper explores the effect of the perceived risk of the Swedish people of Covid-19 on daily auctioned shrimp prices from the start of the pandemic to the end of the year 2021. This topic is of interest to see whether the government intervention in the shrimp market to aid fishers with possible losses was justified. We find that auction prices were negatively affected by covid-19 cases by 19.83 SEK/kg (-9.37 %), and that fishers have suffered a loss of 21.5 million SEK.

Key words: COVID-19, Fisheries, Food prices, shrimp

JEL codes: Q00, Q21, Q22

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1. Introduction

The covid-19 pandemic had a heavy impact on our everyday life, both from a behavioural and an economical point of view. From a behavioural perspective, the pandemic had us restricting our livelihoods with the many lockdowns around the world, as well as making us feel afraid of being infected with the virus. Studies have proven that covid-19 had a negative impact on our mental wellbeing (Akay, 2022). Furthermore, with a combination of people being both afraid, and under heavy restrictions, economies were also impacted throughout their different sectors (Nicola, et al., 2020). Ker and Cardwell (2020) say that the Canadian business sector that was hit the most from the pandemic was the food sector, through shocks on the consumers' income and due to its effect on the supply side of commodities. To counteract the negative economic effect of Covid-19, economic support and relief programs were put in place throughout the world to aid their respective economies, including Sweden, which opted for reduction of company costs along with making loans easier to acquire. (White & Case, 2020)

Sweden is an interesting case regarding the pandemic. Though most of the western world decided to utilize quarantines and isolations as means of mitigating the spread of the virus, Sweden decided on a more hands-off approach, not mandating facemasks, and being lax on its restrictions (Diderichsen, 2021). There were some regulations, but mostly mandated to service-based businesses. Nonetheless, the pandemic has had some impact on the people anyway, as parties independently chose whether to close or to operate depending on how they saw fit, and therefore people were exposed to the idea of the virus being threatening. Restaurants specifically had to slow down operations due to rules imposed by the government regarding distancing in restaurants, resulting in facilities being utilized less despite remaining open. This along with the fear of the virus, led people to prefer purchasing things at stores instead (Statistics Sweden, 2022).

The Swedish Agency for Marine and Water Management (SWAM) carried out surveys in 2021 and 2022 on Swedish fishers to inquire how the pandemic affected them. According to SWAM, more than half of the Swedish marine fishing fleet claims that they have been negatively affected by the Pandemic (SWAM, 2022). One of the negative effects mentioned was the reduced value of landings due to reduced demand. Shrimp was included among the species that suffered from the highest negative effect of Covid-19.

To our knowledge, little research has been done regarding how the Pandemic affected commercial fishers. Swedish shrimp fishing that we study is complex since boiled shrimp are consumed both at restaurants as well as bought in fish shops and consumed privately at home. It is therefore not obvious, as discussed by (Asche, et al., forthcoming), that demand for boiled shrimp decreased due to reduced frequency of restaurant visits, since consumption of boiled shrimp might have shifted to consumption at home.

The purpose of this paper is therefore to study the economic effects of covid on shrimp fishers' income. The main objective is to see whether covid-19 has caused an actual price change in shrimp in Sweden over the course of the pandemic. We do so by using a seven-day moving average with a two-day lag to examine how the number of confirmed cases potentially influence the shrimp price. We focus on the high value product of boiled shrimp, which is the larger boiled shrimp that are consumed fresh. The econometric analyses are done over the time period starting in March 2020 when Covid-19 was declared a pandemic until the end of year 2021.

The approach of the study is to establish if the variation in confirmed Swedish cases of Covid-19 is driving the variance in auction prices of boiled shrimp. Since shrimp are sold on auctions with daily clearance of the market, variation in demand can only be analysed if also variation in supply is considered. Another complicating factor is that expected auction prices for boiled shrimp are likely to affect the landed weights for shrimp. Due to this simultaneity between supply and demand, our approach is to control for variation in supply by using weather observations as instruments for the landed amount of boiled shrimp. To our knowledge, the use of wind observations as an instrument for landed weights is not common in fishery literature. Our paper therefore adds an interesting approach in tackling the issue of endogeneity when analysing demand both based on supply and prices within fisheries. We also aim to control for demand shifts by controlling for the price of Norwegian salmon, which we deem to be a potential substitute for Swedish boiled shrimp. Price for salmon is good to use since the volumes for Norwegian farmed salmon are very high compared to Swedish shrimp volumes (948 million Kg salmon compared to 1150 thousand Kg shrimp, year 2020), and since the product is sold to a great part of the world compared to Swedish shrimp that are instead only sold on auctions within Sweden. Further, the salmon is farmed, and thereby the supply is not as weather sensible as fresh caught shrimp. Based on this we theorise that Swedish shrimp prices have no effect on Norwegian salmon prices.

Our results show that the pandemic caused an average auction price decrease for boiled shrimp of 19.83 SEK/Kg, from 211.66 SEK/Kg to 191.83 SEK /Kg, from the start of the pandemic in week 11 2020 to the end of 2021. This implies a loss in revenues of 9.37%, and to Swedish shrimp fishers meant a loss of 21.5 million SEK. Since there were around 50 operating boats during this period, the results imply an average loss of 400, 000 SEK per shrimp boat. In section 2 we explain how Sweden manages its shrimp fishing, how the shrimp market works as a background, as well as delve into the theoretical framework and literature review relevant to the study. In section 3, the data will be presented, which in section 4 will be used to discuss the empirical strategy as well as the hypotheses that were formulated. Section 5 will present the results, and Section 6 contains the conclusions.

2. Background

The key things to highlight prior to introducing the study's findings are those relating to the overall shrimp market, the operations revolving its supply, and the overall demand of the product.

During 2020, Swedish household consumption decreased by 4.7% compared to 2019. This is an historical decrease explained by the Covid-19 pandemic. The decrease has not been homogenous, but rather varying over different sectors. The greatest negative effect was on Swedish households' consumption outside Swedish borders (-44%) and foreign consumption in Sweden (-34%). Another big decrease is found to have occurred in the sector for hotels, restaurants, and cafés which decreased by 25%. Instead, there was an increase in alcohol, tobacco, and food by about 7%. In SEK, consumption on hotels, cafés, and restaurants decreased by 112 billion SEK while food and non-alcoholic beverages increased by 282 billion SEK. In total, prices in Sweden increased by 0.5% during 2020 compared to 2019 (Centre for retailing, 2021). To summarize, Swedish households redistributed a part of their total consumption to food bought in supermarkets.

2.1 The Swedish shrimp fishery

The fishery for shrimp is regulated under a Total Allowable Catch (TAC) system with annual quotas decided in collaboration between the EU and Norway. This TAC is then divided between Norway (59%), Sweden (14%) and Denmark (27%) (ICES, 2021). Apart from the

14% of the TAC, during 2018-2021 Sweden also had access to 123 tons of the Norwegian quota (SLU, 2021) (Swam, 2022). The Swedish quota was used by 48 boats in 2020 and by 52 boats in 2021. Majority of the Swedish shrimp fishery is done in Skagerrak in the ICES divisions 27. III.a and 27. IV.a east. Most of the Swedish shrimp fishery is done in the green area on the map below, with some fishing further south between Denmark and Sweden. On the map one can see displayed three weather stations in Sweden marked in yellow, as well as two weather stations in Norway marked in red (Google earth, 2022; Björk, 2017).

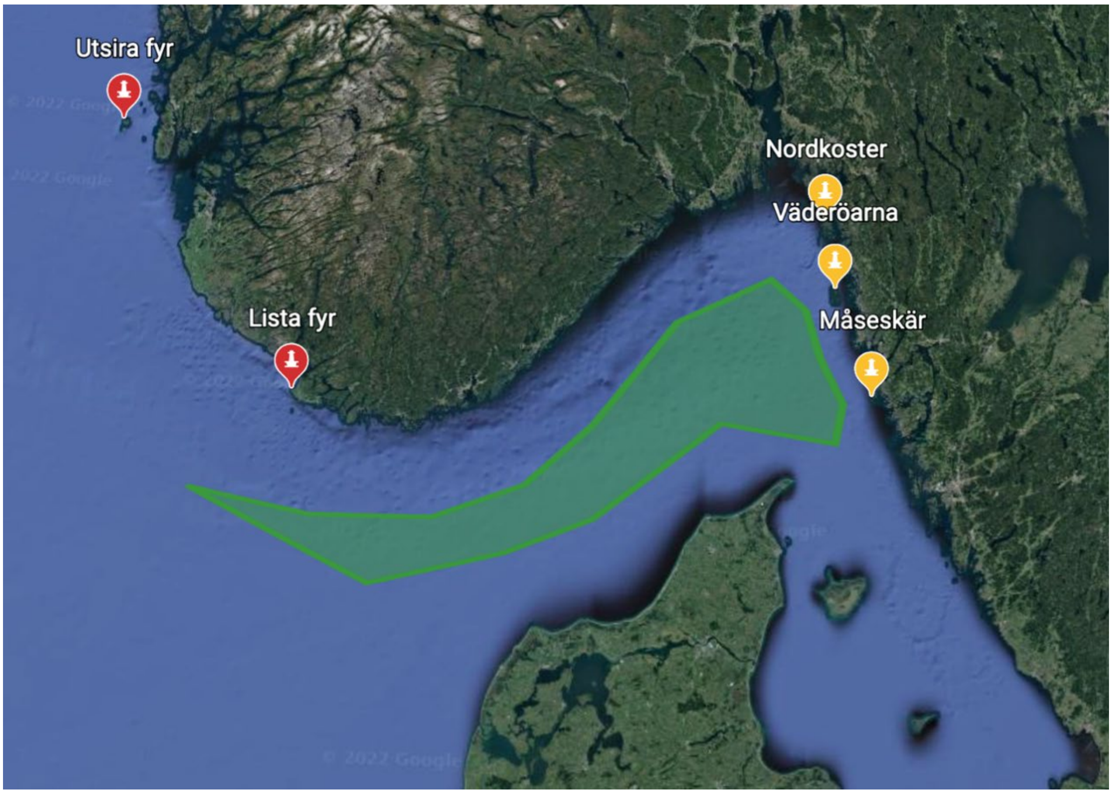

Figure 1 -Map of Weather stations (Google earth, 2022)

2.2 Strong User Rights in the shrimp fishery

Until 2017, the Swedish shrimp fishery was basically a Regulated Open Access fishery (Homans & Wilen, 1997) with vessels competing over the joint Swedish TAC and each vessel was restricted by an amount of allowed fishing days. In 2017 SWAM introduced an ITQ regime for the Swedish coastal shrimp fishery, which comprised 62 vessels. The active boats got shares of the Swedish TAC of about 1300 tons. Smaller and less active boats were gathered in a pool of quotas where insiders can easily exchange shares, while transfer to the larger vessels is restricted. Shares were allocated without cost based on average landings during 2011-14. However, the allocations had a strong distributional element where the differences in shares were reduced, and those landing small quantities got more than 100% and those with large historical landings got less than 100%. The result was that fishers got allocations in the range 50-600% of their historical average. Not surprisingly, fishers with the largest historical landings thought this allocation was unfair. The motivation for the transition to a SURFs system was not economic but based on the view that they were needed to meet the change in EU's fisheries regulation. From 2017 fishers faced an overall landing obligation (discard ban) for commercial species. This meant that the quotas were increased in order to cover the expected amount of undersized shrimp but hoping that the change in incentives would induce fishers to more selective approaches and in the long-run approach a state where only full-sized shrimp are caught.

Fishing operations for shrimp, Pandalus Borealis, are ongoing throughout the whole year. Supply however, varies over the year with highest catchability during the spawning season in autumn and with reduced landed weights during the colder months from November to February. This reduction in landed volumes is due to an increased risk of strong winds complicating fishing operations (Björk, 2017).

The TAC for shrimp in Skagerrak/Kattegat during 2020 was 6115 tons, from which Sweden had an allowance of 1302 tons including the 123 tons from the Norwegian quota. From this quota, Swedish shrimp fishers landed 1190 tons. With this landed weight, Swedish shrimp fishery represents less than 1% of landed seafood in Sweden, but the value for the landed shrimp of 209.6 MSEK represents 22% of the value from Swedish fishery landings (Swam, 2022).

2.2 The shrimp supply and demand

The Swedish shrimp fleet has shrunk from above 60 vessels in the mid 90's to around 50 in 2018-2020 (ICES, 2021). Depending on size, shrimp vessels are divided into two groups, where the smaller class size is typically for 1-2 people, while the bigger class size is staffed by 3-5 people (Swam, 2022). The shrimp are sorted on board, divided into two size groups. The larger ones, (not more than 160 shrimp per kg), are boiled on board. The smaller ones are landed raw and sold for processing. The boiled shrimp in our dataset earn a price in the range SEK 30-650 SEK/Kg with an average price of 182.50 SEK/Kg, while the raw shrimp are paid SEK 20-

30/Kg with an average of 21.43 SEK/Kg. In this paper we focus on the larger boiled shrimp that are later sold on auctions and consumed as fresh food. Even though only larger shrimp are boiled on board and later auctioned, the quotas are for all shrimp landed. Since there is a great difference in the value of larger and smaller shrimp, high grading, the act of throwing smaller shrimp back into the sea to further fill their catch with bigger shrimp, is a tactic that has been employed in the past. As of 2009, this act has been forbidden, but indications from landed volumes suggest it is still conducted to some degree. Estimates made by (ICES, 2021) suggests Swedish shrimp fishers discarded around 10% of the catch from 2018 to 2020.

The boiled shrimp are sold on auctions in Gothenburg and Smögen. The auctions are held in the style of an English auction where prices first descend until someone offers a bid, and then bids are increasing until no one bids higher than the last bid. The last bidder then buys the lot at the last bid. The price for boiled shrimp varies over the year due to the seasonality of catches as well as due to variations in demand, where summer holidays and Christmas/New Year are peak seasons for consumption. These trends are shown in figure 6. Auctions lead to a daily market clearance. Everything always gets sold, otherwise it would be wasted after the auction. Here, landed weights are likely to be endogenous since there might be unobserved events affecting demand as well as supply. Section 4.1 discuss how this paper deals with this problem by using wind gusts as an instrument for landed weights.

2.3 Theoretical Framework

According to protection motivation theory, a decisionmaker is affected by the perceived risk of an activity when deciding upon said activity. If risk is perceived as high the decisionmaker is likely to engage in protective behaviour (Maddux & Rogers, 1983). If the risk of being infected with Covid-19 while visiting a luxury restaurant is perceived as high, a protective behaviour could then be to avoid visiting the restaurant. This in turn might affect the demand for food served at luxury restaurants. The important part in this process is not whether the restaurant visit is prohibited by the government, but rather upon one's own perceived risk based on influences from different sources such as media, peers, and official government statements (Peng & Chen, 2021).

Consumption of luxury food however varies with change in income. We know of luxuries as goods and services that increase in consumption when income rises. When people earn less, they pivot from consuming luxury goods, into consuming more of lower priced goods. The relevance of this observation is evident when we look at the economic struggle that were the times of peak Covid-19 infections. This said, the distinction Sweden made of shrimp being a luxury good was more one of perceived risk, where the uncertainty of the situation led people to opting out of restaurant visits as their luxury food consumption (Statistics Sweden, 2022), and instead opting for the less luxurious option of purchasing from stores. (FAO, 2020)

As explained by (Stock & Watson, 2020) any attempt in establishing fluctuations in demand by merely observing changes in prices will run into endogeneity problems due to prices also being affected by supply. Therefore, to be able to observe shifts in demand, supply must be controlled for. When controlling for supply in analyses of auction prices for fresh food, again a problem of endogeneity occurs. This is because the price resulting in market clearance may affect supply in a near future, as well as due to possible exogenous shocks affecting both supply and price. Philip Wright solved this problem already in 1929 by using weather observations as instruments for supply (Stock & Watson, 2020). The idea behind the approach is to replace the supply in the equation by the variation in supply caused by the variation in the weather. For this approach to work two main assumptions must be fulfilled. Firstly, the instruments must be relevant, meaning that they have an effect on the supply, and secondly, the instruments must be valid, meaning that they don't affect the price in other ways than through their effect on supply.

2.4 Literature Review

Janssen et al (2021) conducted a study during the first lockdown period where infrastructures like restaurants were halted in Denmark Germany and Slovenia. The Covid-19 pandemic both caused a reduction in times people engage in food shopping, and a shift of the purchased goods from fresh food to frozen food, like frozen fish, and non-perishables. Furthermore, consumption rates of goods we deem necessary like bread and dairy did not vary. This said, there was an increase in consumption of cookies, cake, and sweets. The authors state that this could be because of the comfort factor these goods provide to cope with the ongoing pandemic. The study attributes the consumption variation to the fear of the virus during the first wave of the pandemic.

A report from the Food and Agriculture Organization of the United Nations (FAO, 2020) supports the finding of increased demand for frozen food and suggests that consumer demand for frozen and packaged aquatic products increased during 2020 due to the pandemic, while at the same time demand for high-value fresh fish and aquatic products fell due to hotels and restaurants being either fully or partially closed. The report further states that fresh seafood, which represents 45% of seafood consumed worldwide, suffered from logistical challenges in the supply chain due to restrictions and the spread of the disease. The report mentions the reduction in US live catches by 40 % during 2020 and a 30% reduction of fresh fish in Italy, France, and Spain during the same year. They also observe a pattern that in areas where the pandemic led to an economic downturn, sales of canned mackerel, sardines and tuna experienced an upward boost while at the same time the markets for luxury food such as lobster had a weakening demand. Monetary measurements to protect the fishing industry were taken all over the world, including the EU. In Sweden the measure to protect the fishery business was in the form of tie-up support compensating commercial fishers who temporary suspended their fishing activities (Government offices of sweden, 2021).

3. Data

The main question this study explores is if confirmed covid cases negatively influenced auction prices on boiled shrimp, with reporting of confirmed covid cases representing the perceived danger of the virus. As a start, a scatterplot is constructed. The observations for daily average auction prices, daily landed weights, weekly price for a good that could be considered a substitute for shrimp, wind data and data on confirmed covid cases are combined. These are used to construct a scatterplot consisting of auction prices on the y-axis and the residuals of confirmed cases cleaned from time fixed effects, substitution effects, and from supply effects in the form of predicted landed weights based on wind data on the x-axis, as seen in *Figure 2*. The scatterplot clearly indicates that an increase in confirmed cases has a negative effect on daily average auction prices.

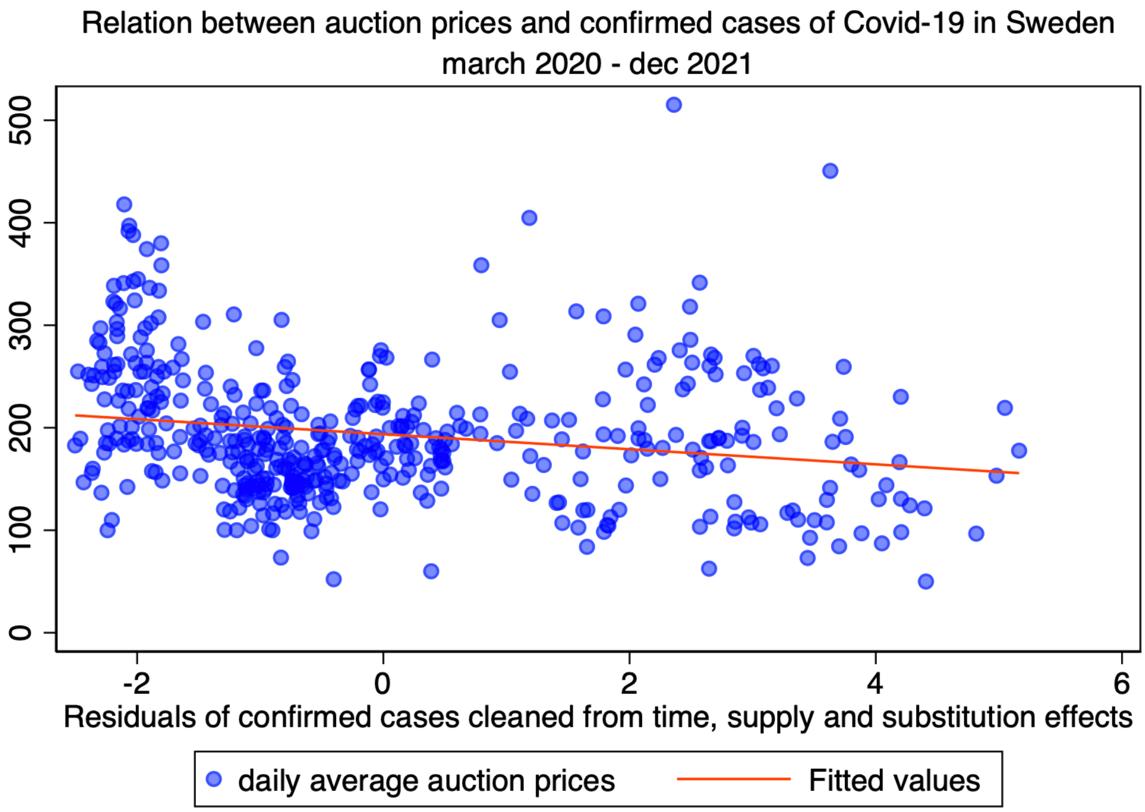

Figure 2 -Relationship between auction prices and confirmed Swedish confirmed Covid-19 cases

The Covid-19 data was collected from the Public Health Agency of Sweden. With this data, a moving average over 7 days for confirmed cases in thousands was made, Price data for auctioned shrimp is being collected from fishers by SWAM. The data consists of daily auction prices for landings by 10-15 vessels per day. From these observations, a daily geometric average price for shrimp was created. Since there is data for 80% to 90% of all landings, the estimated average auction prices should be quite accurate. The total landed weights for said observations were also kept. Having said this, since reporting landed weights to SWAM is not mandatory, these landed weights don´t fully control for supply. Comparing the dataset with the official statistics from SWAM, it can be seen that the dataset consists of 83-90% of the total Swedish landings of boiled shrimp. Since wind strength impacts fish harvesting negatively, data on observed wind gusts, which are a brief increase in the wind strength usually lasting for less than 20 seconds, was collected for two relevant weather stations. One of these two stations is located in Sweden, and one in Norway, around the shrimp fishing area. The data on the wind gusts from the Swedish weather station was collected from the Swedish meteorological and hydrological institute (SMHI, 2022), and the corresponding Norwegian station's weather data was collected from the Norwegian Centre for Climate Services (NCCS, 2022). Using *Figure 1* as a reference, the two weather stations that were chosen were the Swedish station of Väderöarna as well as the Norwegian station of Lista fyr. We also collected data from (Statistics Norway, 2022) for weekly export prices of Norwegian farmed salmon.

3.1 The dataset

The orange line in the left panel of *Figure 3* presented below indicates the annual Swedish quota for shrimp during the years 2018 to 2021. The blue line in the same panel represents Swedish actual landings during the same time. As one can see, the distance between the red and blue lines are varying between the years indicating quota usage was not constant. This can better be seen in the right panel, where the quota usage in percent over the four years from the dataset is shown. Here, one more clearly sees see that the quota usage was a bit lower in 2021 than for the previous years. Important to note is that these graphs display total values for Sweden. From this, the study consists of observations representing 83-90% depending on year. Since the size of the dataset is not constant over time, interpreting the registered weights as a proxy for total supply of Swedish boiled shrimp should be done carefully. However, we see no concern using collected daily average auction prices since the auction price for the non-reported landings are likely to be the same as for the reported ones.

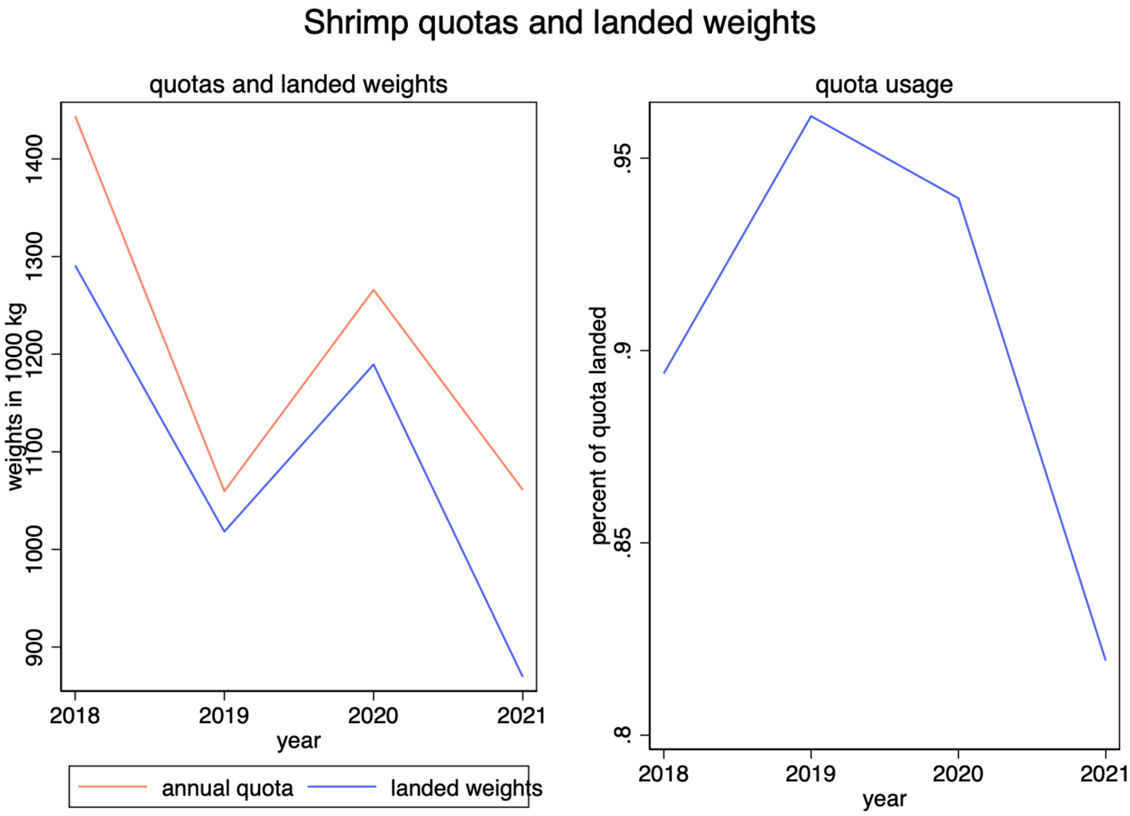

Figure 3 -Shrimp quotas and landed weights

3.2 Descriptive Statistics

The relevant observations in *Table 1* below are the ones regarding the daily price and landed weight of shrimp. Over the course of 2018-2021 the daily mean price for shrimp is 182 SEK/Kg. Furthermore, for the landed weight, there is a minimum number of 3Kg and a maximum number of 14705Kg. The high standard deviation for the landed weight is because daily catch varies a lot, with some days where there is barely any landed shrimp. Wind gusts are measured in meters per second (m/s) at the two different meteorological weather stations at Väderöarna and Lista Fyr. The salmon price data point is in Norwegian crowns. We are not interested in the value, but rather the change it had over time.

The measurement the study will use throughout the paper to investigate the effect of the spread of Covid-19 on shrimp prices is represented by the number of daily new Swedish cases by the thousands smoothed over the prior seven days with a two-day lag from the beginning of the pandemic in March 2020 to December 2021. The descriptive statistics in *Table 1* account for both of these time periods. A two-day lag is chosen with the following reasoning: media is communicating yesterday's values, and since the auctions are held early in the mornings the auctioneers are not exposed to these numbers until after the auction, meaning that the auctioneers are acting based on the covid-19 knowledge of two days prior.

Table 1 -Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
price day	1093	181.70	59.49	22.37	515.14
weight date	1093	2228	1899	3	14705
Salmonprice	1093	59.79	7.44	46.09	78.20
gust väderöarna	1092	10.26	4.22	2.22	25.57
gust lista fyr	1050	14.59	4.94	4.40	33.10
cases 1000	490	1.909	1.951	.044	7.442

For an overview at how the chosen variable for the covid-19 pandemic looked like across 2020-2021, *Figure 4* shows the trend in time of confirmed new covid-19 cases. From this figure it can be noted that there were very little observations as of the middle of 2020, and, that there were 3 main spikes in the number of cases, one at the end of 2020, one in spring 2021, and one at the end of 2021. We theorize that the low number of cases in spring 2020 is due to lower amount of testing.

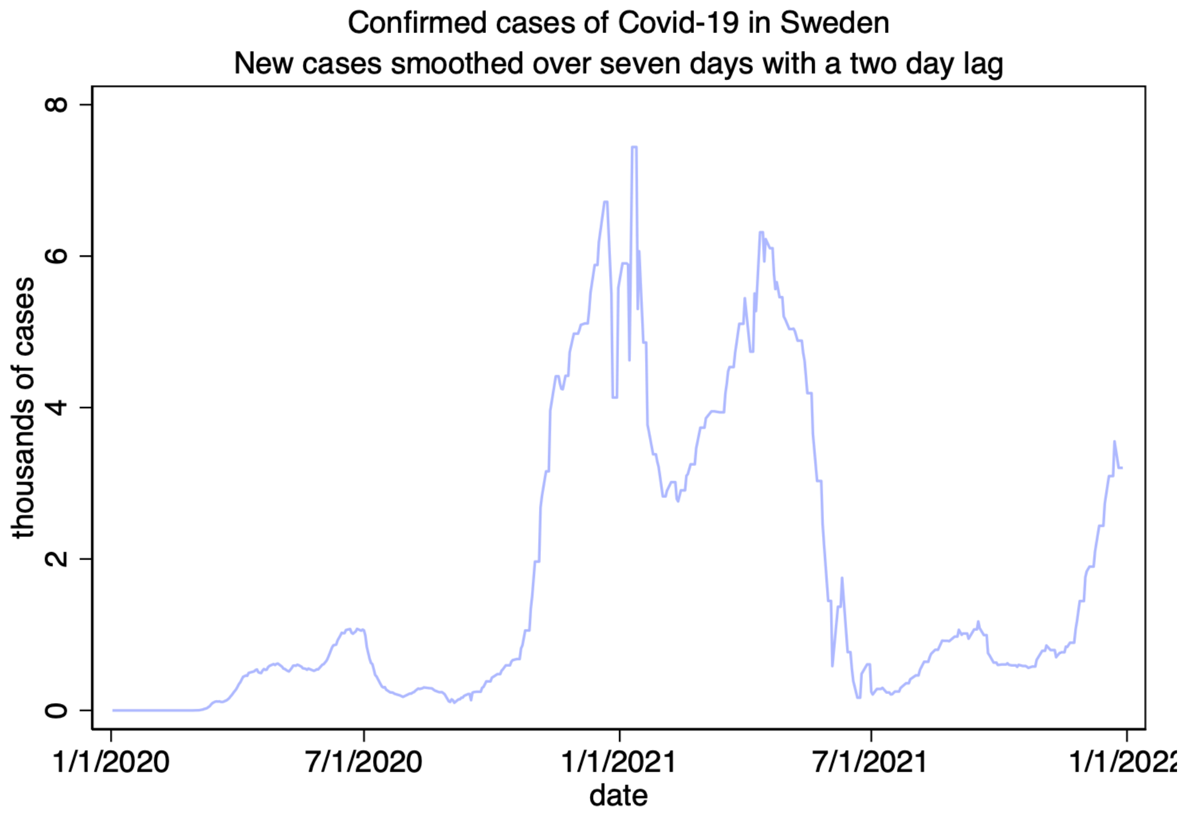

Figure 4 -Confirmed cases of Covid-19 over time

Figure 5 below shows the price variation of shrimp during the 4 years of 2018-2021. There clearly are some seasonal trends in price, as demand for shrimp rises during certain periods of the year, like the summer and New Year's.

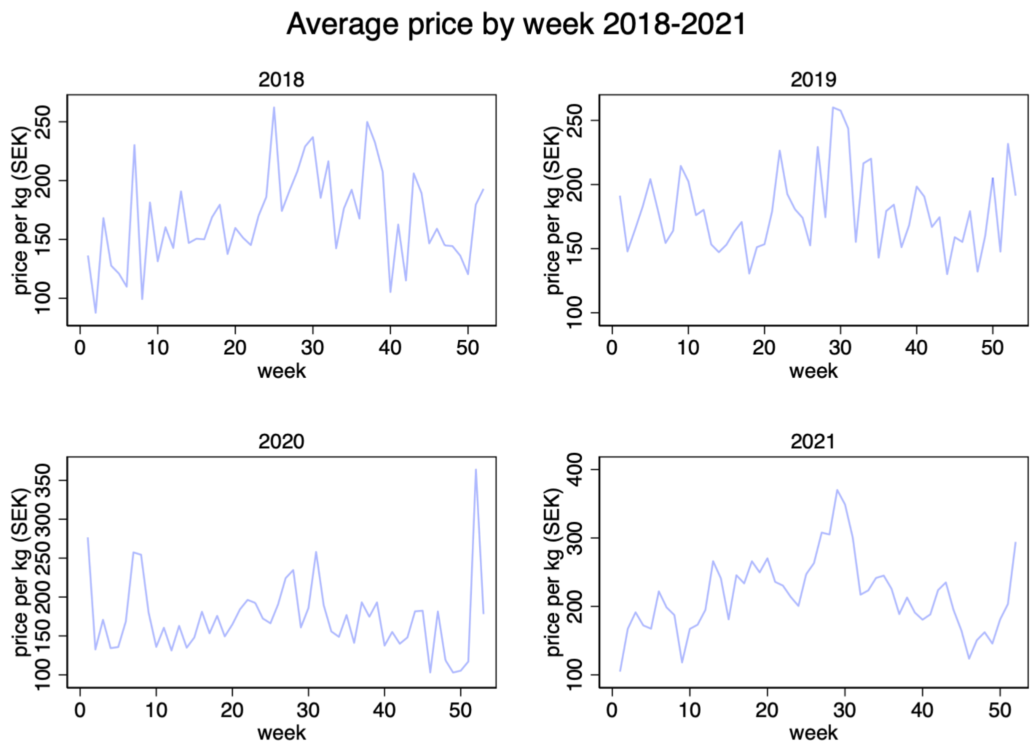

Figure 5 -Average price per week 2018-2021

A similar study was conducted on the landed weights by week for every one of the individual years in 2018-2021 as seen in *Figure 6* below. The important part of these figures is the fact that the trends are somewhat similar between themselves as well as to price, indicating there is a seasonality effect on the landed weights during the year. Just like price, there are spikes in landed weights during the New Year's period. From the four years observed in *Figure 6*, one can see that the landed weights for 2019 and 2021 are showing lower landings for the summer months than those in 2018 and 2020. This is due to reduced recruitment during 2017 & 2019 (ICES, 2021).

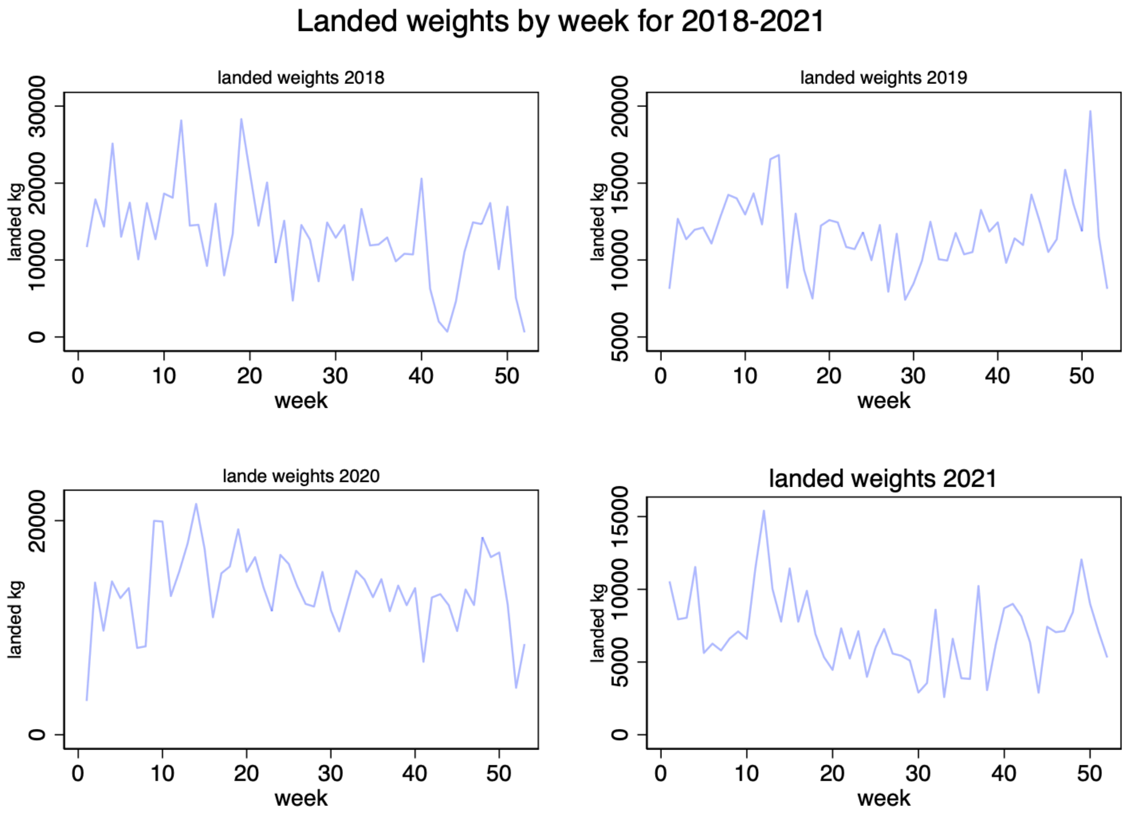

Figure 6 -Landed weights by week 2018-2021

4. Empirical Approach

4.1 Econometric Model

One issue with using auction prices to determine changes in demand is that auction prices are also affected by supply. This is particularly true when it comes to auctions of fresh commodities. Since these auctions create daily market clearance, supply and demand strongly affect the daily prices. Therefore, to control for variations in supply a measurement for landed weights is included in the analyses. Since there are reasons to believe that landed weights are endogenous, an instrumental approach is used. This approach is useful when one of the explanatory variables is correlated with the error term. According to (Stock & Watson, 2020) one can see it as if the variation in the endogenous variable is divided into two parts, one part correlated with the error term and one part uncorrelated to the error term. Naturally we would like to isolate the effect from the uncorrelated part and disregard the correlated part from the regression. This can be done if a good instrument is found that catches the uncorrelated part of the endogenous variable, where the predicted values for the endogenous variable based on the uncorrelated part is used instead of the actual endogenous variable. For an instrument to be considered good it must be relevant, meaning that it is catching a part of the endogenous variable. Furthermore, the instrument must also be valid, meaning that it is not correlated to the error term. The following empirical approach is used to investigate the effect of the pandemic by using a measure to specifically estimate its effect on daily auction prices for Swedish boiled shrimp.

$$p_t = \beta_0 + \beta_1 * Cases_{t-2} + \beta_2 * \widehat{weight}_t + \beta_3 * salmon_t + \beta_4 * timeeffects_t + \varepsilon_t$$

Index t is for daily observations from 1 to 490 and represents every day from the start of the pandemic in March 2020 until end of 2021 with registered auction prices. The dependent variable p_t is a measure for daily average auction prices for boiled shrimp at Swedish fish auctions. The independent variable $Cases_{t-2}$ is a measure for daily confirmed Swedish cases of Covid-19 smoothed over seven days and with a two-day lag. This is the chosen measurement to control for the effect of Covid-19. The independent variable $\widehat{weight}_t$ is the predicted landed weight of boiled shrimp estimated by the following first stage equation.

$$\widehat{weight}_t = \alpha_0 + \alpha_1 * gust\_Väderöarna_{t-1} + \alpha_2 * gust\_Lista\_fyr_{t-1} + time\_effects_t + \gamma_t$$

The predicted landed weight is based on wind gusts measured by the two relevant weather stations mentioned above and is used to control for variation in supply. The instruments were chosen because wind strength affects fishing operations greatly, with fishing becoming harder the stronger the winds. The one-day lag in the first stage equation is motivated by the fact that shrimp are fished one day before they are auctioned. Since prices for shrimp are dependent on the weekday, as well as annual trends, the weekday as well the year effects are controlled for in the variable $time\_effects_t$ for both the first stage equation as well as in the main equation. Further seasonal effects are difficult to control for since they would also catch the seasonality of confirmed Covid-19 cases. To account for the substitution effect that might have occurred for shrimp, the export price of Norwegian salmon as an independent control variable is used. The econometric models also consist of the stochastic error terms ε_t and γ_t.

4.2 Identification

To be able to state that the empirical approach used will catch the causal effect from confirmed Covid-19 cases upon auction prices, all price observations must have the same characteristics. Since individual vessels cannot be identified within the data set, this is not easy to control for. However, since each vessel has its own quota, there is no reason to believe that the characteristics of daily landings should vary in a systematic way other than what we control for with our weekday control. One must also be assured that we don't observe a reverse causality between cases and prices. Firstly, shrimp prices would obviously not have any effect on confirmed Covid-19 cases, also a two-day lag is used on the data for confirmed cases, which guarantees no reverse causality.

4.3 Estimator

The dependent variable is auction price per Kg in SEK and the independent variables consist of numerical values for confirmed covid cases and predicted landed weights in Kg. The dependent variable is linearly dependent on the independent variables who are of full rank. With the help of instrumental variables, the exogeneity assumption is fulfilled. Since the possibility that the residuals are heteroscedastic can't be ruled out, regressions are run with robust standard errors. Based on this we hold that OLS is the Best Linear Unbiased Estimator (Stock & Watson, 2020).

4.4 Method

With the knowledge from (Björk, 2017) explaining that high wind speeds complicate fishing operations together with the information that wind gusts are often up to 40% stronger than average winds (Bureau of meteorology, 2022), wind gusts are used as an instrument to control for supply. The reasoning is that, since one can see from *Figure 6* that landed weights appear to be similar throughout the years (with some differences in 2019) regardless of the onset of the pandemic, wind gusts could be a good instrument to control for the total amount of landed weights.

There is a clear connection between increased daily landed weights and decreased daily auction prices. This was expected since the data set consists of more than 80% of the daily Swedish landings. In *Figure 7* below, landed weights were cleared from yearly, weekly and weekday effects to show how weights are affecting prices.

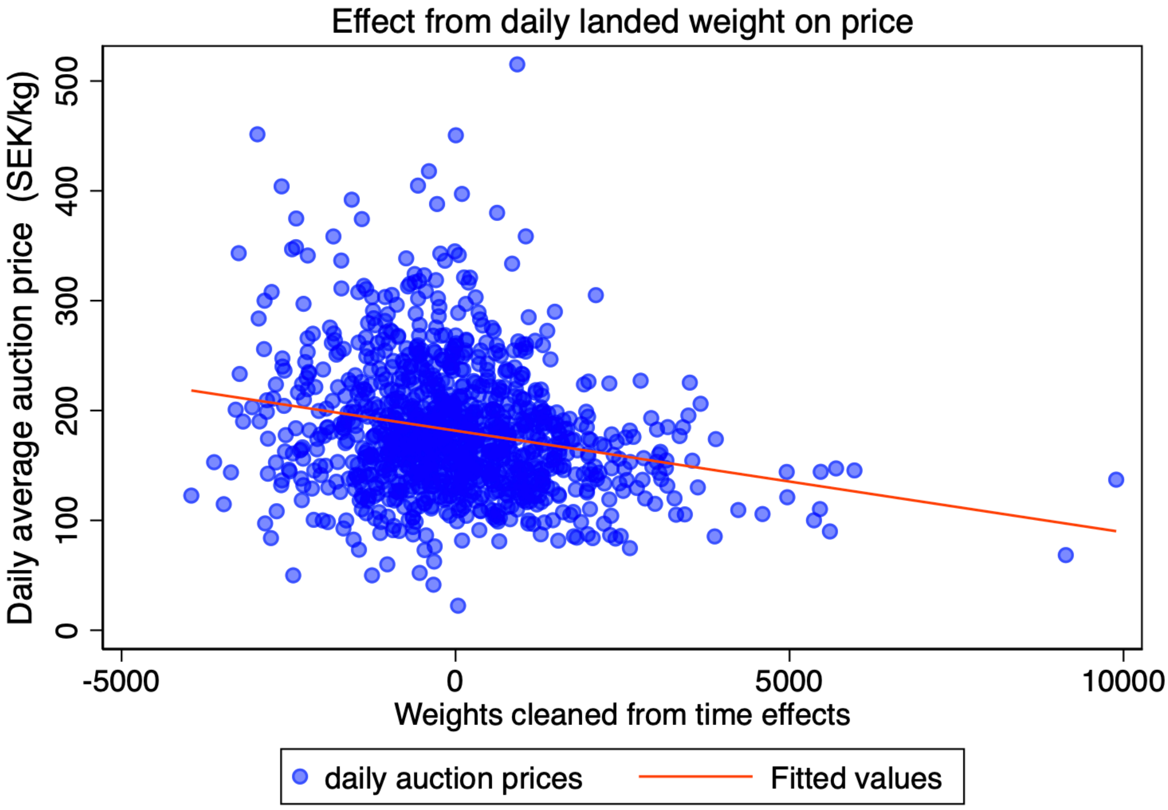

Figure 7- Effect from daily landings on price

In *Figure 7*, where daily auction price is displayed on the y-axis and the daily weights cleaned from time effects are displayed on the x-axis, the whole effect of landed weights was used. To make sure that only the unforeseen change in supply is caught, the effect from daily landed weights depending on the strength of wind gusts for the two weather stations were isolated. By doing so, we argue that variation in supply is controlled for in the calculations. The effect of daily wind gusts on daily landed weights is displayed in *Figure 8* below.

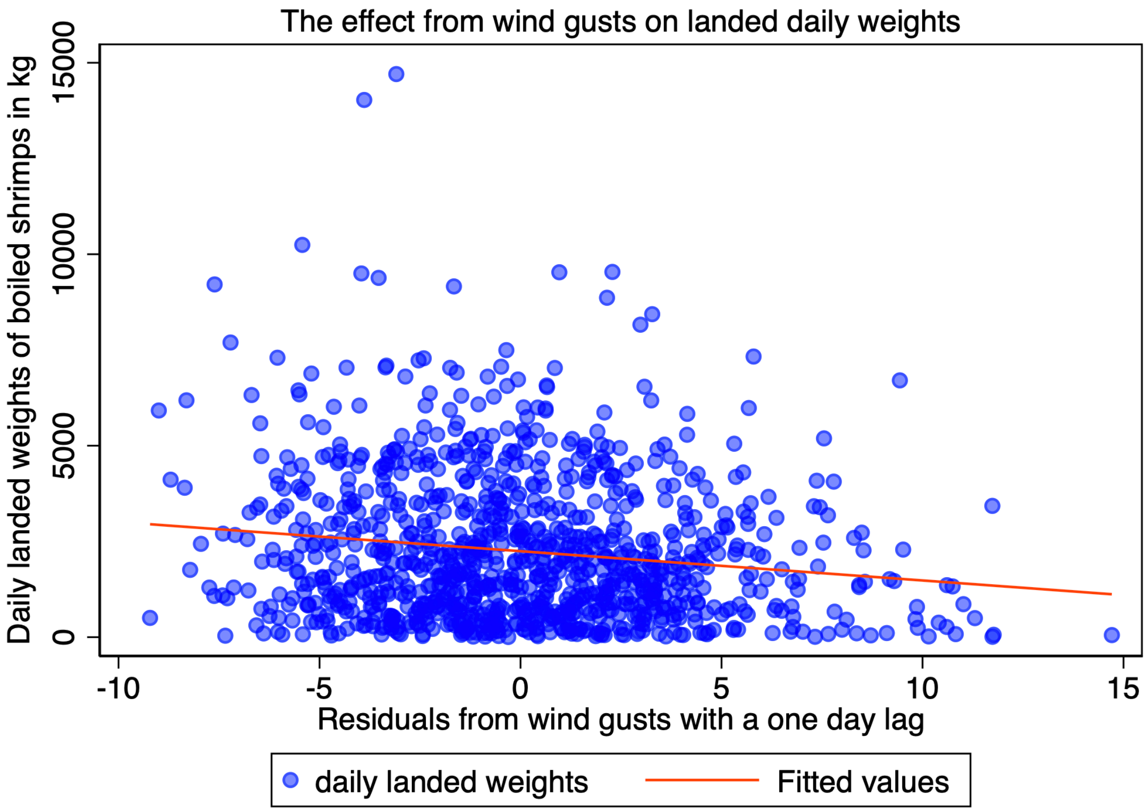

Figure 8 -the effect from gusts on landed weights

Figure 8 visually confirm the expected result that landed weights are less when gusts are higher. The y-axis displays daily landings, and the x-axis displays gusts cleaned from seasonal effects. Section 5.5 further elaborates on the relevance and validity of the use of wind gusts as instruments for landed weights to control for the variation in supply.

4.5 Theory and Hypothesis

Confirmed Swedish cases of Covid-19 are expected to have a negative effect on demand for shrimp. The downward sloping curve in *Figure 9* indicates that predicted auction prices decrease with each decile increase in confirmed cases of Covid-19.

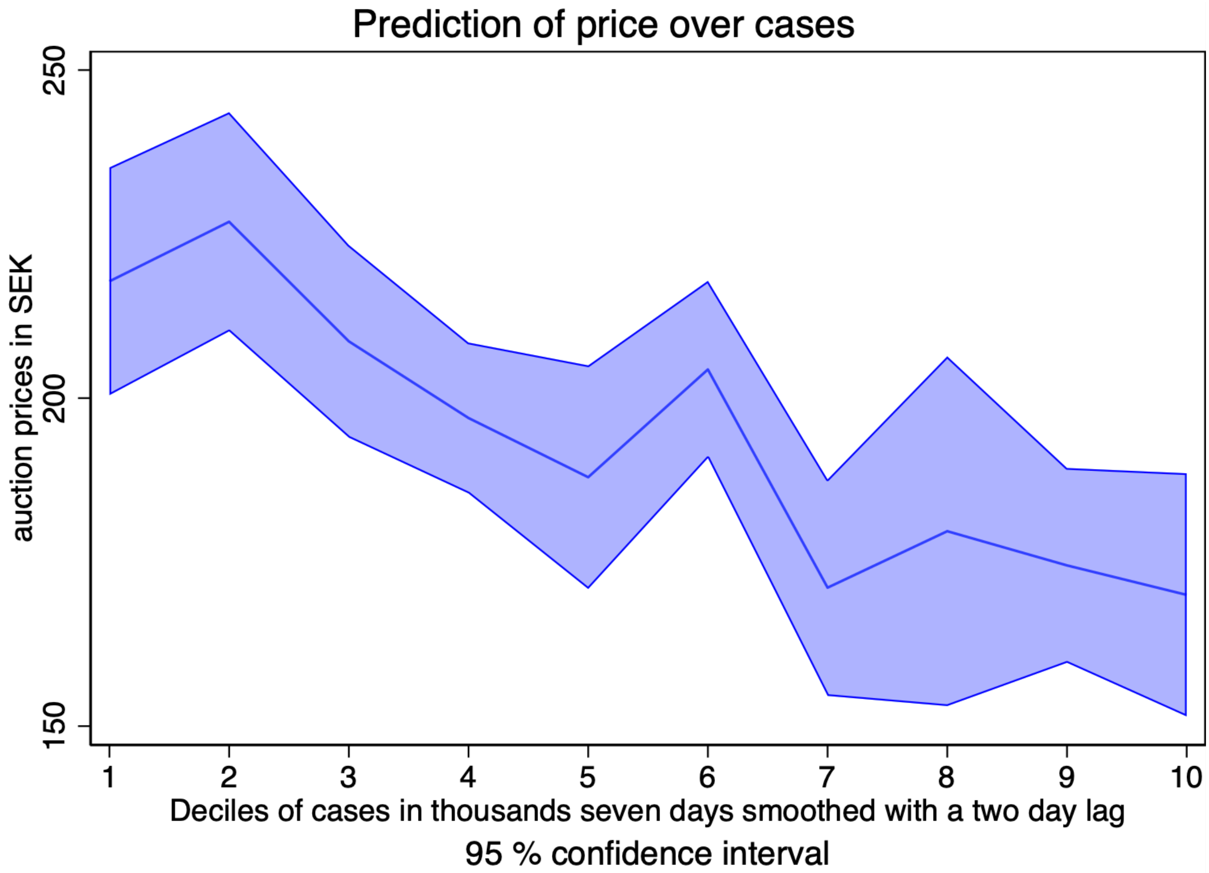

Figure 9 -Prediction of prices over confirmed cases

Figure 9 has auction prices on the y-axis and the confirmed cases with a moving average of seven days divided into ten deciles on the x-axis. The graph shows the price at every decile of confirmed cases with a 95 % confidence interval. From the graph we learn that for the median number of confirmed cases the price for boiled shrimp is 190 SEK with a 95 % confidence interval of 170 – 210 SEK.

4.6 Diminishing effect from cases on prices

The marginal effect from Covid-19 cases on auction prices for boiled shrimp is diminishing. This relationship is displayed in *Figure 10*, where the y axis displays the predicted marginal effect on auction prices, while the x-axis consists of values for daily new confirmed cases. The graph shows that at low numbers of new daily confirmed cases the marginal effect is about -15 SEK per Kg, and that the magnitude of the effect becomes smaller when the number of confirmed daily cases increases. The graph further indicates that the marginal effect from one extra case is not significantly different from zero when 4000 new cases per day are reached.

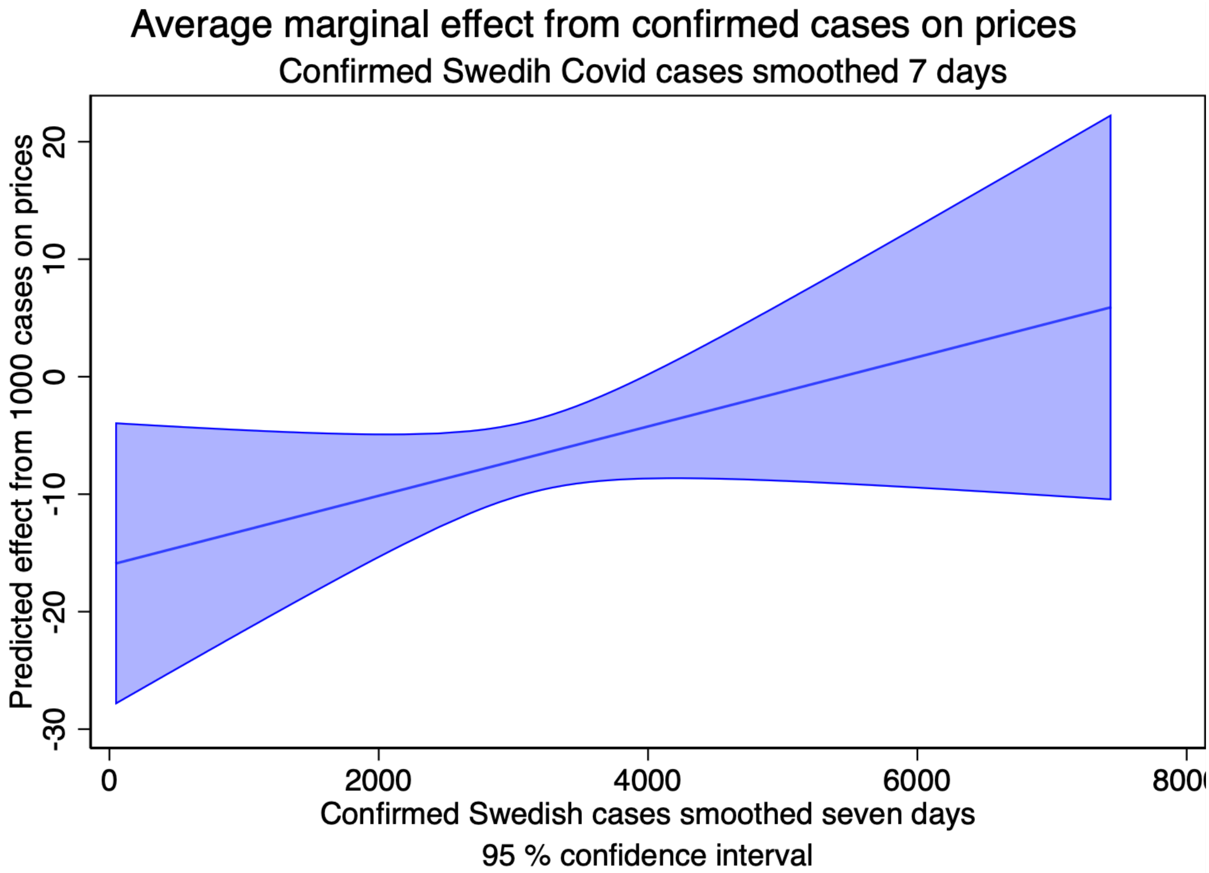

Figure 10 -Diminishing effect from confirmed cases on prices

5. Results

The results are reported in the following manner. Some general results from the main regression are first presented. Afterwards, the effect from a squared value from the confirmed Swedish cases is analysed. Since these results are difficult to interpret in a table, a graph was chosen to display the marginal effect from an increase in confirmed cases on a linear prediction of auction prices. Total effects from the pandemic on auction prices for boiled shrimp are later calculated. Lastly, some tests of robustness and analyses of our chosen instruments for landed daily weights are presented.

5.1 main result

Table 2 -Main results

VARIABLES	1 base	2 + diminishing	3 + supply	4 + substitution
cases_1000	-5.9968***	-12.7688**	-15.1395**	-16.0362***
	(1.7278)	(6.4444)	(6.3733)	(6.1973)
c.cases_1000#c.cases_1000		1.1496	1.1713	1.4751
		(1.0028)	(0.9954)	(0.9541)
weight_instrument			-0.0457***	-0.0489***
			(0.0102)	(0.0102)
Salmonprice				1.8028***
				(0.3977)
Constant	170.5039***	174.5747***	231.8420***	135.6198***
	(13.1801)	(13.0290)	(19.6063)	(29.7034)
i.day	Yes	Yes	Yes	Yes
i.year	Yes	Yes	Yes	Yes
Observations	490	490	460	460
R-squared	0.1601	0.1628	0.2388	0.2702

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The first column of *Table 2* above, which represents the dataset from the start of the pandemic in March 2020 to December 2021, shows that there is a negative marginal effect from an increase in confirmed Swedish cases smoothed over seven days and with a two-day lag on the auction prices of boiled shrimp. The effect is statistically significantly different from zero at a 1% level. The magnitude of the effect explains that an extra 1000 new confirmed cases will reduce the auction price of boiled shrimp by about 6.00 SEK/Kg. Annual effects as well as weekday effects on demand and supply are controlled for. Since there are reasons to believe that the marginal effect from confirmed cases of Covid-19 is diminishing, squared values from the independent variable cases_1000 are included in column 2. As expected, the squared values have a positive slope indicating a diminishing effect. In column 3, predicted weights are included to control for supply. The coefficient of this measurement has a negative slope strengthening the theory that an increase in landed weights lower auction prices. Whilst using this variable to control for supply, the degree of explanation increases from 16.3 % to 23.9 %. To further consider different aspects of the price – supply issue, a control for a substitutional effect in the form of the price for Norwegian salmon is included in column 4. The slope of the coefficient for the chosen substitutional good is positive, meaning that as price of fresh salmon increases, the demand, and thereby price, for boiled shrimp increases. With this inclusion the adjusted degree of explanation is 27 % and the coefficients for both control variables are highly statistically significant.

5.2 Predicted effect when including squared values

Since it was found in section 4.6 and further displayed in *Table 2* that there is a diminishing effect from the number of confirmed Swedish Covid-19 cases onto auction prices for shrimp, an analysis of the predicted effect when including a squared value for confirmed cases, as well as wind gusts and substitution effect, was made. These results are difficult to interpret in a table since the effects from confirmed cases and the square of confirmed cases will have different signs making the marginal effect difficult to read. Therefore, these results are presented in *Figure 11* below. To show the heterogeneity of the effect from the pandemic onto auction prices over time, the predicted marginal effects for each quarter in the timespan of 2020-2021 are shown.

The predicted linear effect on auction prices from an increase of 1000 confirmed cases is negative varying between -15 SEK to -5 SEK. Over the whole period, every quarter except for the first quarter of 2021(which is not statistically different from zero) has a negative and significant effect from an increase in cases onto auction prices for boiled shrimp.

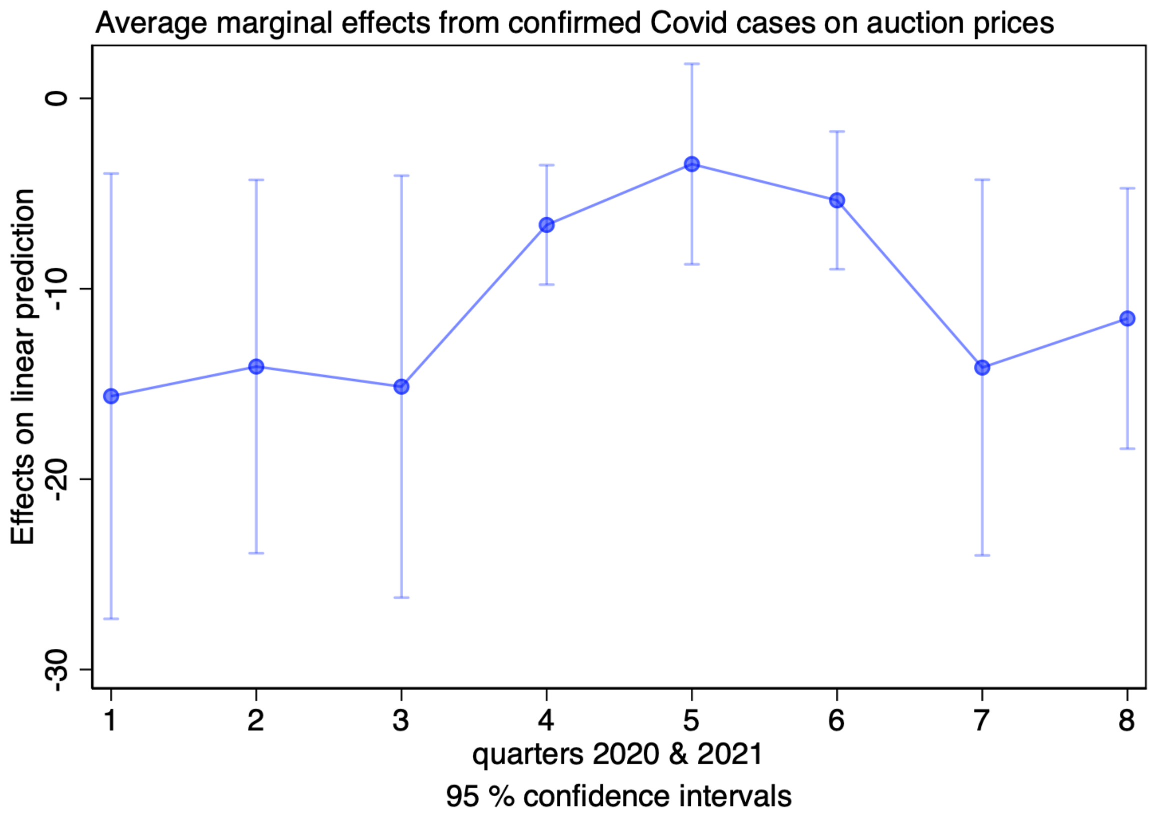

Figure 11 -Average marginal effect over quarters

Looking at column 4 in *Table 2*, where the square effect of covid cases is shown and the controls for supply as well as substitution effect are included, the marginal effect can be calculated. The first and second degree of cases have different signs, therefore, to make a meaningful interpretation of the average marginal effect from confirmed Swedish Covid-19 cases smoothed over seven days with a two-day lag the following calculation is done. The average amount of the measurement for Covid-19 during the pandemic part of our dataset is used, which is 1909 new cases per day.

$$\overline{marginal\ effect} = -16.04 + 2x1.48x1.91 = -10.39$$

By this, it can be concluded that the average marginal effect from confirmed Swedish Covid-19 cases smoothened over seven days with a two-day lag is a price decrease of about 10.39 SEK/Kg

5.3 Total effect from Covid-19 onto auction prices.

Table 2 column 4 indicates that the average marginal effect from the used Covid measurement on auction prices for boiled shrimp is about -10.39 SEK/Kg for an increase of 1000 cases. With an average of 1909 new cases reported per day in the pandemic part of the dataset, we get an average loss of $1.909\ x\ 10.39 \approx 19.83\ {}^{SEK}/_{Kg}$. Since the average price for boiled shrimp during the pandemic period of our dataset is 191.83 SEK/Kg, the fishers incurred a loss of $\frac{19.83}{(19.83+191.83)} \approx 9.37\%$. Expressing loss in SEK, loss per Kg is multiplied with total landings during the pandemic period of the dataset. Here one must consider that not all total landings are present in the data, but rather 90.1 % for 2020 and 83.1 % for 2021. Estimating total landings for the pandemic part of our dataset based on these figures gives us the following total landed weight:

$$\frac{575868}{0.901} + \frac{369600}{0.831} = 1083909\ kg$$

Considering this total landed weight and the calculations for loss per sold kg, the total loss for Swedish shrimp fishers due to the Covid pandemic is calculated roughly to be $1083909\ x\ 19.83 \approx 21.5\ M\ SE$K

5.4 Test for heteroscedastic error terms

As a first step in testing whether the error terms are heteroscedastic, the residuals from the main regression are scattered against the predicted values for auction prices in *Figure 12,* where a fitted line for the residuals is also present. The shape of the scatter plot seems to have a somewhat wider spread at the higher predicted auction prices indicating that the error terms are heteroscedastic.

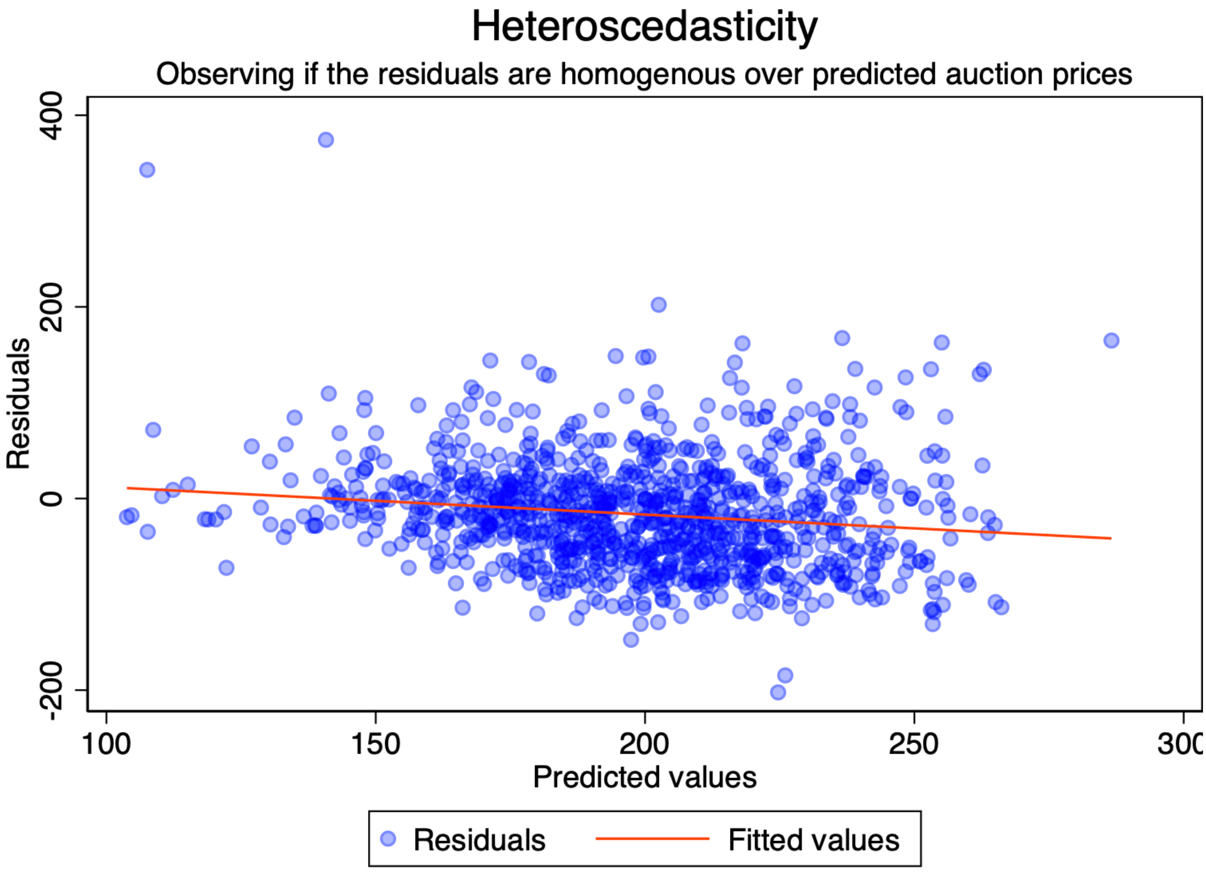

Figure 12 -Heteroscedasticity

To test for Heteroscedasticity both a Breusch-Pagan as well a White test is conducted and displayed in *Table 3*. The first column, the Breusch-Pagan test for linear heteroscedasticity, is constructed by running the squared residuals from our main equation over our choice of independent variables. The null hypothesis for the F-test presented in column 1 is that all slopes for our independent variables equal zero, which would indicate homoscedastic error terms. However, since the F-test clearly rejects the null-hypothesis we can't rule out Heteroscedasticity. The White test, that tests for non-linear heteroscedasticity, displayed in column 2 is constructed by regressing the squared residuals from our main regression on the predicted values as well as on the square of the predicted values from the main equation. Again, the null hypothesis of the conducted F-test is that the slopes equal zero which would imply homoscedastic error terms. As observed in column 2, the null hypothesis is rejected and thereby also the White test fails to rule out heteroscedasticity. Given that heteroscedasticity cannot be ruled out, the regression was run with robust standard errors to address this.

Table 3 -Breusch-Pagan and White test to test for heteroscedasticity

	1	2
	Breusch-Pagan test	White test
VARIABLES	residuals_sqr	residuals_sqr
cases_1000	523.1367	
	(1,113.9842)	
cases_1000_sqr	-36.0475	
	(151.1446)	
weight_instrument	-2.4736**	
	(1.1754)	
Salmonprice	112.7884**	
	(47.9297)	
y_est		-360.9660***
		(70.7028)
y_est_2		0.9701***
		(0.1801)
Constant	2,894.8795	36,111.0657***
	(6,025.4471)	(6,871.8127)
i.day	Yes	Yes
i.year	Yes	Yes
Observations	460	1,05
R-squared	0.0679	0.0320
F-test	5.794	17.31
Prob > F	0.00	0.00

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.5 The use of wind gusts as instruments for landed weights

Economic intuition suggests landed weight to be endogenous, since there are likely to be for us unknown events affecting both landed weights as well as price for boiled shrimp. A method that indicates that this intuition is valid is as follows.

Column 1 in *Table 5* displays the results from the following first stage equation:

$$\widehat{weight}_t = \alpha_0 + \alpha_1 * gust\_Väderöarna_{t-1} + \alpha_2 * gust\_Lista\_fyr_{t-1} + time\_effects_t + \gamma_t$$

As can be seen in column 1 the instrument gust_väderöarna is statistically significantly different from zero by itself, while the instrument gust_lista_fyr is not. However, as identified by the t-test they are, when used together, statistically different from zero at a 95 % level. The next step in examining if the variable weight_date is exogenous is to include the residuals from the first stage equation into the main equation as follows.

$$price\_day_t = \beta_0 + \beta_1 cases_t + \beta_2 cases_t{}^2 + \beta_3 weight_t + \beta_4 salmon_t * \beta_5 first\_resid_t + time_t + \varepsilon_t$$

As seen in column 2 in *Table 4* the slope of the residuals from the first stage equation is statistically significantly different from zero indicating that we can´t rule out endogeneity. Column 1 and 2 together justifies the use of instruments to predict landed weights.

Table 4 - Endogeneity test

	1	2
VARIABLES	1:st stage	endogeneity test
gust_väderöarna	-60.1658***	
	(12.8918)	
gust_lista_fyr	-9.7300	
	(11.4136)	
cases_1000		-13.5599**
		(5.9759)
c.cases_1000#c.cases_1000		1.2198
		(0.9126)
weight_date		-0.0548***
		(0.0097)
Salmonprice		1.9735***
		(0.3984)
first_resid		0.0432***
		(0.0100)
Constant	1,947.3436***	133.0980***
	(192.0086)	(29.3503)
i.day	Yes	Yes
i.year	Yes	Yes
Observations	1,05	460
R-squared	0.4029	0.3103
t-test instruments	5.536	
Prob > t	0.0188	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

For instruments to be useful they firstly must be relevant, meaning that when used they must offer explanatory value to the main regression. Column 2 and 3 in *Table 5* show that the gusts from Väderöarna as well as gusts from Lista are significant by themselves, and column 4 tells that they are also significant when used together. The F-tests for column 2 to 4 are all above ten, which according to (Stock & Watson, 2020) is a good sign that the instruments are relevant. The fact that Column 1 which is the main regression without any control for supply offers a lower degree of explanation than column 2 to 4 do, further supports the statement that the instruments are relevant.

Secondly, instruments must be valid, meaning they may not affect the independent variable in any other way than through the instrumented variable. In column 5 the residual from the main regression is regressed on the two weather observations. The fact that they both are not significantly different from zero as well as the degree of explanation in column five being only 4.8%, assures that the instruments only affect the independent variable through the instrumented variable landed weight. Column 5 also reveals an F test for the two weather stations, again clearly indicating that they are neither together nor by themselves statistically significantly different from zero.

Table 5 – relevance and validity of the instruments

VARIABLES	1 price_day	2 price_day	3 price_day	4 price_day	5 resid
cases_1000	-13.35**	-13.94**	-15.52**	-16.04***	-7.782
	(6.309)	(6.097)	(6.352)	(6.197)	(6.208)
c.cases_1000#c.cases_1000	1.391	1.406	1.503	1.475	1.439
	(0.971)	(0.936)	(0.977)	(0.954)	(0.956)
iv_väderöarna		-0.0422***			
		(0.0102)			
iv_lista			-0.0375**		
			(0.0147)		
weight_instrument				-0.0489***	
				(0.0102)	
gust_väderöarna					0.984
					(0.853)
gust_lista_fyr					-0.866
					(0.722)
Constant	83.07***	124.2***	127.4***	135.6***	-94.49***
	(26.24)	(29.09)	(32.57)	(29.70)	(27.24)
i.day	Yes	Yes	Yes	Yes	Yes
i.year	Yes	Yes	Yes	Yes	Yes
Salmonprice	1.650***	1.806***	1.672***	1.803***	1.830***
	(0.400)	(0.394)	(0.399)	(0.398)	(0.400)
Observations	490	490	460	460	460
R-squared	0.189	0.218	0.242	0.270	0.048
F-test	9.180	12.47	11.14	15.56	0.865
Prob > F					0.422

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.6 robustness tests

In the main model, the variable for confirmed Swedish Covid-19 cases smoothed over seven days and with a two-day lag has been used as a measurement for the spread of the pandemic. To justify this choice of measurement and time lag, *Table 6* and *7* are presented.

To investigate what estimator for the spread of Covid -19 to use, five different variables have been tested. Registered cases in Sweden, as displayed in the first column below, gives a statistically significant coefficient at a 1% level and gives an explanatory degree of 26.59 %. The measurement for confirmed deaths due to Covid-19, as displayed in column 3 below, is highly statistically significant but offers a slightly lower R^2. The two measurements for confirmed cases and confirmed deaths worldwide, columns 4 & 5, offer no results statistically significantly different from 0. The effect from Swedish patients in need for intensive care is displayed in column 2. This measurement is also statistically significantly different from zero but offers a slightly lower degree of explanation. The three measurements offering a statistically significant slope all indicate a negative correlation between an increase in the spread of Covid-19 and the auction prices for shrimp in Sweden.

Table 6 -robustness over different measurements of Covid-19 on auction prices of boiled shrimp

	1	2	3	4	5
VARIABLES	cases_swe	icu_swe	deaths_swe	cases_world	deaths_world
cases_sweden_lagged	-0.0074***				
	(0.0016)				
icu_sweden_lagged		-0.0503***			
		(0.0173)			
deaths_sweden_lagged			-0.2851***		
			(0.0670)		
cases_world_lagged				0.0000	
				(0.0000)	
deaths_world_lagged					0.0005
					(0.0016)
weight_instrument	-0.0488***	-0.0429***	-0.0428***	-0.0435***	-0.0442***
	(0.0100)	(0.0101)	(0.0099)	(0.0099)	(0.0100)
Constant	133.1115***	96.2077***	120.5633***	88.1282***	93.7510***
	(29.5161)	(32.1037)	(30.0103)	(31.3022)	(29.3833)
i.day	i.day	i.day	i.day	i.day	i.day
i.year	i.year	i.year	i.year	i.year	i.year
Salmonprice	1.7514***	2.2842***	1.8182***	2.1928***	2.1298***
	(0.3982)	(0.4609)	(0.3993)	(0.4361)	(0.4156)
Observations	460	460	460	460	460
R-squared	0.2659	0.2367	0.2386	0.2246	0.2235

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

As can be seen in *Table 7*, the choice of days to lag the measurement by does not affect the outcome very much. This is probably since the spread is going in waves as seen in *Figure 4*, meaning there are strong correlations between confirmed cases from one day to another. Said correlation is further investigated in the Appendix. In the first column of *Table 7* the registered confirmed cases for the same day as the auction are being displayed. Column 2 displays values with a one-day lag, the third column represents a two-day lag, and the last column displays the result with a three-day lag.

Table 7 -robustness over different lags

	1	2	3	4
VARIABLES	no lag	lag_1_day	lag_2_day	lag_3_day
cases_swe	-0.0077***			
	(0.0015)			
cases_swe_lag_1		-0.0077***		
		(0.0015)		
cases_swe_lag_2			-0.0074***	
			(0.0016)	
cases_swe_lag_3				-0.0066***
				(0.0019)
weight_instrument	-0.0492***	-0.0489***	-0.0488***	-0.0487***
	(0.0100)	(0.0100)	(0.0100)	(0.0100)
Constant	134.6848***	134.6211***	133.1115***	130.4112***
	(29.7215)	(29.6157)	(29.5161)	(28.8629)
i.day	Yes	Yes	Yes	Yes
i.year	Yes	Yes	Yes	Yes
Salmonprice	1.7453***	1.7390***	1.7514***	1.7765***
	(0.3995)	(0.3988)	(0.3982)	(0.3953)
Observations	460	460	460	460
R-squared	0.2712	0.2702	0.2659	0.2573

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

To find applicable instruments for landed weights, observations from five weather stations were investigated. The geographical position of the five stations can be seen in *Figure 1*. Out of the five stations, the Norwegian station Lista fyr and the Swedish station Väderöarna were chosen. From these weather stations, daily data for highest wind gusts were collected. Since gusts heavily affect the ability to operate a fishing boat, this is a good instrument for landed weights. As presented in *Table 8,* the correlation between the three Swedish weather stations is very high, and the choice fell on Väderöarna since this was the station with the highest correlation to the two others. Furthermore, Lista Fyr was chosen since it is relatively close to the fishing waters compared to Utsira fyr. To instrument landed weights the wind gust observations from the previous day were used since the shrimp are being fished one day before they are auctioned. A robustness check regarding other choices of instruments is presented in the Appendix.

Table 8 -correlation between weather stations

Variables	1	2	3	4	5
(1) gust_väderöarna	1.000				
(2) gust_nordkoster	0.956	1.000			
(3) gust_måseskär	0.956	0.893	1.000		
(4) utsirafyr	0.525	0.513	0.525	1.000	
(5) gust_lista_fyr	0.597	0.564	0.620	0.583	1.000

6. Conclusions

To conclude, our study provides evidence supporting what the fishers observed when it came to price reductions in shrimp because of Covid-19, with our results indicating an average price reduction of 19.83 SEK/Kg (-9.37%) from the start of the pandemic to the end of 2021, causing a loss of 21.5 million SEK in revenues throughout the two years. Therefore, we can see that the desire for shrimp fishers to get economic aid during Covid-19 was justified.

With consumers opting for store bought food with longer perishing time at the expense of fresher food, demand, and therefore the price for shrimp, decreased throughout the pandemic. Alongside the uncertainty of the economic situation during the pandemic where people's consumption patterns changed because of the fear of Covid-19, the other factor to pay attention to is also the shift in purchase capabilities of the average consumer. With Covid-19 slowing down economies with people earning less, it is also plausible that people shifted their consumption from more luxury goods to either inferior or normal goods, in our example shifting their consumption away from shrimp, the luxury good.

6.1 Limitations

Our main issue in this research has been to separate demand effects from supply effects of auction prices for boiled shrimp. Our approach was to try and isolate the supply effect by using predicted weights based on wind strength. We also used a measurement to account for a substitution effect. We are aware that there might be seasonal effects of prices that we are not able to catch since all attempts to do so would also catch the seasonality of the spread of Covid-19

6.2 Future research

To control for the possible substitution effect that was caused from Covid-19, only one commodity, Norwegian salmon, is used. It would be better to include a vector of prices for several substitutional goods, such as salmon, crayfish, lobster, and deep-frozen shrimp. To expand this research, it would be interesting to observe if there were similar patterns for other luxury sea food products such as crayfish and lobster.

We used wind gusts to control for supply in this study. It would be interesting to have this relationship tested more thoroughly and have its validity as a control for supply tested, as well as study more ways to control for supply.

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Appendix

An alternative approach to investigate how the Covid-19 pandemic affected Swedish auction prices for boiled shrimp would be to perform a diff in diff analysis. However, there is no untreated control group since the whole of Sweden was affected. A variation to a diff in diff, as done by (Chen, et al., 2021), could be to use the part of the dataset outside the pandemic as a control group and run a regression over daily auction prices over the whole timespan for the dataset on a dummy variable for being in the time of the pandemic, again controlling for supply with the help of the predicted landed weights based on the wind gusts from the two weather stations Väderöarna and Lista fyr. In this regression, variations in both demand and supply with time effects for year, month, and weekday are controlled for.

$$p_t = \beta_0 + \beta_1 pandemic_t + supply_t + time_t + \epsilon_t$$

Where p_t is the auction price at day *t*, $pandemic_t$ is a dummy variable with the value 1 if day *t* is in the pandemic period and zero otherwise. The variable $supply_t$ controls for supply at day *t* based on landed weights predicted by wind gusts from our two chosen weather stations. The vector $time_t$ controls for weekday effects, monthly effects as well as year effects. Lastly, we have a stochastic error term ϵ_t

Table 9 - Alternative approach

VARIABLES	price_day 2018 - 2021
pandemic	-25.9443***
	(8.6934)
weight_instrument	-0.0672***
	(0.0064)
Constant	208.8363***
	(11.8386)
i.day	Yes
i.month	Yes
i.year	Yes
Observations	1050
R-squared	0.3516

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Even though this method has its flaws in stating a causal effect from the pandemic on prices, *Table 9* indicates that auction prices for Swedish boiled shrimp went down during the pandemic with a negative effect on prices by about 26 SEK.

To investigate why the difference between the four different lags tested for in *Table 7* is so small, the following table of correlations is included. As displayed on *Table 10*, the correlation between the different lags for the smoothed value of new confirmed cases of Covid-19 in Sweden is very high. Therefore, as earlier commented, the results were not sensitive to the choice of lag.

Table 10 - correlation between different lags for explanatory variable

Variables	1	2	3	4
(1) cases_swe	1.000			
(2) cases_swe_lag_1	0.993	1.000		
(3) cases_swe_lag_2	0.986	0.994	1.000	
(4) cases_swe_lag_3	0.981	0.988	0.994	1.000

Table 11 Presents the use of different instruments for the endogenous variable landed_weight and how this affects the sign and magnitude of the marginal effect from the explanatory variable as well as the R^2. The first column displays our choice of instruments and columns 2 and 3 respectively display the effect of instead combining the observations of Lista fyr with the observations from Måseskär and Nordkoster. Column 4-6 respectively display the effect of only using the three Swedish weather stations, and column 7 lastly displays the effect of combining all weather observations, including the more western Norwegian observations from Utsira fyr. As seen in said table, the results are robust regarding which weather observations to use, with a slightly higher degree of explanation when combining one of the Swedish observations with the one from Lista.

Table 11 -robustness over different wind observations

	1	2	3	4	5	6	7
VARIABLES	our choice	Nordkoster	Måseskär	Väderöarna	Lista & Måseskär	Lista & Nordkoster	all observations
cases_1000	-16.0362***	-13.7617**	-14.1195**	-13.9377**	-16.1934**	-15.8836**	-15.7408**
	(6.1973)	(6.0714)	(6.1700)	(6.0969)	(6.2720)	(6.1566)	(6.1384)
c.cases_1000#c.cases_1000	1.4751	1.4002	1.4664	1.4065	1.5311	1.4675	1.4423
	(0.9541)	(0.9315)	(0.9506)	(0.9358)	(0.9682)	(0.9471)	(0.9431)
weight_instrument	-0.0489***						
	(0.0102)						
iv_nordkoster		-0.0385***					
		(0.0095)					
iv_mÃ¥seskÃ¤r			-0.0341***				
			(0.0113)				
iv_vÃ¤derÃ¶arna				-0.0422***			
				(0.0102)			
iv_mÃ¥seskÃ¤r_lista					-0.0439***		
					(0.0112)		
iv_nordkoster_lista						-0.0462***	
						(0.0096)	
iv_all							-0.0479***
							(0.0094)
Constant	135.6198***	123.0139***	119.6579***	124.2374***	134.1633***	135.5295***	135.4639***
	(29.7034)	(29.7319)	(30.1076)	(29.0928)	(30.6688)	(30.3332)	(30.0042)
i.day	Yes	Yes	Yes	Yes	Yes	Yes	Yes
i.year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Salmonprice	1.8028***	1.7397***	1.7048***	1.8060***	1.7085***	1.7374***	1.7782***
	(0.3977)	(0.3954)	(0.3975)	(0.3943)	(0.4006)	(0.3988)	(0.3968)
Observations	460	489	490	490	460	459	459
R-squared	0.2702	0.2180	0.2049	0.2182	0.2575	0.2718	0.2754

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1