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SMEA 584

Policy Memo
Trends in Aquaculture Import in the United States

Introduction and Background

Aquaculture is defined as the propagation and rearing of aquatic species in controlled or selected environments for any commercial, recreational, or public purpose. This definition covers all production of finned fish, shellfish, plants, algae, and other marine organisms for food/commercial products, replenishment of wild stock and endangered/threatened species, and conservation and recovery of marine ecosystems (Upton, 2019, p. 4). The growing demands of the global population coupled with effects of climate change and overexploitation of fish stocks has led to detrimental losses of stock abundance unable to satisfy maximum sustainable yields (MSY) for food security. Many stock species and ecosystems face extinction due to lack of efficient management systems to replenish abundance of species.

As US stocks have been fished at or above MSY, wild fisheries are limited in their productive capacity and has paved way for increased imports of aquaculture products in many developed countries. The system poses economic risks associated with trade across international boundaries, impacts on surrounding ecosystem services, and may lead to disease outbreaks within the population. In the US, aquaculture imports account for 50% of seafood consumption with shrimp and salmon imports from Southeast Asia and Norway or Chile respectively (Upton, 2019, p. 3). As countries like the US become heavily dependent on imports from developing nations, the increased pressure of fishing harvests will account for greater responsibility to monitor and manage production through effective regulations and policies in place as it concerns not only species abundance, but also the surrounding ecosystem.

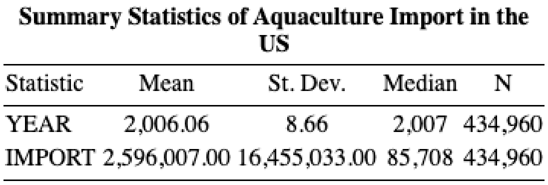
Increased trade is beneficial for exporters especially those in developing regions of Southeast Asia as a result of economic development. It is also beneficial for those consumers of developed regions as the imports provide a higher quantity at competitive prices. However, consumers in exporting regions experience higher prices in products which may lead to food insecurity as a result of greater economic inequality. In addition to this, imports lead to pressure on demand for products with negative implications for local fishing communities whose income is dependent on production and market value (Asche & Smith, 2010, pp. 10-11). As a result, the need for more effective and sustainable management policies alongside a regulated trade regime that ensures sustainability and safety becomes desirable. This implies a more effective multilateral mechanism to ensure non-tariff measures (NTMs) do not become just an opportunity for disguised protectionism in the trading system. A global mapping system is required to better understand the nature and impact of these measures as the sustainability of fish stock abundance is a part of an international community whereby nations should lead in assisting one another to meet this challenge through equitable and sustainable goals (Valles & Eugui, 2016, p. 25). The aim of this analysis is to investigate the predictability of trends in aquaculture import as it pertains to current data collected through a regression analysis and ultimately explore its efficacy for policies in fisheries management.

Data Description

The dataset for this analysis was retrieved from the United States Department of Agriculture database and depicts information on aquaculture import of fish and shellfish in the US for the period of 1989 to 2019 (Davis, 2020). The dataset included descriptions of the commodity, region the commodity was imported from, time period including the number of months per imported commodity for 1989-2019, and the amount of commodity imported measured in kilograms (kg). For the purpose of this analysis, data on amount of import and time period was used to develop a regression model to explore the predictability of projections and rate of increase of aquaculture import in developed countries such as the US. The explanatory variable is time, and the response variable is the amount of imported aquaculture.

Summary Statistics of Dataset

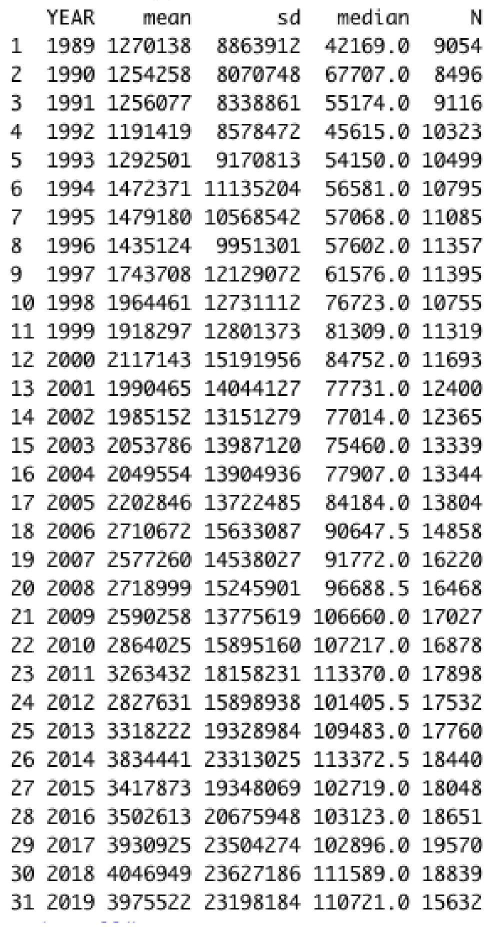
<u>Table 1:</u> *Summary Statistics for Aquaculture Import in the US from 1989-2019.*



Summary Statistics of Aquaculture Import in the US

Statistic	Mean	St. Dev.	Median	N
YEAR	2,006.06	8.66	2,007	434,960
IMPORT	2,596,007.00	16,455,033.00	85,708	434,960

<u>Table 2:</u> *Summary Statistics for Aquaculture Import per Year in the US from 1989-2019.*



```
   YEAR    mean       sd   median     N
1  1989 1270138  8863912  42169.0  9054
2  1990 1254258  8070748  67707.0  8496
3  1991 1256077  8338861  55174.0  9116
4  1992 1191419  8578472  45615.0 10323
5  1993 1292501  9170813  54150.0 10499
6  1994 1472371 11135204  56581.0 10795
7  1995 1479180 10568542  57068.0 11085
8  1996 1435124  9951301  57602.0 11357
9  1997 1743708 12129072  61576.0 11395
10 1998 1964461 12731112  76723.0 10755
11 1999 1918297 12801373  81309.0 11319
12 2000 2117143 15191956  84752.0 11693
13 2001 1990465 14044127  77731.0 12400
14 2002 1985152 13151279  77014.0 12365
15 2003 2053786 13987120  75460.0 13339
16 2004 2049554 13904936  77907.0 13344
17 2005 2202846 13722485  84184.0 13804
18 2006 2710672 15633087  90647.5 14858
19 2007 2577260 14538027  91772.0 16220
20 2008 2718999 15245901  96688.5 16468
21 2009 2590258 13775619 106660.0 17027
22 2010 2864025 15895160 107217.0 16878
23 2011 3263432 18158231 113370.0 17898
24 2012 2827631 15898938 101405.5 17532
25 2013 3318222 19328984 109483.0 17760
26 2014 3834441 23313025 113372.5 18440
27 2015 3417873 19348069 102719.0 18048
28 2016 3502613 20675948 103123.0 18651
29 2017 3930925 23504274 102896.0 19570
30 2018 4046949 23627186 111589.0 18839
31 2019 3975522 23198184 110721.0 15632
```

Figures

<u>Figure 1:</u> *Average Aquaculture Import in the US from 1989-2019.*

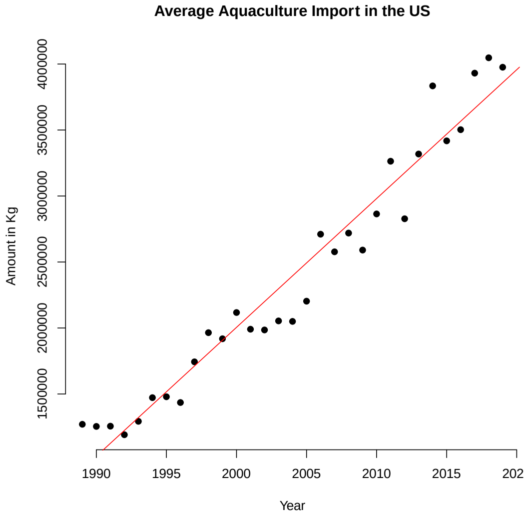


Figure 1 depicts the average amount of aquaculture imports for each year of the time period 1989-2019. The figure below suggests a linearly increasing relationship of aquaculture import over time. The overall trend in the data depicts an upward shift in the amount of aquaculture import over time. In addition to this, an estimated regression line was plotted with the equation: Aquaculture Import = – 193,188,740 + 97,597*Time where aquaculture import is the dependent variable (y) and year is the independent variable (x). The intercept is –193,188,740 and interpreted as the predicted amount of import when x is equal to 0, assuming the error term (ε) is 0. The slope of the regression line is 97597 indicating that for each 1 unit increase in the x variable (year), on average aquaculture import will increase by 97,597 kg/year

Regression Analysis

Hypothesis

Two-tailed t-tests are used to conduct the hypothesis tests on regression coefficients of a simple linear regression. The first t-test is related to the population intercept term (β_0), whereby the null hypothesis states that the population intercept term is equal to 0 and the associated alternative hypothesis states that the population intercept term is not equal to 0. The second t-test is related to the population slope term (β_1), whereby the null hypothesis states that the population slope term is equal to 0 and the associated alternative hypothesis is that the population slope term is not equal to 0. Thus, the null hypothesis states that there is no association between amount of aquaculture imported and time in the US while the alternate hypothesis states that there is an association between amount of aquaculture imported and time in the US.

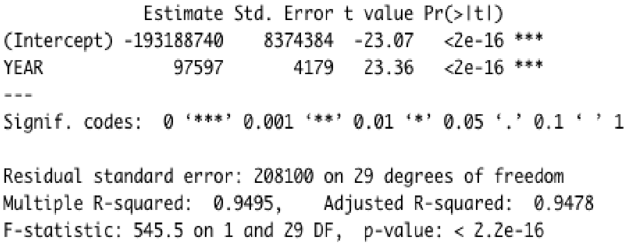
Model for Aquaculture Import in the US from 1989-2019:

1. H_0: $\beta_0 = 0$ and H_A: $\beta_0 \neq 0$
2. H_0: $\beta_1 = 0$ and H_A: $\beta_1 \neq 0$

Conditions for Simple Linear Regression

1. The population model is linear in the parameters
2. Independent observations
3. Sample variation in the explanatory variable
4. Residuals have a conditional mean of zero $E(\varepsilon | x) = 0$
5. Constant variability (homoskedasticity)
6. The error terms are normally distributed $\varepsilon \sim N(0, \sigma^2)$

Figure 2: *Regression Output for Average Aquaculture Import in the US from 1989-2019.*



```
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -193188740    8374384  -23.07   <2e-16 ***
YEAR             97597       4179   23.36   <2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 208100 on 29 degrees of freedom
Multiple R-squared:  0.9495,	Adjusted R-squared:  0.9478 
F-statistic: 545.5 on 1 and 29 DF,  p-value: < 2.2e-16
```

Results

Intercept ($\hat{\beta}_0$)

–193,188,740 is the estimated amount of import in kilograms when time is equal to 0. The estimated standard error is 8,374,784. The test-statistic is calculated assuming the null hypothesis is 0 when the independent variable (x) is equal to 0. By dividing the estimated coefficient –193,188,740 by the estimated standard error 8,374,384, the test statistic (t-value) is –23.07. The p-value indicates the probability of calculating a test- statistic as extreme or more extreme as the one calculated (–23.07) when the null hypothesis is true. Therefore, 2e-14% of the time, if the true difference is population means was 0, one would observe a test statistic as extreme or more extreme as the one calculated in favor of the null. Since 2e-14% is less than the alpha level of 0.001, the null hypothesis is rejected. The confidence interval (Appendix I) for the intercept parameter is (–223,832,075, –162,545,405) which indicates that with 99.9% certainty, the average amount of aquaculture imported in the US when time is 0 lies in the interval. Since time cannot be equal to 0, the intercept is meaningless.

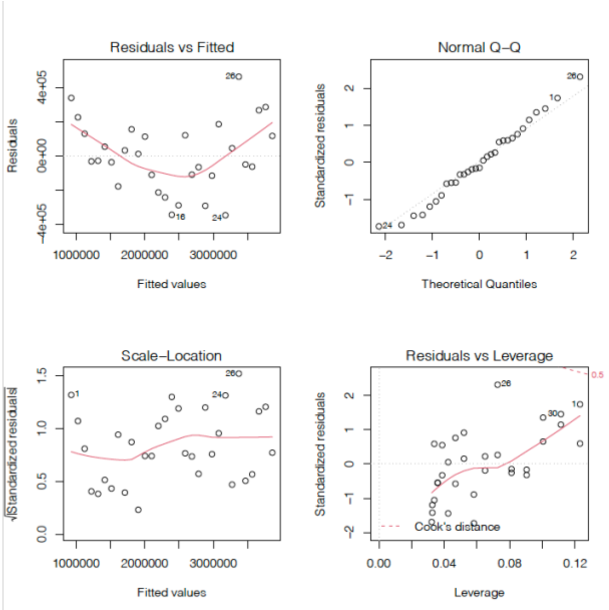
Slope ($\hat{\beta}_1$)*:*

97,597 is the change in amount of import in kilograms (kg) with a one-unit change in time. Therefore, each year is associated with a 97,597 kg increase in imports. The estimated standard error is 4,179. The test-statistic is calculated assuming the slope is equal to 0. By dividing the estimated coefficient 97,597 by the estimated standard error 4,179, the test statistic (t-value) is 23.36. The p-value indicates the probability of calculating a test-statistic as extreme or more extreme as the one calculated (23.36) when the null hypothesis is true. Therefore, 2e-14% of the time, if the true difference is population means was 0, one would observe a test statistic as extreme or more extreme as the one calculated in favor of the null. Since 2e-14% is less than the alpha level of 0.001, the null hypothesis is rejected. The confidence interval (Appendix I) for the slope parameter is (82,306.039, 112,887.961) which indicates that with 99.9% certainty, every additional one unit increase in time, the average amount of aquaculture imported in the US increases between 82,306.039 and 112,887.961 kg/year.

Since both p values are less than the significance level of 0.001, we reject the null hypothesis in both cases in favor of the alternative hypotheses. However, since time cannot be 0, the intercept term is in this analysis is meaningless. This indicates that if the amount of aquaculture imported over time are not correlated (i.e., the null hypothesis is true), the observed data points in the scatterplot would not exhibit a linear relationship. The r^2 value of 0.9495 indicates that 94.95% of the variability in the amount of aquaculture imported is explained by the linear relationship relative to time and 5.05% of the variability is unexplained or due to error. The r^2 value indicates that the relationship between the independent and dependent variable is quite strong.

Diagnostic Plot Analysis

<u>Figure 3:</u> *Diagnostic Plot for Average Aquaculture Import in the US from 1989-2019.*



Residual vs Fitted

The plot indicates approximately equally and randomly spread residuals around the horizontal line which indicates that the impact of x on y does not have a non-linear relationship. However, the slight curvature may indicate an assumed linear relationship between x and y whereby the relationship may be satisfied by a different model.

Normal Q-Q Plot

The plot indicates that the residuals are approximately normally distributed as the residuals follow the straight line and do not deviate severely.

Scale-Location

The plot indicates that the residuals are randomly and equally spread along the ranges of the predictors. The assumption of equal variance (homoscedasticity) is satisfied.

Residuals vs Leverage

The plot indicates that there are no significantly influential observations as the line for the Cook's distance is barely visible and all cases are inside the value of the Cook's distance lines. In addition to this, a second plot was observed without observations 1, 26, and 30 (Appendix II) which showed no change in the r^2 value.

Discussion

To investigate the predictability of trends in import of aquaculture products in the US, a linear regression analysis was conducted to evaluate the prediction of amount of import over time. The predictor was time (in years) and the outcome was the amount of aquaculture import (kg). The results of the analysis revealed time to be a statistically significant predictor to the model (p-value < 0.001) indicating each year is associated with a 97,597 kg increase in imports. Preliminary analyses using diagnostic plots were performed to ensure there was no significant violation of the assumptions of normality, linearity, and variance; the linear model explained approximately 94.95% of the variability. Therefore, the null hypothesis was rejected in favor of the alternative hypothesis. Predicted aquaculture imported in the US is equal to – 193,188,740 + 97,597(Time) in kilograms when time is measured in years.

However, there are number of factors that may limit the projection of trends in aquaculture import and scope of this analysis. The population of interest is aquaculture imports globally and the sample focused on trends in import in the US. Since, the analysis is an observational study, it lacks internal validity. The analysis also lacks representativeness to the population of interest due to a number of reasons. Firstly, the amount of aquaculture imported vary strongly within the region. For example, coastal states in the US may be more efficient in domestic fisheries production, therefore the amount of aquaculture import varies within the sample itself. Similarly, the sample is not applicable to the population as a result of variation in trends of import across regions. Global trends in aquaculture production are heavily reliant on the presence of capital, land, technology, and ecosystem services, hence aquaculture imports may vary based on socio-economic conditions. The availability of technology and production capacities at lower costs in developing countries can lead to differences in amounts imported in developed and developing countries. In addition to this, trends in aquaculture imported reported by the FAO indicate that the ten largest importers make up 67.5% of all imports indicating that the amounts of import are concentrated and lack global application of projections (Asche & Smith, 2010, p. 10). The growth rate of aquaculture is also subject to variation with time and regions based on availability of resources, species, and trends in the supply-demand chain whereby the model may indicate the assumed linear relationship; hence, the study is lacking in external validity in prediction of import trends. In addition to this, considering the intercept coefficient from the analysis presented when x is equal to 0, a theoretical value such as this leads one to over extrapolate beyond the range of the data. Without consideration of other variables that may affect the data, the analysis cannot present accurate measurement on the impact of x on y outside the range of the data which can also lead to differences in the functional relationship of the variables presented. Since time cannot be equal to zero, the intercept is meaningless in this analysis.

Besides regionality and socio-economic factors, the analysis may be influenced by confounding variables. For example, the species types being imported may be correlated with the dependent variable and independent variable (Appendix III) and is an example of a spurious relationship. The variability in the availability of species of interest is affected by a combination of abiotic and biotic factors, whereby individual and population interactions can vary across geographical distributions thereby influencing the amount of import available at a given time. The demand for particular import by a region is also influenced by economic feasibility and market value of products that influence imports being concentrated in some regions relative to others. In addition to this, regulations on trade and fisheries management at exclusive economic zones and their legal or illegal interactions with aquaculture production and consumption can influence import trends over time and may also indicate variability in the linearity of the relationship. The study also fails to account for all products other than fish in its definition of aquaculture products which can lead to differences in unit of measurement and discrepancies in reported trends.

Although the analysis does not seem to indicate any immediate issues with reverse causality and simultaneity, the use of time as an independent variable can present a problem with the analysis. Although the index plot does not depict a specific pattern, whereby time does not change regardless of the outcome; it may invalidate independence of the data as amount of import recorded at one particular moment may be influenced by factors in the previous year. It would be necessary to control for variables, include factors pertaining to socio-demographic, ecological, environmental indicators, and improve analyses through cross sectional studies on policies of fisheries management and aquaculture trends between developed and developing countries in order to make an accurate assessment on the predictability of the data and improve its applicability to other scenarios. Models on projection trends should include socio-economic variables of human dimensions, policies, and improve data collection and monitoring through individual, local, and regional cases in order to develop models that may be more applicable to different scenarios in aquaculture production and other sectors within the fisheries department.

Policy Recommendations

The multifunctional role of fisheries and aquaculture production and consumption in development has paved way for the need to improve analyses and policy design at local, regional, and national scales. The fisheries sector plays a vital role in the economic development, food security, employment, and livelihoods of coastal communities in least developing countries (LDCs) and other small island developing states (SIDS) (UNCTAD, 2016, p. 2). It becomes increasingly important to develop policies that address issues in fisheries production, consumption, and management in order to develop models that provide a holistic approach in understanding predictability and management of the sector. As wild fisheries level off in the production capacity, aquaculture will play an important role in filling the gap between demand and supply within and across regions globally. Thus, the development of sustainable fisheries policies and practices in production, consumption, trade, and ecosystem services are required to allow populations to recover and meet human needs across international borders.

The 2030 Agenda for Sustainable Development by the United Nations has introduced 17 Sustainable Development Goals (SDGs) whereby these interlinked goals are designed to be a “blueprint to achieve a better and more sustainable future for all” (United Nations, 2015). SDG 14 ‘Life Below Water’ prioritizes the conservation and sustainable use of oceans, seas, and marine resources for sustainable development and serves to highlight the importance of sustainable management and use of marine resources and its ecosystems and can serve as the basic foundation of policy design in the fisheries sector to ensure equitable development of the environment and the economy (UNCTAD, 2016, p. 7).

With any policy process, it is important to define targets in order to enable development of sustainable practices based on standards and criteria pertaining to particular scenarios. This addresses the global sustainability of fisheries within and across sectors. It is necessary to address market efficiency and cost internalization in policy design as aquaculture and fisheries production is essential to the economic development of many communities and human food security. This can be achieved through marketing strategies such ecolabelling to indicate sustainable production practices/standards and better interconnections between top down and bottom-up strategies to improve market access that includes traditional, and other small-scale fisheries in equitable market share and development. This emphasizes the need for a participatory form of governance that encourages multi-stakeholder participation from both developed and developing countries, to ensure creditability and improve governance of international supply chains thereby improving economic development alongside the sustainability of livelihood across governance systems. The promotion of fair and equitable access to international fisheries markets will require a better understanding of trade flows that can only be done through dictated Harmonized System of Tariffs (HST) codes for products that are produced in compliance with these standards (Valles & Eugui, 2016, p. 40).

These recommendations further stress the need to integrate social factors in order to enhance long term sustainability of the fisheries sector. Compliance with organizations such as the WTO, FAO, and environmental sector standards can enhance monitoring of responsible production and consumption, lead to transparency of policy implementation and governance systems thereby undermining distortionary effects as a result of trade malpractices. The introduction of incentives, disincentives such as implementations of preferential taxes/tariffs can level the playing field of a competitive market and facilitate wider acceptance and transition into sustainable market practices across the sector (Valles & Eugui, 2016, p. 40).

In addition to market-based policies, other practices that encourage ecosystem wide management will become an important secondary step in ensuring the recovery and restoration of ecosystem services alongside economic benefits. These considerations will not only be important for those developing countries that are on the rise in dominating aquaculture exports, but also the consumers in developed countries in order to better monitor efficiency consequences of trade in fisheries. Therefore, in order for fisheries to meet growing human needs for the future, it is necessary to cultivate successful management that emphasizes conservation-based fisheries rights with support for legally enforced and tested harvest strategies in its path to sustainable development that enhances economic, environmental, and social benefits.

REFERENCES

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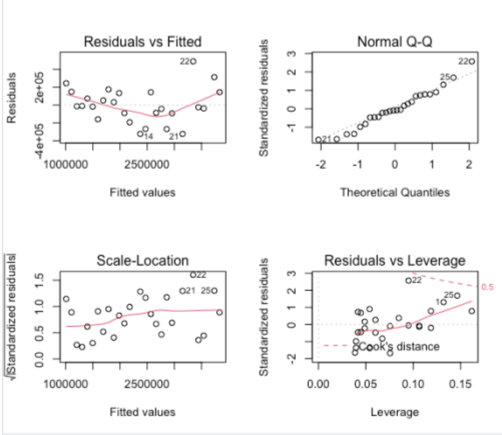
DATASET

- Economic Research Service United States Department of Agriculture. 2020. Aquaculture Data. [ONLINE] Available at: https://www.ers.usda.gov/data-products/aquaculture-data/. [Accessed 10 December 2020].

APPENDIX

I. Methodology for calculating confidence intervals: Sample estimate ± (t-multiplier × standard error)

II. Diagnostic Plot for Average Aquaculture Imports without observations 1, 26, 30



The Residuals vs Leverage plot indicates that the removal of observations 1, 26, 30 did not influence the data significantly as the values remain within the lines for the Cook’s Distance with no change in the r^2 value.

III. Regression Analysis for all observations of aquaculture imported from 1989-2019 in the US.

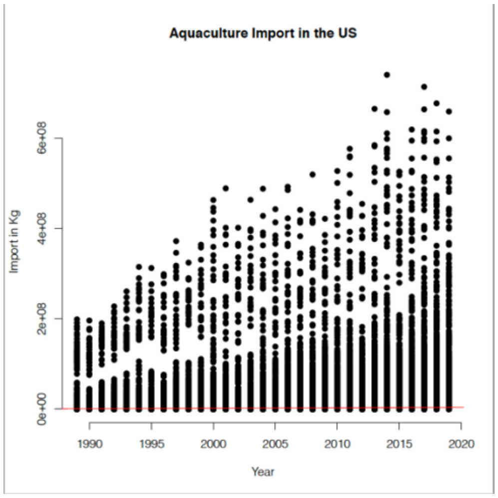
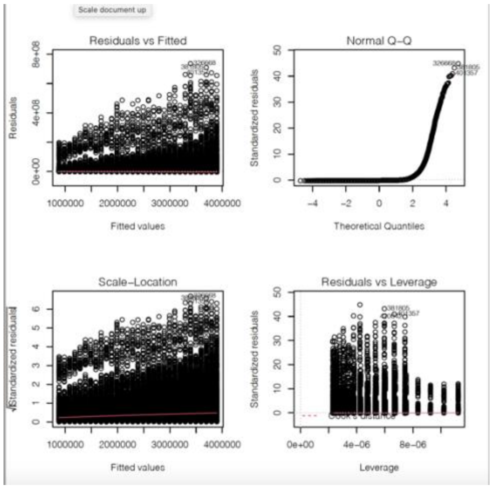
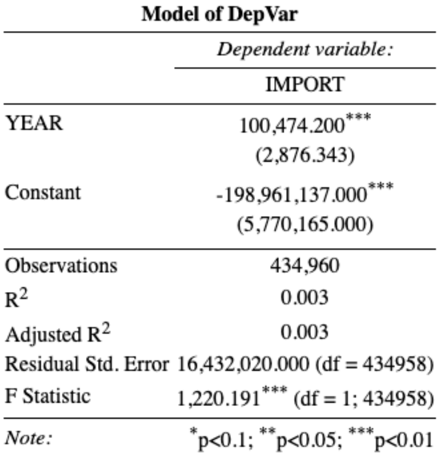


Figure 3: *Aquaculture Imported in the US from 1989-2019 for all observations per year.*

Figure 4: *Regression Output and Diagnostic Plots for all observations of aquaculture imported from 1989-2019*





Model of DepVar

	Dependent variable:
	IMPORT
YEAR	100,474.200***
	(2,876.343)
Constant	-198,961,137.000***
	(5,770,165.000)
Observations	434,960
R^2	0.003
Adjusted R^2	0.003
Residual Std. Error	16,432,020.000 (df = 434958)
F Statistic	1,220.191*** (df = 1; 434958)
Note:	*p<0.1; **p<0.05; ***p<0.01

Regression Output Analysis for Figure 4

The regression output indicates only 0.3% of the variability in the amount of aquaculture imported is explained by the linear relationship. The residuals vs fitted plot indicates variance of residuals increasing with the x variable thereby violating the assumption of variance (homoscedasticity). The curvature of the normal QQ and residuals vs leverage plots indicate the presence of extreme values which results in a skew of the distribution and violation of the data to be approximately normally distributed. This may be indicative of a variety of products imported and exhibit how some products may be at more of a demand than others within and across states in the United States and is subject to variation with time. As a result, the regression line indicated in red (Figure 3) is flat at 0 along the x axis and indicates that the model does not have the ability to predict amount of aquaculture imported over time and presents a non-linear relationship.

IV. R CODE APPENDIX

```
##############
#Final Project: Trends in Aquaculture Import in the US
#SMEA 584
#Fall 2020
##############
library(plyr)
library(here)
library(tidyverse)
library(stargazer)
library(ggResidpanel)
library(ggmosaic)

#DATASETS
dat <- read_csv(here("data", "Viswanathan_Data1.csv"))
dat1 <- read_csv(here("data", "Viswanathan_Data2.csv"))
dat2 <- read_csv(here("data", "Viswanathan_Data3.csv")) #Average Imports without potential outliers

##############
#Summary Statistics I
#Summary Statistics of Aquaculture Import in the US for all observations from 1989-2019
##############
stargazer(as.data.frame(dat),
        digits = 2,
        summary.stat = c("mean", "sd", "median", "n"),
        title = "Summary Statistics of Aquaculture Import in the US from 1989-2019",
        out = here("output", "ImportStats.htm"))

##############
#Summary Statistics II
#Aquaculture Import per Year in the US from 1989-2019
##############
head(dat)
aggregate (IMPORT~YEAR, data=dat, mean)
mystat <- function(x){
  tab <- c(mean=mean(x), sd=sd(x))
  return(tab)
}
aggregate(IMPORT~YEAR, data=dat,mystat)

library(plyr)
ddply(dat,.(YEAR),summarize,
     mean=mean(IMPORT),
     sd=sd(IMPORT),
     median=median(IMPORT),
     N=n())


##############
```

```
#Visualization
#Average Aquaculture Import in the US from 1989-2019
##############
xdata<- c(1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001,
          2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014,
          2015, 2016, 2017, 2018, 2019)
y1<- c(1270137.948, 1254258.183, 1256076.729, 1191419.045, 1292501.122, 1472370.738, 1479180.259,
1435123.865, 1743707.717,
       1964460.979, 1918297.192, 2117142.896, 1990464.731, 1985152.262, 2053785.627, 2049554.444,
2202845.926, 2710671.873,
       2577260.294, 2718998.669, 2590258.304, 2864024.912, 3263431.875, 2827630.513, 3318221.524,
3834440.685, 3417873.098,
       3502613.115, 3930925.413, 4046948.764, 3975521.712)
pdf(here("output", "AverageFishImport.pdf"))
plot(xdata, y1, main = "Average Aquaculture Import in the US",
    xlab = "Year", ylab = "Amount in Kg",
    pch = 19, frame = FALSE)
abline(lm(IMPORT ~ YEAR, data = dat1), col = "red")
dev.off()

##############
#Regression Analysis
#Average Aquaculture Import per Year in the US from 1989-2019
##############
lm1 <- lm(IMPORT ~ YEAR, data = dat1)
stargazer(lm1,
          digits = 3,
          title = "Model of DepVar",
          out = here("output", "AverageImportRegResults.html"))
summary(lm1)
#Diagnostic Plot
pdf(here("output", "AverageImportDiagnostics.pdf"))
par(mfrow=c(2,2)) # Change the panel layout to 2 x 2
plot(lm1)
par(mfrow=c(1,1)) # Change back to 1 x 1
dev.off()

#Average Import without extreme data points (APPENDIX II)
lm2 <- lm(IMPORT ~ YEAR, data = dat2)
stargazer(lm2,
          digits = 3,
          title = "Model of DepVar",
          out = here("output", "AverageImportIIRegResults.html"))
#Diagnostic Plot
pdf(here("output", "AverageImportIIDiagnostics.pdf"))
par(mfrow=c(2,2)) # Change the panel layout to 2 x 2
plot(lm2)
par(mfrow=c(1,1)) # Change back to 1 x 1
dev.off()
```

```r
##############
#Visualization (APPENDIX III)
#Aquaculture Imports in the US from 1989-2019 for all observations
##############
reg1 <- lm(IMPORT~YEAR,data=dat)
summary(reg1)

with(dat,plot(YEAR, IMPORT))
abline(reg1)

pdf(here("output", "FishtImport.pdf"))
plot(dat$YEAR, dat$IMPORT, main = "Aquaculture Import in the US",
    xlab = "Year", ylab = "Import in Kg",
    pch = 19, frame = FALSE)
abline(lm(IMPORT ~ YEAR, data = dat), col = "red")
dev.off()

##############
#Regression Analysis (APPENDIX III)
#Regression Output and Diagnostic Plots for all observations of aquaculture imported from 1989-2019
##############
lm3 <- lm(IMPORT ~ YEAR, data = dat)
stargazer(lm3,
        digits = 3,
        title = "Model of DepVar",
        out = here("output", "FishImportRegResults.html"))
#Diagnostic Plot
pdf(here("output", "FishImportDiagnostics.pdf"))
par(mfrow=c(2,2)) # Change the panel layout to 2 x 2
plot(lm3)
par(mfrow=c(1,1)) # Change back to 1 x 1
dev.off()
```