# Terrorist Acts and Arts Market Analysis

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## Motivation

The National Counterterrorism Center (NCTC) is a United States government organization responsible for national and international counterterrorism efforts. Their mission is to lead the nation's effort to protect the United States from terrorism by integrating, analyzing, and sharing information to drive whole-of-government action and achieve national counterterrorism objectives. Our team was tasked with finding out if terrorist actors use the global arts and antiquities markets as part of their terrorist financing cycle.

## Data and Materials

To find significance between terrorist attacks and the art market, the following data was gathered from publicly available sources:

1. Global Terrorism Database is an open-source database that includes information on terrorist events around the world. From this source we gathered a dataset containing all terrorist attacks from 1970 to 2021.
2. Christie's is the world's biggest art house in terms of lots sold, and archives of past art auctions. These past auctions were scraped, creating a dataset of more than 10,000 art sales mainly coming from London, Hong Kong, and New York.
3. Consumer Confidence index, unemployment rates, and GDP for each country was gathered from the OECD database.

## Methodology

-For the first model, logged art sales were used as a dependent variable and terrorist attacks as an independent variable. For Model 1, Christie's data was utilized and a SARIMAX (0,1,1) x (1,0,0,12) model was ran. The team used the natural log of top terroristic acts with dates offset by 1 months, 2 months, and 3 months.

-For the second model, the dependent and independent variables were reversed. The team fit an ARIMAX(0,1,1) model on monthly terrorist acts. Like in the first model, this model was ran three times: one for each of three-month offsets.

- For the Bayesian model, the team set the prior assumptions as the mean of the art sales and terrorist attacks and then created a model that would place sampled data on either end of a switch point in the form of an exponential distribution. The data was sample to create two distributions, one on each side of the switch point, and calculated a tau value that would be used to determine the point(s) with the highest probability of the switch occurring.

## Results

For each model, we chose the one with the best results out of the three month-offset iterations.

**Model 1 (2-Month Offset):**

SARIMAX Results

| | | | |
|---|---|---|---|
| Dep. Variable: | Sales | No. Observations: | 240 |
| Model: | SARIMAX(0, 1, 1)x(1, 0, [], 12) | Log Likelihood | -155.465 |
| Date: | Tue, 06 Dec 2022 | AIC | 320.930 |
| Time: | 23:01:57 | BIC | 338.312 |
| Sample: | 01-01-2000 | HQIC | 327.934 |
| | - 12-01-2019 | | |
| Covariance Type: | opg | | |

| | coef | std err | z | P>\|z\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| CCI | 8.3403 | 3.055 | 2.730 | 0.006 | 2.352 | 14.329 |
| Attacks | 0.0520 | 0.056 | 0.931 | 0.352 | -0.057 | 0.161 |
| ma.L1 | -0.9824 | 0.014 | -71.495 | 0.000 | -1.009 | -0.955 |
| ar.S.L12 | 0.8619 | 0.028 | 30.788 | 0.000 | 0.807 | 0.917 |
| sigma2 | 0.2000 | 0.011 | 18.123 | 0.000 | 0.178 | 0.222 |

| | | | |
|---|---|---|---|
| Ljung-Box (L1) (Q): | 1.81 | Jarque-Bera (JB): | 368.12 |
| Prob(Q): | 0.18 | Prob(JB): | 0.00 |
| Heteroskedasticity (H): | 1.05 | Skew: | -0.48 |
| Prob(H) (two-sided): | 0.83 | Kurtosis: | 9.00 |

**Model 2 (2-Month Offset):**

SARIMAX Results

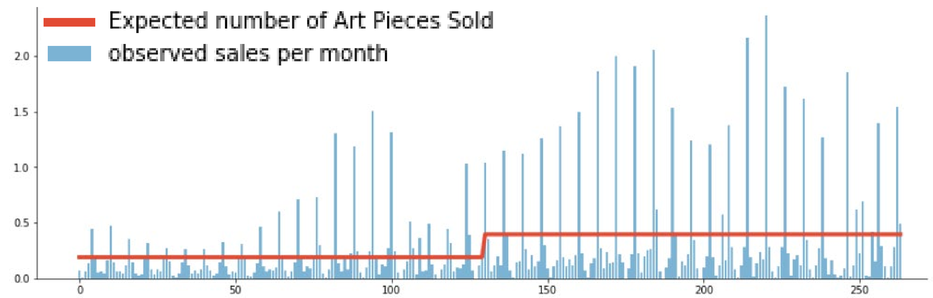
| | | | |
|---|---|---|---|
| Dep. Variable: | Attacks | No. Observations: | 144 |
| Model: | SARIMAX(0, 1, 1) | Log Likelihood | -729.039 |
| Date: | Tue, 06 Dec 2022 | AIC | 1464.077 |
| Time: | 23:43:36 | BIC | 1472.966 |
| Sample: | 01-01-2008 | HQIC | 1467.689 |
| | - 12-01-2019 | | |
| Covariance Type: | opg | | |

| | coef | std err | z | P>\|z\| | [0.025 | 0.975] |
|---|---|---|---|---|---|---|
| Sales | 5.2057 | 2.756 | 1.889 | 0.059 | -0.195 | 10.606 |
| ma.L1 | -0.4688 | 0.080 | -5.852 | 0.000 | -0.626 | -0.312 |
| sigma2 | 1566.8517 | 167.075 | 9.378 | 0.000 | 1239.390 | 1894.313 |

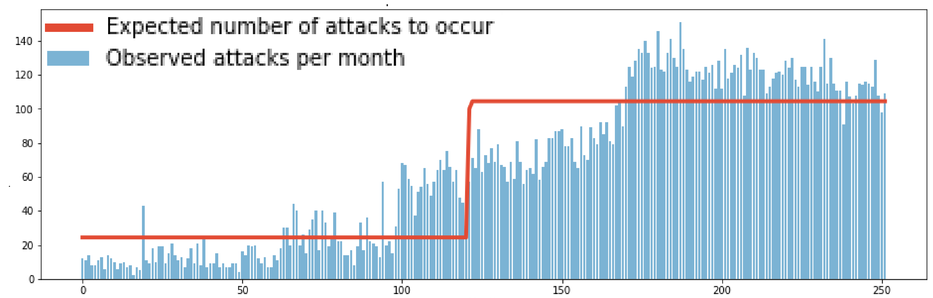
| | | | |
|---|---|---|---|
| Ljung-Box (L1) (Q): | 0.19 | Jarque-Bera (JB): | 2.77 |
| Prob(Q): | 0.66 | Prob(JB): | 0.25 |
| Heteroskedasticity (H): | 2.68 | Skew: | 0.26 |
| Prob(H) (two-sided): | 0.00 | Kurtosis: | 3.43 |

## Bayesian Analysis

Number of Art Pieces Sold (1/1/2000 – 12/31/2020)




Number of Attacks That Have Occurred (1/1/2000 – 12/31/2020)




## Conclusion

While the analysis shows a combination of mirrored trends and an insignificant relationship between art sales and terrorist activity, the relationship between the two becomes weaker as additional variables are incorporated into the analysis. Even though these variables have nearly significant coefficients at a 2-month offset, the team believes that the dataset is not a 100% accurate representation of the larger global population. Therefore, the team believes that the results should be interpreted as while there is a positive correlation between art sales and terrorist activity, there is no significant direct relationship between the two. It could be the case that there are external variables that affect both art sales and terrorist attacks in a similar manner.

## Restrictions/Limitations

Currently, open-source art sales data is difficult to acquire. Auction houses do not publicly report their sales to a centralized organization. Without purchasing data, the only option was to scrape it. This proved to be a challenge as the team never felt the dataset was large enough to represent the global art market and collecting that much data was out of the project's scope and timeframe.

Terrorist groups usually launder their art/antiquities through middlemen and private channels. This makes it difficult to gather data that may incriminate them.