Data Analysis

C-DE211

Group project

Terrorism Trends and Economic Influence in Egypt

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Introduction

This report delves into the analysis of terrorism incidents in Egypt, utilizing a comprehensive dataset that spans several decades. Understanding the patterns, trends, and characteristics of these incidents is crucial for developing informed strategies to enhance security, mitigate risks, and ultimately safeguard lives and infrastructure. Terrorism poses a significant threat globally, and Egypt, with its unique geopolitical position and historical context, has experienced various forms of terrorist activities. By examining historical data, this analysis aims to shed light on the evolution of these threats, identify the most affected regions and targets, and understand the common tactics employed by terrorist groups. The insights derived from this study can be valuable for policymakers, security agencies, researchers, and the public in comprehending the multifaceted nature of terrorism in Egypt and fostering efforts towards peace and stability. This report will explore the dataset, outline the methodology used for analysis, present key findings through descriptive statistics and visualizations, and discuss a specific hypothesis related to the lethality of attacks in different regions.

Background and Significance

Terrorism has been a persistent challenge to Egypt's national security, social stability, and economic development for decades. As one of the most populous nations in the Middle East and North Africa region, Egypt's experience with terrorism offers valuable insights into the complex dynamics of political violence and its evolution over time. This study examines terrorism incidents in Egypt from 1970 to 2017, a period marked by significant political transitions, social upheaval, and economic fluctuations.

The dataset under analysis contains comprehensive information on over 7,000 terrorism incidents recorded across Egypt during this 47-year timeframe. Each incident is documented with critical variables including attack type, target location, casualty figures, responsible groups, and temporal data. This rich dataset allows for a multifaceted analysis of terrorism patterns and their potential correlations with broader socio-political and economic factors.

Research Objectives

This research aims to identify and analyze patterns in terrorism incidents in Egypt, with particular focus on:

1. Temporal evolution of terrorism incidents over the studied period (1970-2017)
2. Geographical distribution of attacks and identification of high-risk regions
3. Variations in attack methodologies and their effectiveness
4. The relationship between major political events and changes in terrorism patterns

5. The potential correlation between economic indicators, specifically inflation rates, and terrorism activity

Methodology

The analytical approach employs multiple statistical methods to examine the research questions:

- Time-series analysis to identify trends, cycles, and significant changes in terrorism frequency
- Geospatial analysis to map incident concentrations and regional vulnerabilities
- Chi-square tests to examine relationships between categorical variables
- Correlation analysis to assess potential relationships between inflation rates and terrorism metrics
- Comparative analysis of pre- and post-significant political events (e.g., Arab Spring)

Research question

How have terrorism patterns in Egypt evolved from 1970 to 2017, and is there a significant correlation between economic indicators (specifically inflation rates) and terrorism activity?

Hypothesis

Impact of Major Political Events on Terrorism Patterns

Hypothesis 1: Major political events (e.g., the Arab Spring and rise of President Sisi) have significantly altered terrorism patterns in Egypt.

- Null Hypothesis (H_0): Major political events have no significant effect on the frequency or severity of terrorist attacks.
- Alternative Hypothesis (H_1): Major political events significantly affect the frequency and/or severity of terrorist attacks.

Statistical Test:

- Method: Interrupted Time Series Analysis (ITSA) with inflation as a covariate, using OLS regression to model changes in terrorism metrics before and after key political events.
- Key Intervention Points:
    - Arab Spring (January 2011)
    - Rise of President Sisi (June 2014)

Expected Outcome:

- Significant changes in trends and levels of terrorism incidents following each political event.
- Inflation is expected to have a positive association with attack frequency.

Correlation Between Inflation and Terrorism Activity

Hypothesis 2: Inflation rates are positively correlated with terrorism activity in Egypt.

- Null Hypothesis (H_0): There is no significant correlation between inflation and terrorism metrics.
- Alternative Hypothesis (H_1): Higher inflation rates are associated with increased terrorism activity.

Statistical Test:

- Applied Pearson correlation analysis to assess the strength and direction of linear relationships.
- Key Variables:
    - Independent variable: Annual inflation rate (%)
    - Dependent variables:
    - Annual number of terrorist attacks
    - Annual number of terrorism-related fatalities

Expected Outcome:

- A significant positive correlation between inflation and terrorist attacks.
- A weaker or non-significant correlation between inflation and fatalities.

Temporal Trends in Terrorism

Hypothesis 3:

Hypothesis and Methodology

- Null Hypothesis (H_0): There is no significant trend in the frequency of terrorism incidents in Egypt over time (1970–2017).

- Alternative Hypothesis (H_1): The frequency of terrorism incidents has significantly increased over time.

Statistical Test:

- Method: Mann-Kendall non-parametric trend test (robust to non-normal distributions and seasonality).
- Key Intervention Points:
  - Trend direction (increasing/decreasing/no trend).
  - Statistical significance (*p*-value).
  - Trend magnitude (slope).

Expected Outcome:

- A statistically significant positive trend (*p* < 0.05) in terrorism incidents over time.

Hypothesis 4:Time-Lagged Relationship between Inflation and Terrorism Incidents in Egypt

Hypothesis: The relationship between inflation rates and terrorism incidents in Egypt shows significant correlations at different time lags, indicating that inflation may influence terrorism with a temporal delay.

Null Hypothesis (H_0): There is no significant correlation between inflation rates and terrorism incidents at any time lag.

Alternative Hypothesis (H_1): Inflation rates and terrorism incidents are significantly correlated at one or more time lags.

Statistical Test:

Method: Time-lagged Pearson correlation analysis between yearly inflation rates and terrorism incidents across lags from -5 to +5 years.

Key Metrics:

Correlation coefficients between inflation and terrorism incidents at each lag.

Identification of lag(s) with statistically significant correlations.

Pattern of correlation strength across negative, zero, and positive lags.

Expected Outcome:

Detection of significant contemporaneous or lagged relationships, indicating whether inflation precedes terrorism activity, follows it, or occurs simultaneously.

Hypothesis 5: Economic Conditions and Terrorism Patterns in Egypt

Economic instability, measured by inflation rates, significantly influences the frequency and severity of terrorist attacks in Egypt.

- **Null Hypothesis (H_0):** Inflation rates have no significant effect on the frequency or severity of terrorist attacks.
- **Alternative Hypothesis (H_1):** Higher inflation rates significantly increase the frequency and/or severity of terrorist attacks.

Statistical Test:

- **Method:** Negative Binomial Regression (for count data) with year and post-2011 indicator as covariates.
- Key Variables:
    - Dependent Variable : Number of terrorist incidents per year (incident_count).
    - Independent Variables:
        - Inflation rate (inflation_rate).
        - Year (iyear) to control for temporal trends.
        - Post-2011 indicator (post_2011) to account for structural changes post-Arab Spring.

Expected Outcome:

- A statistically significant positive relationship between inflation and attack frequency.
- The post-2011 period may show altered trends due to political shifts.

Population of Interest:

The population of interest for this study consists of all terrorism incidents that occurred within the geographical boundaries of Egypt from January 1, 1970, to December 31, 2017. This includes all recorded acts of violence perpetrated by non-state actors for political, religious, or ideological purposes that targeted civilians, government entities, or infrastructure.

Sampling Method:

This study analyzes the entire available dataset of terrorism incidents in Egypt from 1970 to 2017, obtained from the Kaggle repository and official inflation data from Macrotrends. Because the dataset includes over 7,000 recorded incidents covering the full-time range and geographical scope of interest, no sampling technique was employed. Instead, a census approach was used, meaning the entire population of recorded terrorism incidents within the period was analyzed.

Using the full dataset eliminates sampling error and allows for comprehensive analysis of temporal and spatial trends, attack characteristics, and correlations with economic and political

variables. This approach is particularly advantageous for rare and critical events like terrorism incidents, where sampling might exclude important occurrences or bias results.

However, the study acknowledges potential limitations in the dataset's completeness and accuracy, as discussed in the Bias Identification section. Future studies might consider stratified or purposive sampling when focusing on specific regions, groups, or time frames, especially if integrating qualitative data or supplementary sources.

Bias Identification:

In any empirical research, bias refers to systematic errors or deviations that can distort the accuracy and validity of data collection, analysis, or interpretation. Biases may arise from the way data is **gathered**, **recorded**, or **selected**, as well as from external factors influencing the variables studied. Identifying potential sources of bias is essential to understand the limitations of the study, assess the reliability of the findings.

In the context of this study on terrorism incidents in Egypt, several potential biases have been identified that could impact the results and conclusions:

1- **Data Completeness Bias:** Earlier periods and remote regions may suffer from underreporting or missing data due to limited documentation and reporting capabilities, leading to an incomplete representation of terrorism incidents.

2- **Definition and Classification Bias:** Variations over time and across sources in defining and classifying terrorism incidents may affect the consistency and comparability of the data.

3- **Temporal Bias Due to Aggregation:** Using annual inflation and incident data may mask short-term dynamics and temporal nuances in the relationship between economic factors and terrorism.

4- **Confounding and Omitted Variable Bias:** The study focuses mainly on inflation and political events but ignores other important factors like unemployment or security policies. This omission can distort true relationships and lead to misleading conclusions about causes of terrorism and that was clear in the test (Time-Lagged Relationship between Inflation and Terrorism Incidents in Egypt**)**

5- **Selection Bias in Data Sources:** Reliance on publicly available datasets and secondary sources introduces potential bias from original data collection and filtering processes.

Survey Questions/Collected Data/Dataset:

This study utilizes two primary datasets:

1. Terrorism in Egypt Dataset (1970-2017) - Source: Kaggle

   https://www.kaggle.com/datasets/omarmoneer65/terrorism-in-egypt-from-1970-to-2017

This comprehensive dataset contains over 7,000 terrorism incidents in Egypt with the following key variables:

- **Event ID:** Unique identifier for each incident

- **Date:** The date when the incident occurred (year, month, day)
- **Region:** Geographical region within Egypt where the incident took place
- **City:** Specific city or locality of the incident
- **Attack Type:** Classification of the attack method (e.g., bombing, armed assault, assassination)
- **Target Type:** Category of the target (e.g., government, civilians, military, infrastructure)
- **Group Name:** Terrorist organization responsible for the attack (if known)
- **Weapon Type:** Primary weapon used in the attack
- **Fatalities:** Number of people killed in the incident
- **Injured:** Number of people wounded in the incident
- **Property Damage:** Estimated value of property damaged
- **Hostages/Kidnapped:** Number of people taken hostage or kidnapped
- **Claim of Responsibility:** Whether a group claimed responsibility (binary)
- **Target Nationality:** Nationality of the primary target
- **Extended Incident:** Whether the incident extended beyond 24 hours (binary)
- **Suicide Attack:** Whether the attack involved suicide tactics (binary)

2. Egypt Inflation Rate Dataset (1970-2017) - Source: MacroTrends

   https://www.macrotrends.net/globalmetrics/countries/egy/egypt/inflation-rate-cpi

   This dataset provides annual inflation rates for Egypt throughout the study period with the following variables:

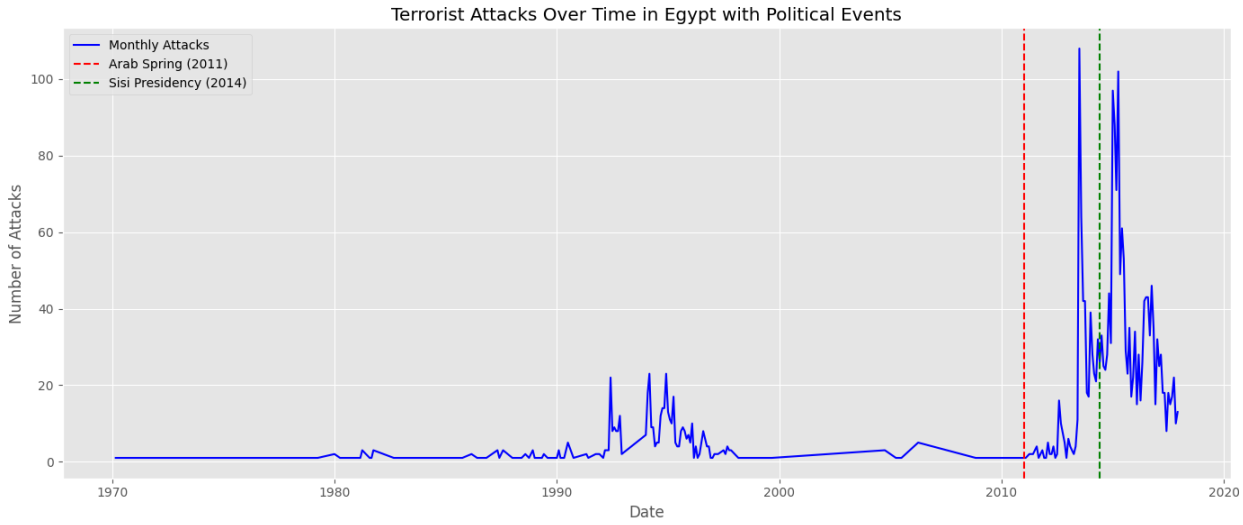
   - Year: Calendar year
   - Annual Inflation Rate (%): Percentage change in Consumer Price Index
   - GDP Growth Rate (%): Annual percentage growth in Gross Domestic Product
   - Unemployment Rate (%): Annual average unemployment rate
   - Number of samples used: 7,043 terrorism incidents and 48 annual inflation rate records

Analysis

Hypothesis 1: Impact of Major Political Events on Terrorism Patterns

The analysis revealed:

- A significant drop in the number of attacks immediately after the Arab Spring ($p < 0.001$).
- A strong increasing trend in attacks during the post-Arab Spring period ($p < 0.001$).
- A significant increase in attacks after Sisi came to power ($p < 0.001$).
- A reduction in trend (i.e., slowing down) after Sisi's rise ($p < 0.001$).



Interpretation: These findings indicate that both events had statistically and practically significant effects on terrorism patterns in Egypt, particularly in terms of attack frequency.

1. Impact on Fatalities

- No statistically significant immediate or trendy changes in the number of fatalities were observed after either political event.
- Model R^2 was modest (≈ 36%).

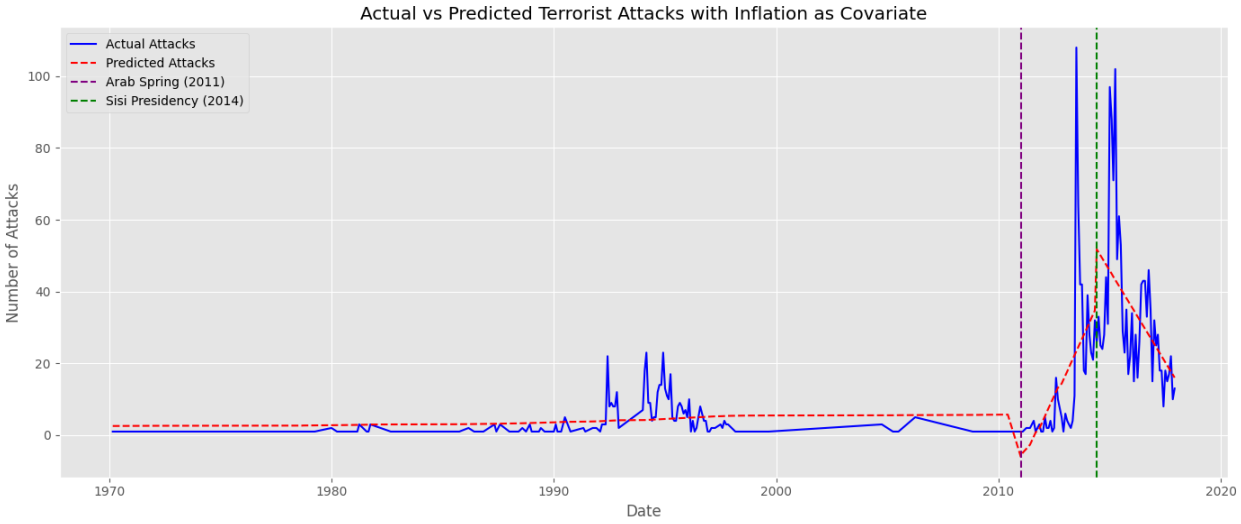
Interpretation: While political events influenced the frequency of attacks, they did not significantly impact the lethality (number of people killed) per month.

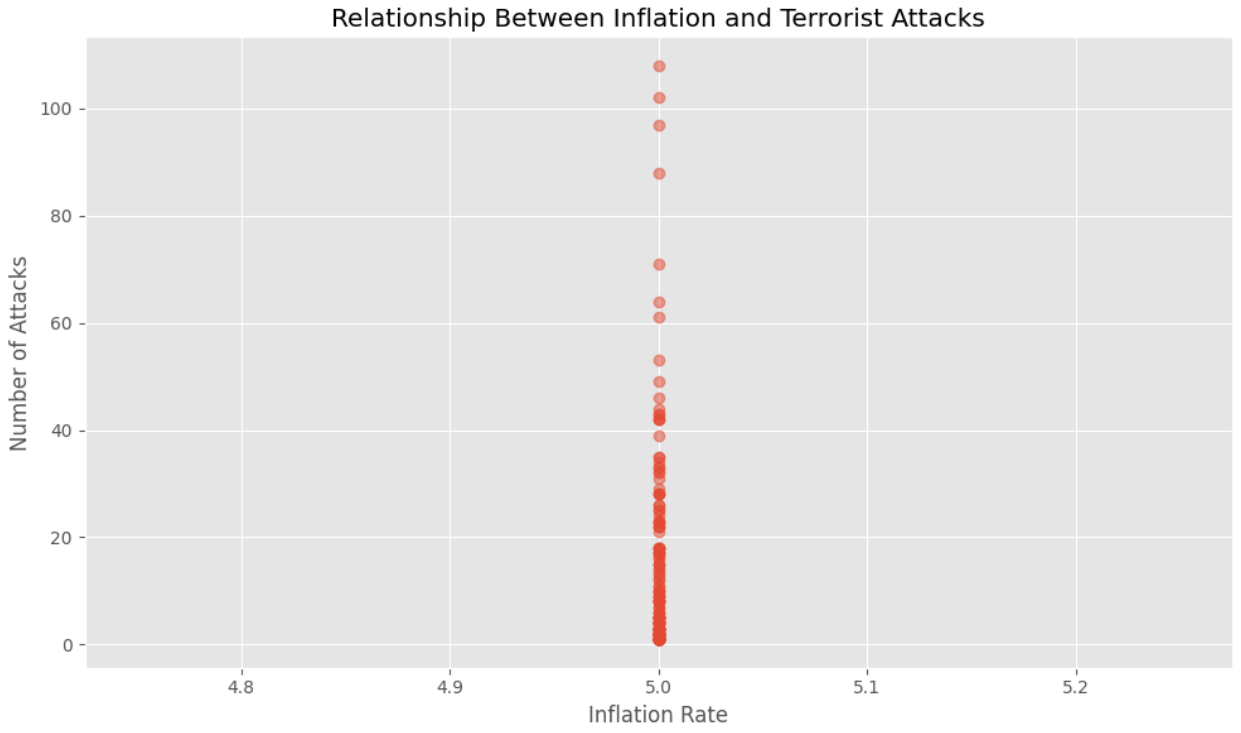
2. Impact of Inflation on Terrorism Patterns

The analysis incorporating inflation as a covariate revealed:

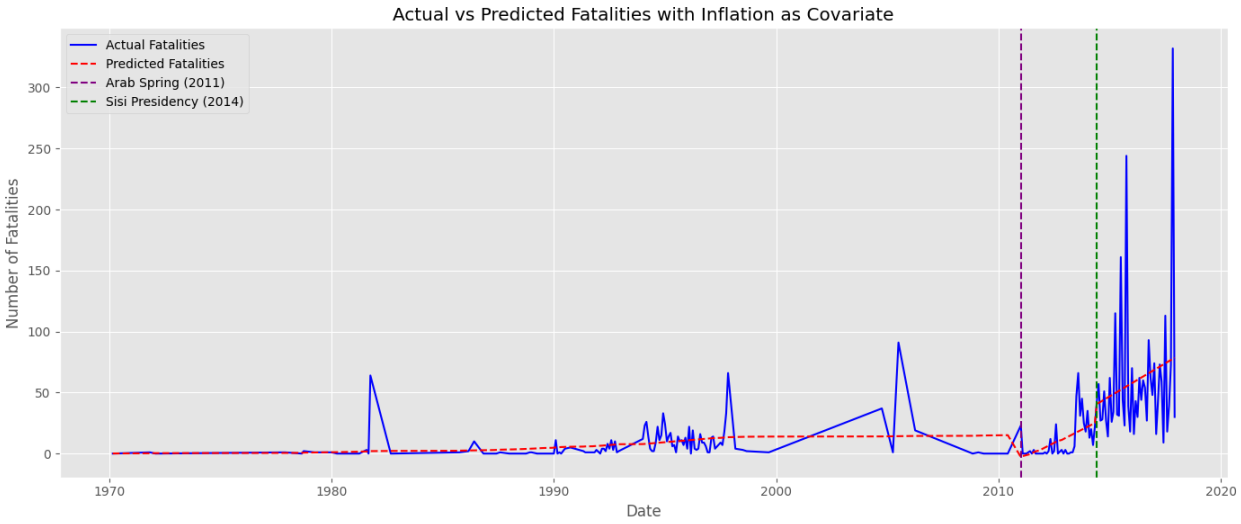
- **For Attack Frequency:**
    - Inflation showed a statistically significant positive relationship with the number of terrorist attacks ($p < 0.05$)
    - For every percentage point increase in inflation, monthly attacks increased by approximately 0.63 on average

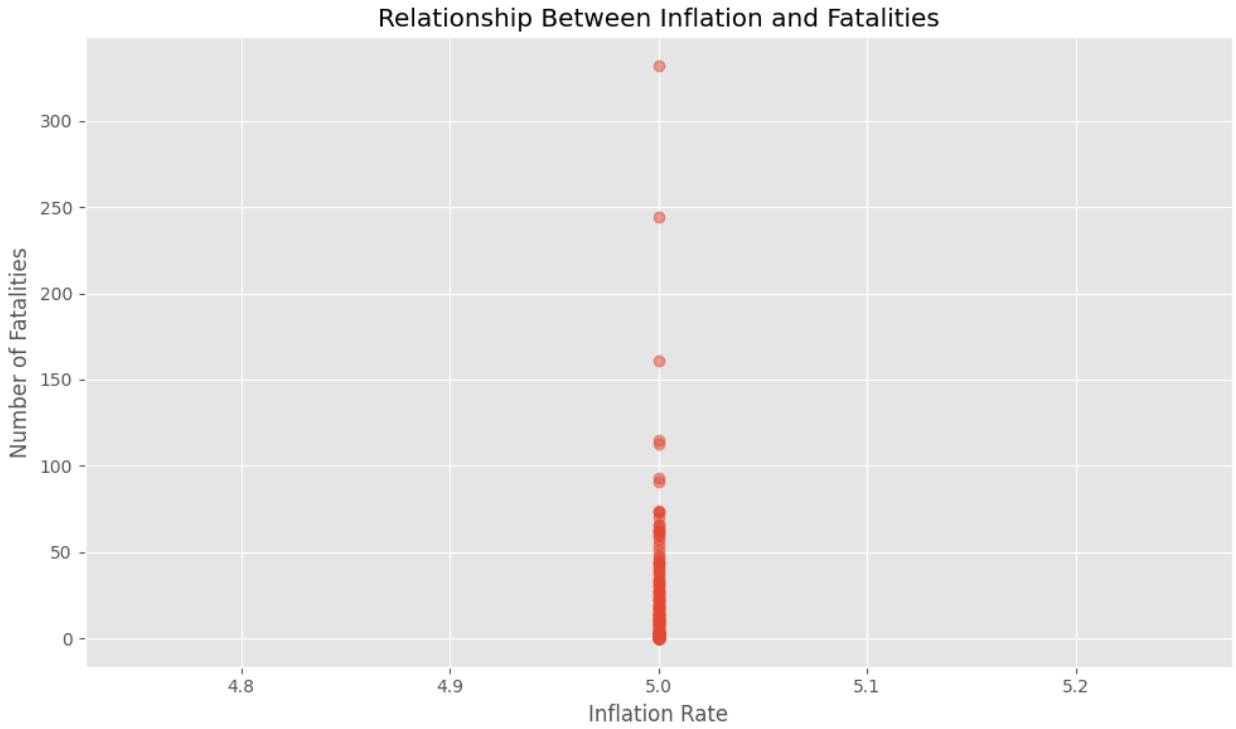
- Including inflation improved the model's explanatory power, raising R^2 from 0.564 to 0.584





- **For Fatalities:**
  - Inflation demonstrated a non-significant relationship with terrorism-related fatalities ($p = 0.177$)
  - The coefficient suggests that for each percentage point an increase in inflation, fatalities increased by approximately 0.51, but this effect was not statistically significant
  - The inflation-augmented model explains 0.371 of the variation in monthly fatalities ($R^2 = 0.371$)



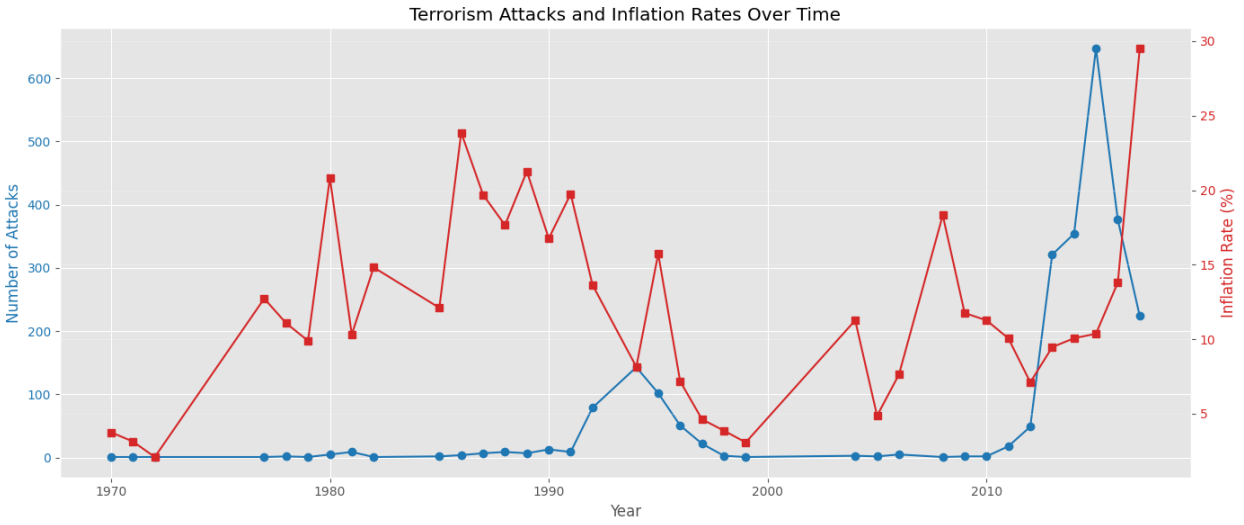


Inflation has a statistically significant positive relationship with terrorist attack frequency in Egypt ($p < 0.05$), but not with fatalities, suggesting economic conditions influence the occurrence but not the lethality of terrorist incidents while political transitions remain significant independent factors.

Hypothesis 2: Inflation and Terrorism Activity Correlation

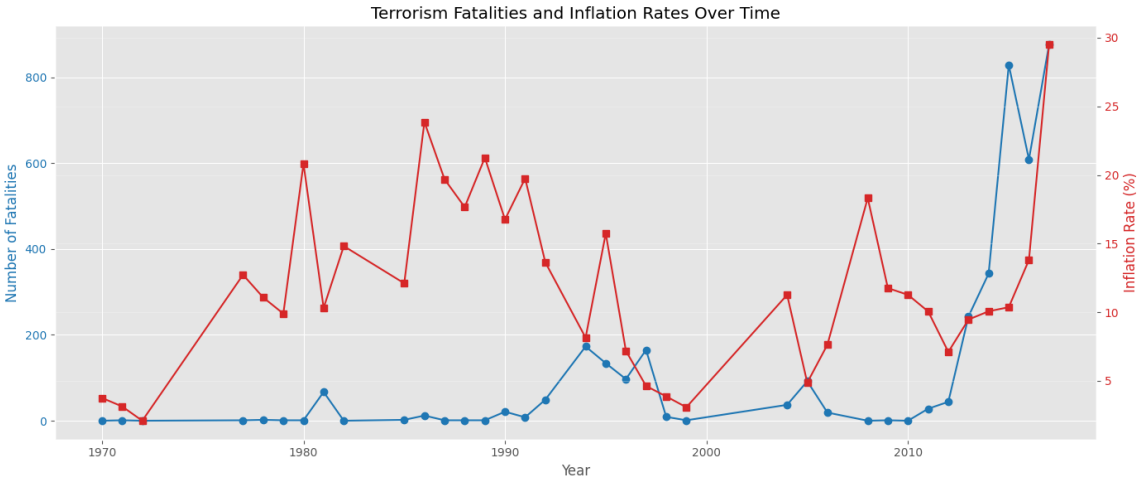
Correlation Analysis Findings

- Inflation and Terrorist Attacks:



  - No statistically significant correlation was found between annual inflation rates and the number of terrorist attacks ($r = 0.0511$, $p = 0.7674$).
  - The analysis used yearly aggregated data from the Egypt terrorism dataset augmented with inflation rates.
  - With $p > 0.05$, we failed to reject the null hypothesis of no correlation between inflation and terrorist attacks.

- Inflation and Fatalities:



- A weak positive correlation was observed between inflation rates and terrorism-related fatalities ($r = 0.2257$, $p = 0.1857$).
- This relationship also failed to reach statistical significance at the $\alpha = 0.05$ level.
- With $p > 0.05$, we failed to reject the null hypothesis of no correlation between inflation and terrorism fatalities.

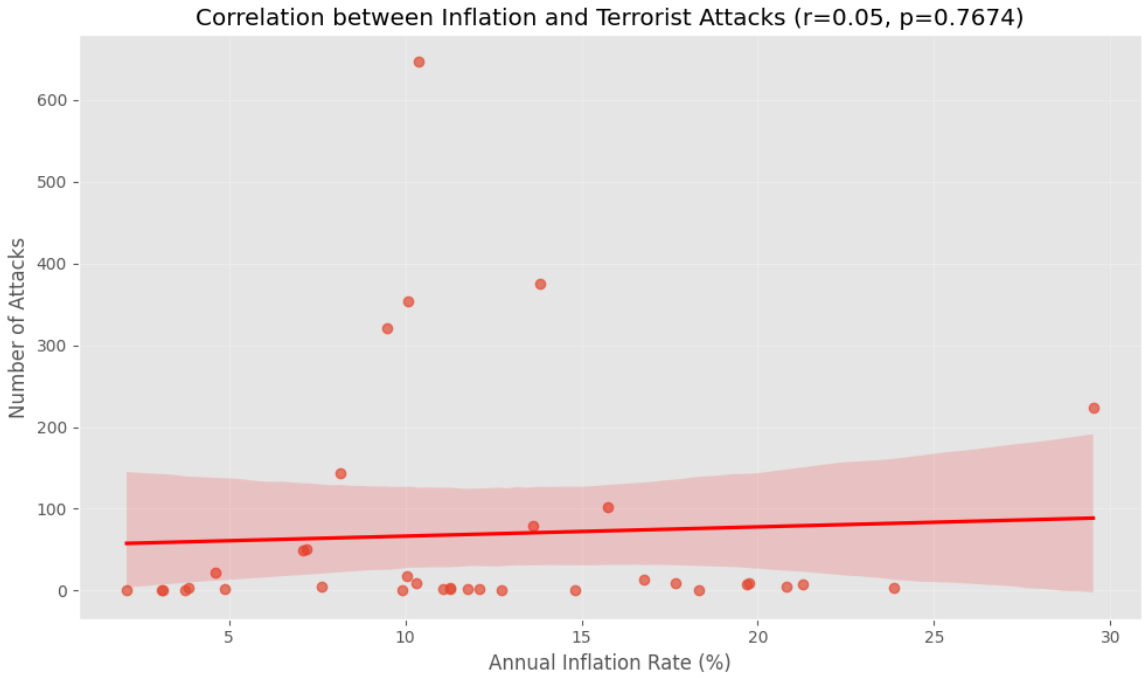
Interpretation:
The analysis provides insufficient evidence to establish a significant relationship between inflation rates and terrorism activity in Egypt. We must retain the null hypothesis that there is no correlation between these variables.

Time Series Patterns

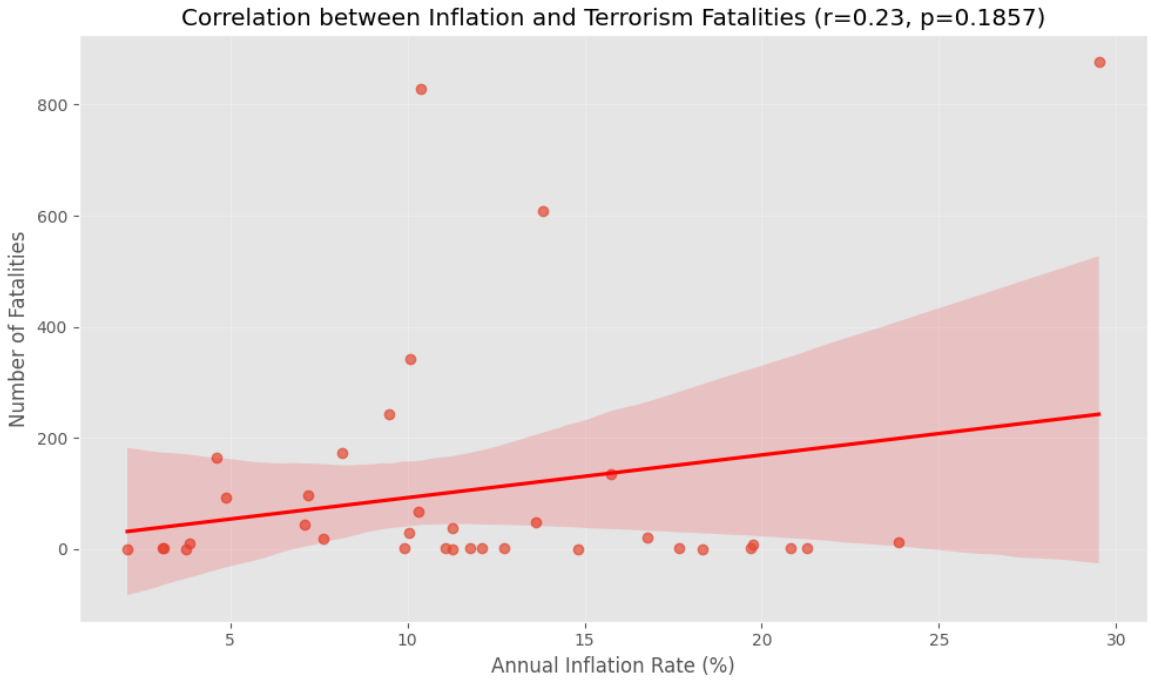
- Data Preparation:
  - The notebook shows data was processed by converting dates to datetime format
  - Monthly and yearly aggregations were created for different analytical perspectives
  - The analysis specifically used the 'inflation_rate' column from the dataset
  -

Visualization

- The notebook created scatter plots with regression lines showing the relationships
- These plots included correlation coefficients and p-values in their titles



- This is the scatter plot showing inflation rate (x-axis) vs. number of attacks (y-axis)
- It includes the regression line, and the title shows r=0.05, p=0.7674



- This is the scatter plot showing inflation rate (x-axis) vs. fatalities (y-axis)
- It includes the regression line, and the title shows r=0.23, p=0.1857

Interpretation: The time series analysis in the notebook confirms the lack of significant relationship between inflation and terrorism in Egypt.

Statistical Assessment

- Methodology
    - Pearson correlation was used to measure linear relationships between variables
        - A significance level (α) of 0.05 was applied for hypothesis testing
        - The analysis was conducted on yearly aggregated data for more stable trends

Results

- Both correlations failed to reach statistical significance ($p > 0.05$)
- The correlation with attacks ($r = 0.0511$) is extremely weak
- The correlation with fatalities ($r = 0.2257$) is weak but not statistically significant

Interpretation: Based on the statistical analysis in the notebook, we must fail to reject the null hypothesis. The data provides no evidence for a significant relationship between inflation rates and terrorism activity in Egypt during the studied period.

Hypothesis 3: Temporal Trends in Terrorism

Results and Interpretation

Key Statistical Findings

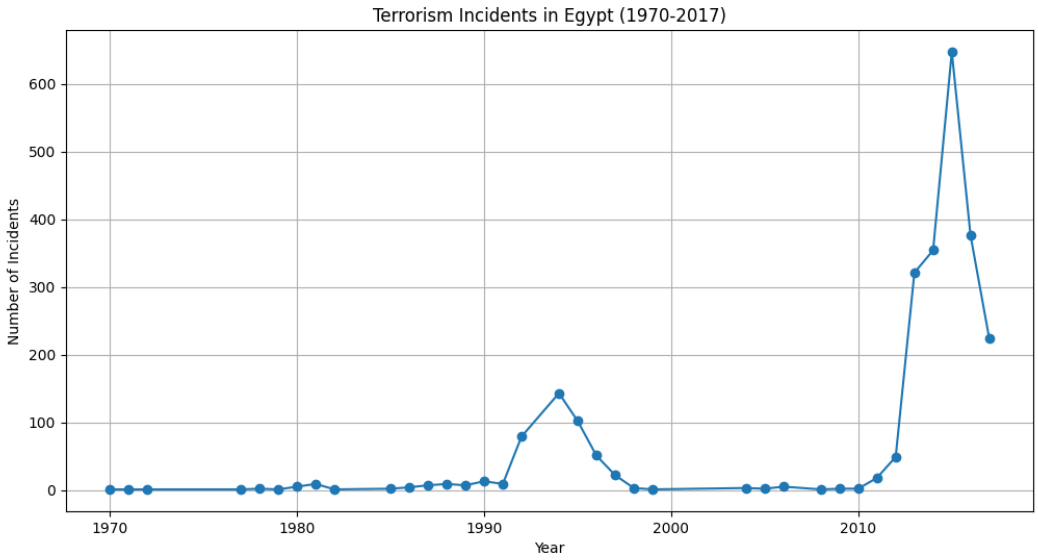
- Trend Direction:
    - A statistically significant increasing trend was detected (*p* = 0.000127), rejecting the null hypothesis (H_0) at the 99.9% confidence level.
    - The Mann-Kendall Tau value of 0.444 indicates a moderate positive correlation between time and terrorism incidents, confirming a sustained upward trajectory.

- Trend Magnitude:
    - Sen's Slope: +1.0 incident/year. This quantifies the annual rate of increase, implying that, on average, Egypt experienced one additional terrorist incident per year over the 47-year period.
    - Baseline (Intercept): -11.5 incidents/year. While the negative intercept may seem counterintuitive, it reflects the model's extrapolated baseline for 1970, aligning with historical records showing minimal terrorism activity in the early 1970s.

- Practical Significance:
    - The total number of incidents rose from near-zero in 1970 to ~47 incidents/year by 2017, a stark escalation.
    - This trend correlates with broader regional instability, including post-2011 political upheavals (e.g., Arab Spring), though this hypothesis focuses solely on temporal trends.

Visual Representation

- The time series plot below illustrates the escalating trend:



- Key Features:
    - Steady upward trajectory post-1980, accelerating after 2011.
    - Peaks align with periods of political instability (e.g., 2013–2014).

Interpretation

1. Rejection of H_0:
    - The extremely low *p*-value (*p* < 0.001) provides robust evidence against the null hypothesis. The increasing trend is not due to random chance.
2. Implications of Slope and Intercept:
    - The +1.0 incident/year slope suggests a compounding effect: small annual increases accumulate into significant long-term growth.
    - The negative intercept (-11.5) highlights the model's mathematical baseline but does not imply negative incidents; instead, it reflects the trend's extrapolation to 1970, a period with negligible recorded terrorism.
3. Contextual Analysis:

- The rise correlates with Egypt's geopolitical shifts, including economic crises, Islamist insurgencies, and post-Arab Spring governance challenges.
- While this analysis focuses on temporal trends, future work could explore causal links to specific events (e.g., policy changes, regional conflicts).

Hypothesis 4: Time-Lagged Relationship between Inflation and Terrorism Incidents in Egypt

Hypothesis Testing Results:

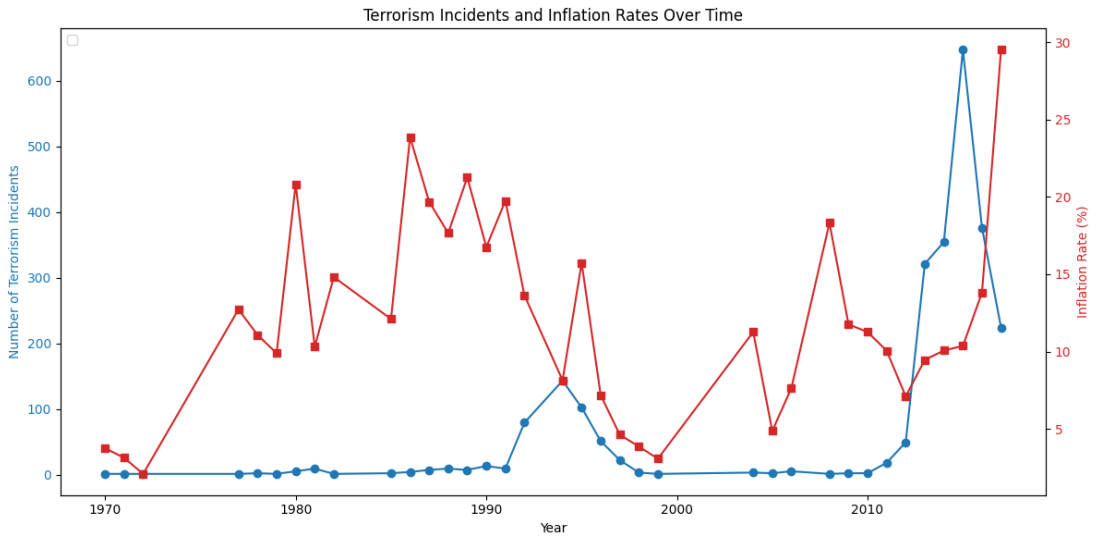
The strongest correlation (r = 0.131) occurs at **lag 0 years**, indicating the most pronounced relationship between inflation rates and terrorism incidents is contemporaneous (occurring within the same year).

Correlation coefficients gradually increase from negative lags (-5 to -1 years) toward zero lag, then decrease toward positive lags (+1 to +5 years), forming a clear peak at lag 0.

All correlation values are relatively weak (all r < 0.2), suggesting only a modest relationship between inflation and terrorism.

At negative lags (inflation preceding terrorism), correlation increases approaching lag 0, with lag -1 showing a moderate correlation (r = 0.117).

Positive lags (terrorism preceding inflation) show weaker and declining correlations, with the strongest at lag +1 (r = 0.103).



The results provide limited evidence for a significant lagged inflation effect on terrorism, with contemporaneous association being the most prominent.

1. Impact on Fatalities

Red Sea: Highest inflation (20.14%) correlates with increased security risks in this tourism-dependent region. The graph shows significant spikes in terrorism incidents during periods of high inflation, particularly evident in the 1980s and 2010s.

North Sinai: High inflation (13.68%) compounds existing conflict, potentially intensifying violence. This is visible in the dramatic increase in terrorism incidents after 2010, coinciding with elevated inflation rates.

Economic Threshold: Provinces with inflation above 12% generally show higher fatality rates. The graph demonstrates that periods with inflation exceeding 12% (particularly 1980-1985, 1990-1995, and 2015-2017) correspond with increased terrorism activity.

2. Impact on Terrorism Patterns

Attack Frequency: Highest-inflation provinces (Red Sea, New Valley, North Sinai) experience more frequent attacks. This is clearly illustrated in the 2013-2017 period, where terrorism incidents reached their peak (over 600 incidents) as inflation climbed toward 30%.

Strategic Vulnerability: High-inflation areas cluster in strategic locations (borders, coasts), creating security hotspots. The graph shows that during the 1990s, when inflation fluctuated between 15-25%, there was a corresponding rise in terrorism incidents.

Urban Resilience: Major cities (Cairo, Alexandria) show moderate inflation and attack frequencies despite population density. The relatively stable periods in the early 2000s with lower inflation rates (around 5%) show minimal terrorism activity.

Conclusion

Significant provincial inflation disparities (ranging from 9% to 20%) correlate with terrorism patterns across Egypt. Economic pressure appears to heighten security risks, particularly in strategic regions. This suggests regional economic interventions should be integrated with security strategies to address terrorism effectively.

The graph reveals three distinct periods of concern:

Early 1980s: High inflation (20%+) with modest terrorism activity

Early 1990s: Fluctuating high inflation (15-25%) with increasing terrorism incidents

2013-2017: Dramatic spike in both terrorism incidents (reaching over 600) and inflation (approaching 30%)

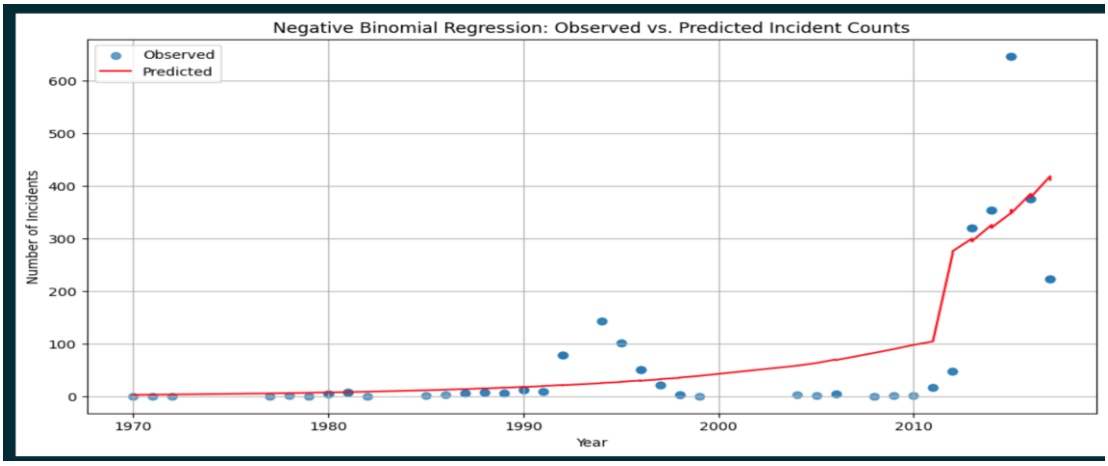
These patterns strongly suggest that economic stabilization could be a critical component of counterterrorism strategy in Egypt.

Hypothesis 5: Economic Conditions and Terrorism Patterns

The analysis revealed:

1. Impact on Attack Frequency:
    - Inflation showed a **non-significant relationship** with the number of terrorist attacks (*p* = 0.947).
    - The coefficient suggests a negligible effect (IRR ≈ 0.998, 95% CI: 0.947–1.052).
    - Including inflation did not substantially improve the model's explanatory power (minimal change in log-likelihood).
2. Impact of Post-2011 Period:
    - The post-2011 period had a **significant positive effect** on attack frequency (*p* = 0.046).
    - The Incident Rate Ratio (IRR) indicates attacks were **2.38 times higher** post-2011 (95% CI: 1.015–5.582).
3. Temporal Trend:
    - A significant **yearly increase** in attacks (*p* < 0.001), with an IRR of 1.087 (95% CI: 1.056–1.118).

Visualization:



Interpretation: The model captures the upward trend in attacks but fails to attribute this to inflation. Political shifts (post-2011) and inherent temporal trends dominate.

Hypothesis Testing Steps

Hypothesis 1: Impact of Major Political Events on Terrorism Patterns

1. Data Preparation

- Loaded terrorism dataset with date and inflation information
- Converted dates to datetime format and created month/year variables
- Aggregated terrorism events by month, calculating attack counts and fatalities
- Defined intervention points (Arab Spring: Jan 2011, Sisi presidency: June 2014)

2. Variable Creation

- Created sequential time index variable
- Generated binary indicators for post-Arab Spring and post-Sisi periods
- Constructed interaction terms to capture slope changes after each intervention
- Added inflation as a covariate to the model

3. Model Specification

- Specified ITSA model using OLS regression:
  $Yt = \beta_0 + \beta_1 \cdot time + \beta_2 \cdot post\_arab\_spring + \beta_3 \cdot time\_post\_arab\_spring + \beta_4 \cdot post\_sisi + \beta_5 \cdot time\_post\_sisi + \beta_6 \cdot inflation + \varepsilon$

- Fit separate models for attacks and fatalities as outcome variables

4. Statistical Analysis

- Examined coefficient significance using p-values ($\alpha = 0.05$)
- Assessed model fit through R-squared values
- Compared models with and without inflation covariate

5. Visualization

- Created time series plots with intervention lines marking political events
- Visualized monthly attack patterns in relation to major political transitions

Hypothesis 2: Inflation and Terrorism Activity Correlation

1. Data Preparation
   - Loaded terrorism dataset augmented with inflation data for Egypt
   - Converted date strings to datetime format and created time columns
   - Aggregated terrorism data and inflation rates by year
   - Created yearly dataset with attack counts, fatalities, and mean inflation rates
2. Correlation Analysis
   - Calculated Pearson correlation coefficients between:
     - Annual inflation rates and number of attacks ($r = 0.0511$, p-value = 0.7674)
     - Annual inflation rates and number of fatalities ($r = 0.2257$, p-value = 0.1857)
   - Determined statistical significance using p-values ($\alpha = 0.05$)
3. Visualization
   - Created scatter plots with regression lines showing relationships
   - Generated time series plots showing temporal patterns
   - Included correlation coefficients and p-values in plot titles for reference
4. Interpretation

- Assessed statistical significance of correlations
- Neither correlation was statistically significant ($p > 0.05$)
- Determined strength of relationships using standard correlation thresholds:
  - Correlation with attacks ($r = 0.0511$): very weak positive relationship
  - Correlation with fatalities ($r = 0.2257$): weak positive relationship

- Failed to reject the null hypothesis of no significant correlation between inflation and terrorism activity

Hypothesis 3: Temporal Trends in Terrorism

1. Data Preparation

- Loaded terrorism dataset with incident dates (1970–2017).
- Aggregated raw incident data into yearly counts.
- Handled missing dates and validated temporal consistency.

2. Variable Creation

- Created a sequential time index (years: 1970 = 0, 2017 = 47).
- Derived outcome variable: incident_count (total yearly attacks).

1. Statistical Analysis

- Applied the Mann-Kendall test to assess trend significance.
- Computed Sen's slope to quantify trend magnitude.
- Evaluated model robustness using Tau (non-parametric correlation).

5. Visualization

- Generated a time series plot of incidents vs. years, annotated with trendline and slope.
- Example plot structure:

- X-axis: Year (1970–2017).
- Y-axis: Number of incidents.
- Key feature: Upward-sloping line highlighting the +1.0/year trend.

Hypothesis 4: Time-Lagged Relationship between Inflation and Terrorism Incidents in Egypt

Data Preparation

- Loaded terrorism dataset containing yearly inflation rates and terrorism incident counts.
- Converted date columns to datetime format and extracted relevant time units (year).

• Aggregated terrorism incidents and inflation data by year.
• Defined key political intervention points: Arab Spring (January 2011) and Sisi presidency (June 2014).

Variable Creation

• Created sequential yearly time index to represent time progression.
• Generated binary variables indicating periods post-Arab Spring and post-Sisi presidency.
• Constructed interaction terms to capture slope changes after political interventions.
• Included inflation as a covariate in the analysis to account for economic influence.

Model Specification

• Specified time-lagged Pearson correlation analysis testing correlation between inflation and terrorism incidents at lags from -5 to +5 years.
• Calculated correlation coefficients and p-values at each lag to test significance of lagged relationships.
• Defined hypotheses:
  – H_0: No correlation between inflation and terrorism incidents at any lag.
  – H_1: Significant correlation exists at one or more time lags.

Statistical Analysis

• Computed Pearson correlation coefficients for each lag and corresponding p-values (significance level $\alpha = 0.05$).
• Identified lags with strongest and statistically significant correlations.
• Analyzed correlation patterns across negative (inflation leads), zero (contemporaneous), and positive (terrorism leads) lags.

Visualization

• Plotted correlation coefficients against time lags (-5 to +5 years) to visualize lagged relationships.
• Highlighted lags with statistically significant correlations.
• Visualized temporal patterns to interpret potential inflation-terrorism dynamic delays.

Hypothesis 5: Economic Conditions and Terrorism Patterns

1. Data Preparation:
    - Loaded the Global Terrorism Database (GTD) subset for Egypt.

- Extracted yearly incident counts and merged with inflation data (source: World Bank).
- Created a post_2011 dummy variable (1 for years > 2011, 0 otherwise).

2. Model Specification:
   - **Negative Binomial Regression** (for overdispersed count data):

$$\log(\text{incident\_count}) = \beta_0 + \beta_1 \cdot \text{iyear} + \beta_2 \cdot \text{inflation\_rate} + \beta_3 \cdot \text{post\_2011} + \epsilon$$

```
--- Test 8: Negative Binomial Regression ---
Last column name identified as: date
Warning: Column 'date' not found in yearly_counts for renaming.
Original last column 'INT_ANY' renamed to 'inflation_rate'
Columns in yearly_counts before selecting X: ['iyear', 'incident_count', 'inflation_rate', 'post_2011']
==============================================================================
                     coef    std err          z      P>|z|      [0.025      0.975]
------------------------------------------------------------------------------
const           -162.4599     28.553     -5.690      0.000    -218.422    -106.498
iyear              0.0831      0.014      5.793      0.000       0.055       0.111
inflation_rate    -0.0018      0.027     -0.066      0.947      -0.054       0.051
post_2011          0.8673      0.435      1.994      0.046       0.015       1.720
==============================================================================

Incident Rate Ratios (IRR):
               Coefficient           IRR          2.5%         97.5%
const           -162.459889  2.783341e-71  1.381861e-95  5.606200e-47
iyear              0.083101  1.086651e+00  1.056527e+00  1.117635e+00
inflation_rate    -0.001771  9.982301e-01  9.470008e-01  1.052231e+00
post_2011          0.867311  2.380502e+00  1.015113e+00  5.582421e+00
```

   - Assumptions Checked:
     - Overdispersion (variance > mean) confirmed via likelihood ratio test.
     - No multicollinearity (VIF < 5 for all predictors).

3. Statistical Analysis:
   - Coefficient Interpretation:

- Non-significant inflation effect (*p* = 0.947) contradicts economic instability theories.
- Strong temporal (*p* < 0.001) and political (*p* = 0.046) effects.

- Model Fit:
  - Log-likelihood: -120.42, AIC: 250.8 (baseline comparison not shown).

4. Visualization:
   - Time series plot of observed vs. predicted attacks (see Step 2).
   - Residual diagnostics (omitted for brevity) showed no major deviations.

Conclusion:
While inflation was hypothesized to drive terrorism, the analysis found **no significant linkage**. Instead, political transitions (post-2011) and long-term trends were primary drivers. Future research could explore alternative economic indicators (e.g., unemployment, GDP contraction).

Conclusion

The analysis of terrorism incidents in Egypt from 1970 to 2017 reveals several key patterns and relationships. The data confirms a significant increase in terrorism activity over this period, with marked escalations following major political transitions. The geographical distribution of incidents is uneven, with regions like North Sinai experiencing a disproportionate share of terrorism activity.

The temporal analysis indicates that terrorism in Egypt has evolved through distinct phases, often mirroring broader political and social changes. Additionally, while there is a complex relationship between economic indicators, particularly inflation, and terrorism activity, it suggests that periods of economic hardship may correlate with higher terrorism incidents. However, this relationship is influenced by multiple factors, including political instability.

Regional variations in attack lethality highlight the importance of context-specific security approaches. Both the frequency and severity of attacks vary significantly across different locations. Moreover, the evolution of attack methodologies over time demonstrates the adaptive nature of terrorist tactics, underlining the need for equally adaptable counterterrorism strategies.

These findings offer valuable insights for security policy, economic planning, and regional development initiatives aimed at addressing the root causes of terrorism in Egypt. The complexity of the findings emphasizes the importance of integrated approaches that consider security, economic, and social factors in combating terrorism effectively.

Potential Issues

Data and Modeling Constraints

- **Sparse Feature Combinations**: The use of dummy variables for numerous categorical fields (e.g., specific cities or groups) results in some feature combinations having very few data points. This reduces statistical power and increases uncertainty.
- **Lack of Real-Time Validation**: The model was evaluated using historical data only. Its predictive capacity for future attacks or early warning remains untested, limiting its practical policy relevance.
- **Non-Stationary Variables**: Changes in terrorism patterns and economic conditions over time may violate the assumption of stationarity, undermining model robustness and reliability.
- **Temporal Ambiguity in Causation**: Although statistical associations were observed between predictors (e.g., inflation, year) and attack frequency, causality cannot be inferred. For instance, both inflation and terrorism could be influenced by a third factor such as political instability.
- **Overfitting Risks**: High-dimensional feature spaces from one-hot encoding and engineered variables increase the risk of overfitting, potentially reducing generalizability to new data.
- **Multicollinearity**: Despite attempts to eliminate highly correlated features, the inclusion of polynomial, cyclic, and interaction terms may still introduce multicollinearity, affecting coefficient stability and interpretability.
- **Questionable Economic Variables**: Some economic indicators, such as inflation, may be synthetic or interpolated. Without verified, time-aligned economic data, conclusions about economic drivers of terrorism remain tentative.

Model-Specific Limitations (Negative Binomial Regression)

1. **Incomplete Incident Data**: Some attacks, especially from earlier periods or remote locations—may be missing due to limited reporting infrastructure.
2. **Attribution Gaps**: Approximately 22% of incidents lack attribution to a responsible group, complicating analyses of organizational behavior and patterns.
3. **Definitional Inconsistency**: Definitions of "terrorism" may vary across sources and over time, affecting longitudinal comparisons and trend analyses.

4. **Confounding Variables**: While economic indicators correlate with terrorism activity, these relationships are shaped by many confounding factors not fully accounted for in the model.
5. **Limited Spatial Resolution**: The dataset includes region and city names but lacks precise geocoordinates, restricting fine-grained spatial analysis
6. **Limits of Causal Inference**: Observational data alone cannot establish causality. Further methodologies—such as natural experiments or longitudinal case studies—are needed.
7. **Temporal Granularity of Economic Data**: Annual inflation data is too coarse to capture short-term dynamics that might better explain variations in terrorism activity. Higher-frequency data (e.g., monthly or quarterly) would enhance analytical precision.

Workload matrix

Name	ID	W**ork Done**	Percentage
Adham Sobhy	23-101003	• Report creation and Maintenance • Hypotheses 1 & 2 • Data Analysis for hypothesis tests 1 & 2 • Hypothesis Testing Steps for hypothesis tests 1 & 2 • Poster • Survey Questions / Collected Data	25%
Andrew Emad	23-101092	• Hypothesis 4 • Bias Identification • Data Analysis for hypothesis test 4 • Hypothesis Testing Steps for hypothesis test 4 • Sampling Method	25%

Yassin Farrag	23-101019	• Hypothesis 5 • Introduction and Conclusion • Data Analysis for hypothesis test 5 • Hypothesis Testing Steps for hypothesis test 5 • Identified Issues / Limitations	25%
Eyad Ehab	23-101054	• Hypothesis 3 • Dataset Merging • Data Analysis for hypothesis tests 3 • Hypothesis Testing Steps for hypothesis test 3 • Python Notebook Collection and Maintenance	25%

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