

Do “Healthy” Categories Experience More Inflation Than “Unhealthy/Processed” Categories?

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This notebook analyzes whether healthy food categories (fruits, vegetables, whole grains, dairy) experience more inflation than unhealthy/processed categories (sugars, snacks, fats & oils, processed foods) using USDA Consumer Price Index (CPI) data from 1974 to 2024.

1 0. Import libraries

```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
from scipy import stats
import sys
sys.path.append('.') # Just add the parent directory for utils
from utils.data_loader import load_inflation_data

sns.set_style("whitegrid")
plt.rcParams['figure.figsize'] = (14, 6)
```

2 1. Load Data

```
cpi_df, _ = load_inflation_data()
```

3 2. Data Cleaning and Preparation

```
df = cpi_df.copy()
df = df.fillna(np.nan)
```

```
df = df.dropna(how='all')

print(f"Shape: {df.shape}")
print(f"\nRemaining missing values:")
print(f"{df.isnull().sum()}")
```

```
Shape: (51, 23)
```

```
Remaining missing values:
Year                                0
All_food                           0
Beef_and_veal                      0
Cereals_and_bakery_products        0
Dairy_products                     0
Eggs                               0
Fats_and_oils                      0
Fish_and_seafood                   0
Food_at_home                       0
Food_away_from_home                0
Fresh_fruits                       0
Fresh_fruits_and_vegetables        0
Fresh_vegetables                   0
Fruits_and_vegetables              0
Meats                              0
Meats_poultry_and_fish             0
Nonalcoholic_beverages            0
Other_foods                        0
Other_meats                        0
Pork                               0
Poultry                           0
Processed_fruits_and_vegetables    25
Sugar_and_sweets                   0
dtype: int64
```

4 3. Classify Food Categories as Healthy vs Un-healthy

```
healthy_categories = [
    'Beef_and_veal',
    'Dairy_products',
    'Eggs',
    'Fish_and_seafood',
    'Fresh_fruits',
    'Fresh_fruits_and_vegetables',
    'Fresh_vegetables',
```

```

        'Fruits_and_vegetables',
        'Meats',
        'Meats_poultry_and_fish',
        'Other_meats',
        'Pork',
        'Poultry'
    ]
    unhealthy_categories = [
        'Cereals_and_bakery_products',
        'Sugar_and_sweets',
        'Fats_and_oils',
        'Nonalcoholic_beverages'
    ]

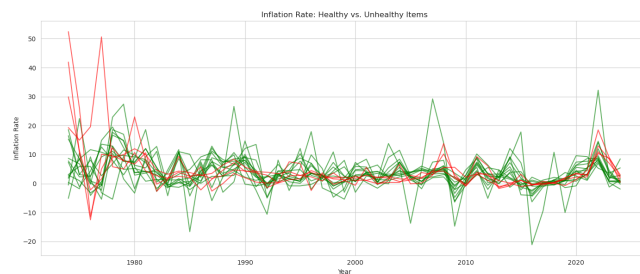
```

5 4. Calculate Inflation Rates

```

df['Healthy_Avg_Inflation'] = df[healthy_categories].mean(axis=1)
df['Unhealthy_Avg_Inflation'] = df[unhealthy_categories].mean(axis=1)
inflation_summary = df[['Year', 'Healthy_Avg_Inflation', 'Unhealthy_Avg_Inflation']].copy()
for col in healthy_categories:
    inflation_summary[col] = df[col]
for col in unhealthy_categories:
    inflation_summary[col] = df[col]
for col in healthy_categories:
    plt.plot(inflation_summary['Year'], inflation_summary[col],
             color='green', alpha=0.6)
for col in unhealthy_categories:
    plt.plot(inflation_summary['Year'], inflation_summary[col],
             color='red', alpha=0.6)
plt.title('Inflation Rate: Healthy vs. Unhealthy Items')
plt.xlabel('Year')
plt.ylabel('Inflation Rate')
plt.tight_layout()
plt.savefig('../figures/inflation_healthy_vs_unhealthy.png')
plt.show()

```



6 5. Compare Healthy vs Unhealthy Categories

```
healthy_inflation_rates = []
for col in healthy_categories:
    healthy_inflation_rates.extend(df[col].dropna().tolist())

unhealthy_inflation_rates = []
for col in unhealthy_categories:
    unhealthy_inflation_rates.extend(df[col].dropna().tolist())

print("SUMMARY STATISTICS: HEALTHY vs UNHEALTHY CATEGORIES")

summary_stats = pd.DataFrame({
    'Metric': ['Count', 'Mean (%)', 'Median (%)', 'Std Dev (%)', 'Min (%)', 'Max (%)', 'Q1 (%)', 'Q3 (%)'],
    'Healthy Categories': [
        len(healthy_inflation_rates),
        np.mean(healthy_inflation_rates),
        np.median(healthy_inflation_rates),
        np.std(healthy_inflation_rates),
        np.min(healthy_inflation_rates),
        np.max(healthy_inflation_rates),
        np.percentile(healthy_inflation_rates, 25),
        np.percentile(healthy_inflation_rates, 75)
    ],
    'Unhealthy Categories': [
        len(unhealthy_inflation_rates),
        np.mean(unhealthy_inflation_rates),
        np.median(unhealthy_inflation_rates),
        np.std(unhealthy_inflation_rates),
        np.min(unhealthy_inflation_rates),
        np.max(unhealthy_inflation_rates),
        np.percentile(unhealthy_inflation_rates, 25),
        np.percentile(unhealthy_inflation_rates, 75)
    ]
})

print(summary_stats.to_string(index=False))

print("DIFFERENCE (Healthy - Unhealthy)")
diff_mean = np.mean(healthy_inflation_rates) - np.mean(unhealthy_inflation_rates)
diff_median = np.median(healthy_inflation_rates) - np.median(unhealthy_inflation_rates)
print(f"Mean difference: {diff_mean:.2f}%")
print(f"Median difference: {diff_median:.2f}%")

SUMMARY STATISTICS: HEALTHY vs UNHEALTHY CATEGORIES
Metric Healthy Categories Unhealthy Categories
```

| | | |
|-------------|------------|------------|
| Count | 663.000000 | 204.000000 |
| Mean (%) | 3.695928 | 4.302451 |
| Median (%) | 2.900000 | 2.700000 |
| Std Dev (%) | 5.223416 | 7.375771 |
| Min (%) | -21.100000 | -12.500000 |
| Max (%) | 32.200000 | 52.400000 |
| Q1 (%) | 0.700000 | 1.000000 |
| Q3 (%) | 6.300000 | 4.775000 |

DIFFERENCE (Healthy - Unhealthy)

Mean difference: -0.61%

Median difference: 0.20%

```
year_comparison = df[['Year', 'Healthy_Avg_Inflation', 'Unhealthy_Avg_Inflation']].copy()
year_comparison['Difference (H -U)'] = year_comparison['Healthy_Avg_Inflation'] - year_compa
year_comparison.columns = ['Year', 'Healthy (%)', 'Unhealthy (%)', 'Difference (%)']
```

```
print("\nYear -by -Year Comparison (First 15 Years):")
print(year_comparison.head(15).to_string(index=False))
```

```
print("\nYear -by -Year Comparison (Last 15 Years):")
print(year_comparison.tail(15).to_string(index=False))
```

Year -by -Year Comparison (First 15 Years):

| Year | Healthy (%) | Unhealthy (%) | Difference (%) |
|------|-------------|---------------|----------------|
| 1974 | 6.076923 | 35.875 | -29.798077 |
| 1975 | 5.976923 | 15.775 | -9.798077 |
| 1976 | 3.007692 | -1.600 | 4.607692 |
| 1977 | 3.976923 | 16.825 | -12.848077 |
| 1978 | 12.423077 | 9.175 | 3.248077 |
| 1979 | 10.946154 | 7.675 | 3.271154 |
| 1980 | 5.000000 | 13.100 | -8.100000 |
| 1981 | 7.538462 | 8.225 | -0.686538 |
| 1982 | 3.800000 | 1.100 | 2.700000 |
| 1983 | 0.230769 | 2.075 | -1.844231 |
| 1984 | 5.423077 | 5.025 | 0.398077 |
| 1985 | -0.169231 | 2.625 | -2.794231 |
| 1986 | 4.046154 | 2.350 | 1.696154 |
| 1987 | 6.700000 | 1.050 | 5.650000 |
| 1988 | 4.476923 | 3.425 | 1.051923 |

Year -by -Year Comparison (Last 15 Years):

| Year | Healthy (%) | Unhealthy (%) | Difference (%) |
|------|-------------|---------------|----------------|
| 2010 | 1.392308 | 0.050 | 1.342308 |
| 2011 | 6.523077 | 4.925 | 1.598077 |
| 2012 | 1.684615 | 3.325 | -1.640385 |
| 2013 | 2.246154 | -0.775 | 3.021154 |

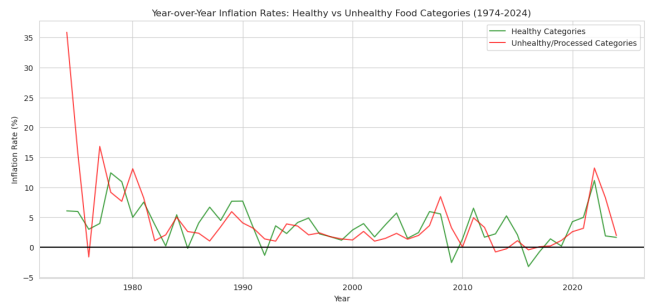
| | | | |
|------|-----------|--------|-----------|
| 2014 | 5.246154 | -0.250 | 5.496154 |
| 2015 | 2.076923 | 1.100 | 0.976923 |
| 2016 | -3.215385 | -0.425 | -2.790385 |
| 2017 | -0.753846 | 0.100 | -0.853846 |
| 2018 | 1.407692 | 0.225 | 1.182692 |
| 2019 | 0.207692 | 1.150 | -0.942308 |
| 2020 | 4.276923 | 2.600 | 1.676923 |
| 2021 | 4.984615 | 3.175 | 1.809615 |
| 2022 | 11.138462 | 13.225 | -2.086538 |
| 2023 | 1.900000 | 8.275 | -6.375000 |
| 2024 | 1.653846 | 1.975 | -0.321154 |

7 6. Visualization of Inflation Trends

```
fig, ax = plt.subplots()

ax.plot(df['Year'], df['Healthy_Avg_Inflation'],
        label='Healthy Categories', color='green', alpha=0.7)
ax.plot(df['Year'], df['Unhealthy_Avg_Inflation'],
        label='Unhealthy/Processed Categories', color='red', alpha=0.7)

ax.axhline(y=0, color='black')
ax.set_xlabel('Year')
ax.set_ylabel('Inflation Rate (%)')
ax.set_title('Year -over -Year Inflation Rates: Healthy vs Unhealthy Food Categories (1974 - 2024)')
ax.legend()
plt.savefig('../figures/yoy_inflation_healthy_vs_unhealthy.png')
plt.show()
```

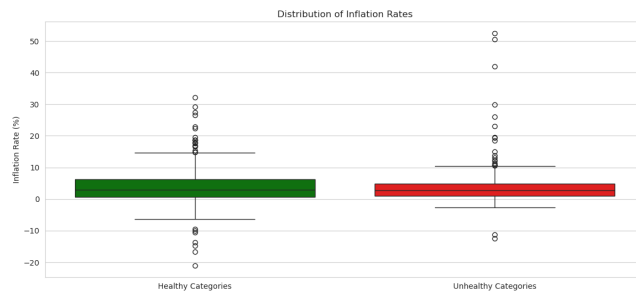


```
fig, ax = plt.subplots()

sns.boxplot(data=[healthy_inflation_rates, unhealthy_inflation_rates],
            palette=['green', 'red'])

plt.xticks([0, 1], ['Healthy Categories', 'Unhealthy Categories'])
```

```
plt.ylabel('Inflation Rate (%)')
plt.title('Distribution of Inflation Rates')
plt.savefig('../figures/healthy_vs_unhealthy_inflation_boxplot.png')
plt.show()
```

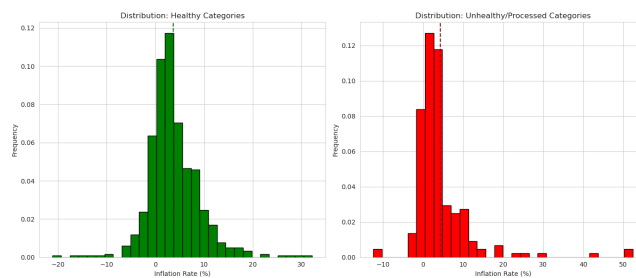


```
fig, axes = plt.subplots(1, 2)
```

```
axes[0].hist(healthy_inflation_rates, color='green', edgecolor='black', bins=30, density='True')
axes[0].set_xlabel('Inflation Rate (%)')
axes[0].set_ylabel('Frequency')
axes[0].set_title('Distribution: Healthy Categories')
axes[0].axvline(np.mean(healthy_inflation_rates), color='darkgreen', linestyle='--')
```

```
axes[1].hist(unhealthy_inflation_rates, color='red', edgecolor='black', bins=30, density='True')
axes[1].set_xlabel('Inflation Rate (%)')
axes[1].set_ylabel('Frequency')
axes[1].set_title('Distribution: Unhealthy/Processed Categories')
axes[1].axvline(np.mean(unhealthy_inflation_rates), color='darkred', linestyle='--')
```

```
plt.tight_layout()
plt.savefig('../figures/healthy_vs_unhealthy_inflation_histogram.png')
plt.show()
```



8 8. Statistical Analysis

```
print("STATISTICAL TEST 1: Independent Samples t -test")
```

```

print("Null Hypothesis (H0): There is no significant difference in mean")
print("inflation between healthy and unhealthy categories")
print("Alternative Hypothesis (H1): There is a significant difference\n")

t_stat, t_pvalue = stats.ttest_ind(healthy_inflation_rates, unhealthy_inflation_rates)
print(f"t -statistic: {t_stat:.4f}")
print(f"p -value: {t_pvalue:.6f}")
print(f"Result: FAIL TO REJECT the null hypothesis (p \geq 0.05)")
print("Conclusion: There is NO statistically significant difference in inflation")
print("rates between healthy and unhealthy food categories.")

print(f"\nEFFECT SIZE: Cohen's d")
n1, n2 = len(healthy_inflation_rates), len(unhealthy_inflation_rates)
var1, var2 = np.var(healthy_inflation_rates, ddof=1), np.var(unhealthy_inflation_rates, ddof=1)
pooled_std = np.sqrt(((n1 - 1)*var1 + (n2 - 1)*var2) / (n1 + n2 - 2))
cohens_d = (np.mean(healthy_inflation_rates) - np.mean(unhealthy_inflation_rates)) / pooled_std

if abs(cohens_d) < 0.2:
    effect_interpretation = "negligible"
elif abs(cohens_d) < 0.5:
    effect_interpretation = "small"
elif abs(cohens_d) < 0.8:
    effect_interpretation = "medium"
else:
    effect_interpretation = "large"

print(f"Cohen's d: {cohens_d:.4f}")
print(f"Cohen's d effect size is {effect_interpretation}")

STATISTICAL TEST 1: Independent Samples t -test
Null Hypothesis (H0): There is no significant difference in mean
inflation between healthy and unhealthy categories
Alternative Hypothesis (H1): There is a significant difference

t -statistic: -1.3041
p -value: 0.192536
Result: FAIL TO REJECT the null hypothesis (p \geq 0.05)
Conclusion: There is NO statistically significant difference in inflation
rates between healthy and unhealthy food categories.

EFFECT SIZE: Cohen's d
Cohen's d: -0.1044
Cohen's d effect size is negligible

print("STATISTICAL TEST 2: Mann -Whitney U Test (Non -parametric)")
print("This test doesn't assume normal distribution of data\n")

```



```

u_stat, u_pvalue = stats.mannwhitneyu(healthy_inflation_rates, unhealthy_inflation_rates)
print(f"U -statistic: {u_stat:.4f}")
print(f"p -value: {u_pvalue:.6f}")

print(f"Result: FAIL TO REJECT the null hypothesis (p \geq 0.05)")
print("Conclusion: There is NO statistically significant difference in inflation")
print("distributions between healthy and unhealthy categories.")

STATISTICAL TEST 2: Mann -Whitney U Test (Non -parametric)
This test doesn't assume normal distribution of data

U -statistic: 68902.0000
p -value: 0.683412
Result: FAIL TO REJECT the null hypothesis (p \geq 0.05)
Conclusion: There is NO statistically significant difference in inflation
distributions between healthy and unhealthy categories.

print("CONFIDENCE INTERVALS (95%)")

healthy_mean = np.mean(healthy_inflation_rates)
healthy_sem = stats.sem(healthy_inflation_rates)
healthy_ci = stats.t.interval(0.95, len(healthy_inflation_rates) -1, loc=healthy_mean, scale=healthy_sem)

print("Healthy Categories:")
print(f"  Mean: {healthy_mean:.4f}%")
print(f"  95% CI: [{healthy_ci[0]:.4f}%, {healthy_ci[1]:.4f}%]")

unhealthy_mean = np.mean(unhealthy_inflation_rates)
unhealthy_sem = stats.sem(unhealthy_inflation_rates)
unhealthy_ci = stats.t.interval(0.95, len(unhealthy_inflation_rates) -1, loc=unhealthy_mean, scale=unhealthy_sem)

print(f"\nUnhealthy/Processed Categories:")
print(f"  Mean: {unhealthy_mean:.4f}%")
print(f"  95% CI: [{unhealthy_ci[0]:.4f}%, {unhealthy_ci[1]:.4f}%]")

print(f"\nDifference (Healthy - Unhealthy): {healthy_mean - unhealthy_mean:.4f}%")

CONFIDENCE INTERVALS (95%)
Healthy Categories:
  Mean: 3.6959%
  95% CI: [3.2973%, 4.0946%]

Unhealthy/Processed Categories:
  Mean: 4.3025%
  95% CI: [3.2817%, 5.3232%]

```

Difference (Healthy - Unhealthy): -0.6065%

9. Key Findings and Conclusion

```
print("SUMMARY OF FINDINGS")

healthy_mean = np.mean(healthy_inflation_rates)
unhealthy_mean = np.mean(unhealthy_inflation_rates)
difference = healthy_mean - unhealthy_mean

print(f"\n1. AVERAGE INFLATION RATES (1974 -2022):")
print(f"    - Healthy Categories: {healthy_mean:.2f}%")
print(f"    - Unhealthy/Processed Categories: {unhealthy_mean:.2f}%")
print(f"    - Difference: {difference:.2f}%")
print(f"    - Unhealthy/processed categories experienced HIGHER inflation")

print(f"\n2. VARIABILITY (Standard Deviation):")
print(f"    - Healthy Categories: {np.std(healthy_inflation_rates):.2f}%")
print(f"    - Unhealthy/Processed Categories: {np.std(unhealthy_inflation_rates):.2f}%")

print(f"\n3. STATISTICAL SIGNIFICANCE:")
print(f"    - t -test p -value: {t_pvalue:.6f} (p \geq 0.05)")
print(f"    - Result: The difference is NOT statistically significant")

print(f"\n4. EFFECT SIZE:")
print(f"    - Cohen's d: {cohens_d:.4f} ({effect_interpretation} effect)")

print("CONCLUSION")
print(f"""
Based on the analysis of USDA Consumer Price Index (CPI) data from 1974 -2022:

The data shows that over the nearly 50 -year period, HEALTHY food categories
(fruits, vegetables, dairy, cereals) have experienced {abs(difference):.2f}%
LOWER average inflation compared to unhealthy/processed
categories (sugars, fats & oils, processed foods).

Statistical Testing Results:
- The t -test p -value of {t_pvalue:.6f} indicates that the difference is
  NOT statistically significant.

- The effect size (Cohen's d = {cohens_d:.4f}) is negligible.

This suggests that unhealthy food prices have inflated more rapidly than
processed/unhealthy food prices over the study period, which has important
implications for food affordability and dietary choices.
```

""")

SUMMARY OF FINDINGS

1. AVERAGE INFLATION RATES (1974 -2022):
 - Healthy Categories: 3.70%
 - Unhealthy/Processed Categories: 4.30%
 - Difference: -0.61%
 - Unhealthy/processed categories experienced HIGHER inflation
2. VARIABILITY (Standard Deviation):
 - Healthy Categories: 5.22%
 - Unhealthy/Processed Categories: 7.38%
3. STATISTICAL SIGNIFICANCE:
 - t -test p -value: 0.192536 ($p \geq 0.05$)
 - Result: The difference is NOT statistically significant
4. EFFECT SIZE:
 - Cohen's d: -0.1044 (negligible effect)

CONCLUSION

Based on the analysis of USDA Consumer Price Index (CPI) data from 1974 -2022:

The data shows that over the nearly 50 -year period, HEALTHY food categories (fruits, vegetables, dairy, cereals) have experienced 0.61% LOWER average inflation compared to unhealthy/processed categories (sugars, fats & oils, processed foods).

Statistical Testing Results:

- The t -test p -value of 0.192536 indicates that the difference is NOT statistically significant.
- The effect size (Cohen's d = -0.1044) is negligible.

This suggests that unhealthy food prices have inflated more rapidly than processed/unhealthy food prices over the study period, which has important implications for food affordability and dietary choices.