

# **IE6600 Computation and Visualization SEC 01 Fall 2024**

## **Assignment 2**

### **Data Visualization Project: Analyzing the U.S. Housing Market Using Time Series Data**

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**Submission Date: 5 November 2024**

- Python Code**
- Analysis Questions**
- Report**
- Tableau Visualization**

### **Task 5 Analysis Questions:**

1.) What are the key trends in home prices, sales, and mortgage rates over time?

- Key Trends in Home Prices, Sales, Mortgage Rates Over Time are as follows:

a) Median Home Prices: It has shown upward trend since 1960s, with the gradually increasing over a decade. There are remarkable peaks around 2006-2007, followed by a decline during 2008 financial crisis and then a steady rise from around 2012 onwards.

b) Mortgage Rates: It has shown a cyclic pattern with maximum rates in the 1980s, followed by a gradual downfall over the time. There are some dips in rates during and AFTER 2008 Financial crisis, reaching low point around 2020-2021, then slight increase again after that.

c) Housing Inventory: It seems to be more unstable with notable peaks and dips, particularly between 2020 and 2022 during COVID-19 pandemic and accompanying housing market dynamics.

2.) How do different metrics relate to each other (e.g., how do changes in mortgage rates affect home sales)?

- Mortgage Rates do affect home prices: Most of the time low mortgage rates makes borrowing more affordable, which increases the demand and inflate home prices. This is more noticeable after 2008, where the decline in mortgage rates line up with steady rise in home prices. Nevertheless, a rapid increase in mortgage rates around 2022 could be linked with a decrease in home price growth (House Price Decrease then Mortgage Increases).

Mortgage Rates also affects housing inventory: The downfall in mortgage rates seem to correspond with reduced housing inventory. Lower borrowing rates often boost increased demand, minimizing the available inventory. Vice versa, when mortgage rates are higher, housing inventory increase as few buyers can afford the new purchase.

3.) Can you identify any cyclical patterns or seasonality in the data?

- Mortgage Rates: It can be identified as a cyclic pattern with peaks and valleys generally in line with economic cycles with high rate in 1980s, downfall during 1990s and 2000s, and the incline in the early 2020s.

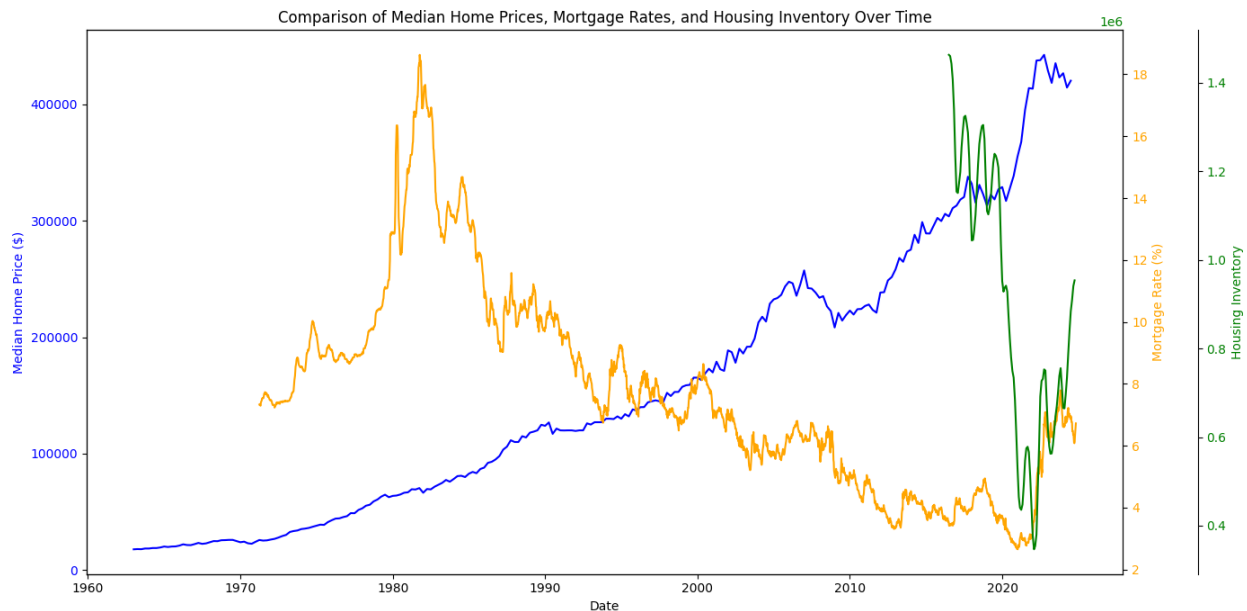
Home Prices: This is also identified as a cyclic pattern, particularly around maximum economic events. The home prices are generally increasing over the long term. There is a decline after 2008 which indicates a clear response to the financial crisis, and price growing again after 2012 which was the time economy recovered.

4.) How did significant economic events (e.g., the 2008 financial crisis or COVID-19 pandemic) affect the housing market?

- 2008 Financial Crisis: The 2008 period is denoted by a sharp decline in home prices and mortgage rates. This crisis has made the market collapse due to high forbid rates and reduced borrowing power, which is the reason of decline demand and downfall of the prices.

COVID-19 pandemic: Around 2020, there is an increase in home prices despite there is decrease in the mortgage rates to historic lows. This was because combination of high demand of housing, reduced housing inventory and shift to remote work. Mortgage rates has increase again during post-pandemic with some potential cooling effect on housing prices.

## Task 7 Deliverables (Report):



The above graph represents the perfect comparison of Median Home Prices, Mortgage Rates and Housing Inventory Over Time. There were some periods like 2008 crisis and COVID-19 have impacted creating the shifts in trends, in the terms of affordability, demand and supply.

The fluctuation of the US housing market represents both consumer behavior and broader economic cycles. There are term trends, cyclic pattern, and the effects of major economic events.

**Median Sales Price of Houses Sold:** This dataset consists of median price of homes sold in the US. This is long-term trend in housing costs and provides the circumstances of market accessibility, affordability over the time.

**Housing Inventory:** This dataset consists of monthly record from July 2016, indicating the number of active housing listings. It also talks about the balance between supply and demand.

**30-Year Fixed Mortgage Rates:** It is weekly data from April 1971, follow the average interest on 30- Years fixed mortgage. This impact affordability directly by monthly payment costs, which also affects home buying activity.

### Analysis of Long-Term Price Trends

The median sales price is indicative of a trend of increase particularly prominent since the 1960s. Housing today is more valuable and more costly to build. This secular trend would suggest that real estate appreciates, thereby making this type of investment one-sided.

This general trend however is frequently interrupted by such recessions as those occurred

in the financial crisis of the 1980 and that one which happened in 2008 when a systemic financial crisis led to a reduction in the value of homes. Recent data shows a recovery and resumption of price increases, reflecting factors such as low mortgage rates and constrained inventory.

### **Cyclical and Seasonal Patterns**

Housing markets are predisposed to be cyclical in pattern. This is in the sense that economic conditions tend to make more people buy homes when the economy grows. This tends to make prices go up. During recessions, home purchases decline, which tends to stabilize and, at times, even lower the prices of houses temporarily. This cycle highlights the responsiveness of the housing market to wider economic cycles. Besides that, the housing market has a seasonal rhythm: activity usually picks up in spring and summer when people like to move during the warmer season. These cycles add yet another layer of predictability to market activity, which helped both buyers and sellers.

### **Impact of Mortgage Rates on Demand**

This plays a big role in the housing market. When the rates are at their low, it becomes cheap to borrow, and the demand for home buying always goes up. Indeed, historical data confirms there was a period when the drops in mortgage rates stimulated market activity, as was witnessed in the aftermath of the 2008 recession and again during the COVID-19 pandemic. With low rates, buyers can afford more expensive houses or decrease the monthly payment. Dovish monetary policy tends to make housing more affordable, increases demand and quickens appreciation. Higher mortgage rates can make homes less affordable, thereby reducing demand and slowing up price growth. With low rates, buyers can afford more expensive houses or decrease the monthly payment. Dovish monetary policy tends to make housing less expensive; boosts demand and accelerates price appreciation. Higher mortgage rates can make homes less affordable, thus reducing demand and slowing down price growth.

### **Effects of Major Economic Events**

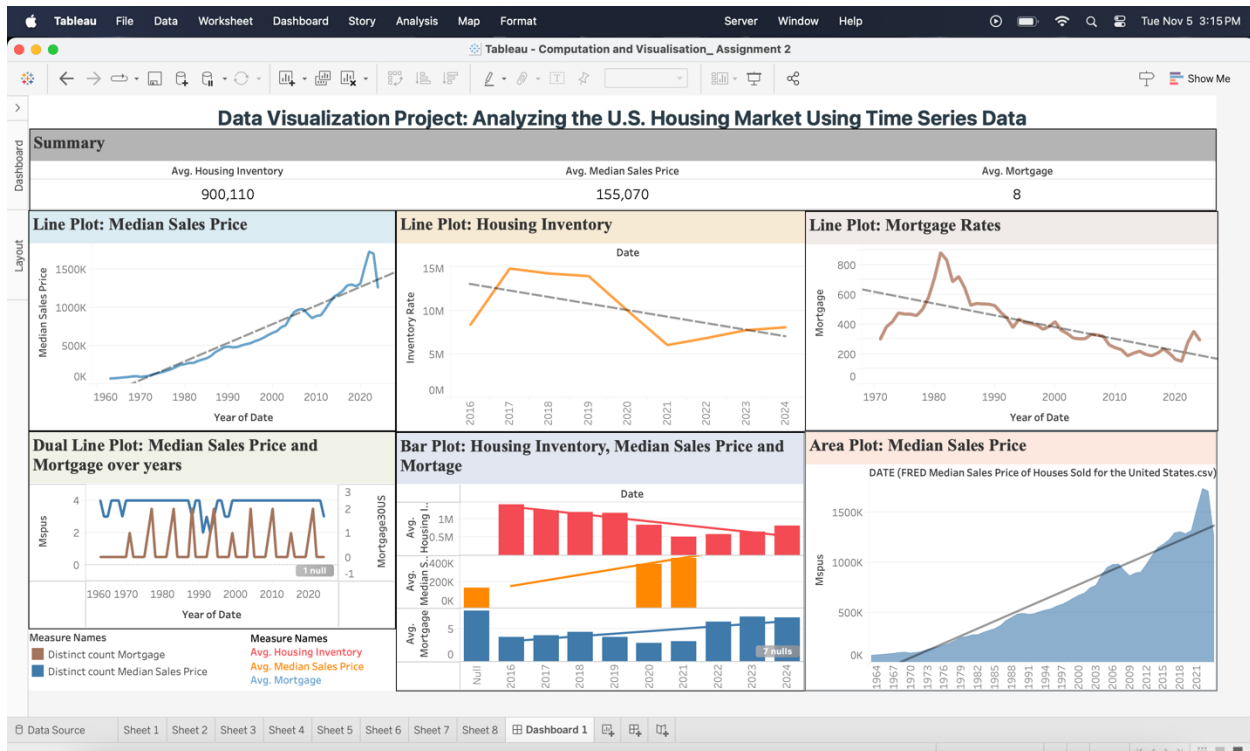
Historical events have greatly impacted the US housing market. The financial crisis in 2008 was a result of a steep decline in the prices of houses after the bursting of the housing bubble. It took years for recovery, showing how over-leveraging, coupled with lax regulatory oversight in lending practices, affects the market.

### **Conclusion:**

The U.S. housing market is an interaction of economic leading indicators, cyclic patterns, and other influential events. Using time series data on house prices, mortgage rates, and housing inventory will help students better understand how changes in one area impact the entire market. Such data points are important to note, not only for the influence they can

have on housing markets but also for real-life implications on affordability, supply, and overall economic health. In this work, students derive an insight into the housing market that, if they are homebuyers, investors, or just informed observers, is going to be truly rewarding to work with.

## Tableau Visualization:



# Importing Libraries

```
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
```

## Uploading Files

```
from google.colab import files
uploaded = files.upload()
```

<IPython.core.display.HTML object>

Saving FRED Median Sales Price of Houses Sold for the United States.csv to FRED Median Sales Price of Houses Sold for the United States.csv

Saving FRED Housing Inventory.csv to FRED Housing Inventory.csv

Saving FRED mortgage.csv to FRED mortgage.csv

*# Loading CSV data for each dataset*

```
median_home_prices = pd.read_csv('/content/FRED Median Sales Price of Houses Sold for the United States.csv')
```

```
mortgage_rates = pd.read_csv('/content/FRED mortgage.csv')
```

```
housing_inventory = pd.read_csv('/content/FRED Housing Inventory.csv')
```

*# Display column names for each dataset*

```
print("Median Home Prices Columns:", median_home_prices.columns)
```

```
print("Mortgage Rates Columns:", mortgage_rates.columns)
```

```
print("Housing Inventory Columns:", housing_inventory.columns)
```

Median Home Prices Columns: Index(['DATE', 'MSPUS'], dtype='object')

Mortgage Rates Columns: Index(['DATE', 'MORTGAGE30US'], dtype='object')

Housing Inventory Columns: Index(['DATE', 'ACTLISCOUUS'], dtype='object')

*# Reload datasets with correct date columns*

```
median_home_prices = pd.read_csv('/content/FRED Median Sales Price of Houses Sold for the United States.csv', parse_dates=['DATE'])
```

```
mortgage_rates = pd.read_csv('/content/FRED mortgage.csv', parse_dates=['DATE'])
```

```
housing_inventory = pd.read_csv('/content/FRED Housing Inventory.csv', parse_dates=['DATE'])
```

*# Set date columns as index*

```
median_home_prices.set_index('DATE', inplace=True)
```

```

mortgage_rates.set_index('DATE', inplace=True)
housing_inventory.set_index('DATE', inplace=True)

# Display the first few rows of each dataset to verify
print("Median Home Prices:\n", median_home_prices.head())
print("Mortgage Rates:\n", mortgage_rates.head())
print("Housing Inventory:\n", housing_inventory.head())

Median Home Prices:
                MSPUS
DATE
1963-01-01    17800.0
1963-04-01    18000.0
1963-07-01    17900.0
1963-10-01    18500.0
1964-01-01    18500.0
Mortgage Rates:
                MORTGAGE30US
DATE
1971-04-02             7.33
1971-04-09             7.31
1971-04-16             7.31
1971-04-23             7.31
1971-04-30             7.29
Housing Inventory:
                ACTLISCOUUS
DATE
2016-07-01    1463007.0
2016-08-01    1460048.0
2016-09-01    1443081.0
2016-10-01    1407698.0
2016-11-01    1339703.0

# Save prepared data to CSV
median_home_prices.to_csv('/content/Prepared_Median_Home_Prices.csv')
mortgage_rates.to_csv('/content/Prepared_Mortgage_Rates.csv')
housing_inventory.to_csv('/content/Prepared_Housing_Inventory.csv')

```

## Data Cleaning

```

# Checking the data types
median_home_prices.dtypes

MSPUS    float64
dtype: object

# Get a summary of the dataset structure and data types
print(median_home_prices.info())

```



```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 247 entries, 1963-01-01 to 2024-07-01
Data columns (total 1 columns):
 #   Column  Non-Null Count  Dtype
---  -
 0   MSPUS   247 non-null    float64
dtypes: float64(1)
memory usage: 3.9 KB
None
```

```
# Get a statistical overview of numeric columns
print(median_home_prices.describe())
```

	MSPUS
count	247.000000
mean	155069.635628
std	115012.001181
min	17800.000000
25%	55700.000000
50%	127000.000000
75%	234600.000000
max	442600.000000

```
# Check for missing values
missing_values = median_home_prices.isnull().sum()
print("Missing Values:\n", missing_values)
```

```
Missing Values:
MSPUS    0
dtype: int64
```

```
# Checking the data types
mortgage_rates.dtypes
```

```
MORTGAGE30US    float64
dtype: object
```

```
# Get a summary of the dataset structure and data types
print(median_home_prices.info())
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 247 entries, 1963-01-01 to 2024-07-01
Data columns (total 1 columns):
 #   Column  Non-Null Count  Dtype
---  -
 0   MSPUS   247 non-null    float64
dtypes: float64(1)
memory usage: 3.9 KB
None
```

```
# Get a statistical overview of numeric columns
print(mortgage_rates.describe())
```

```

      MORTGAGE30US
count    2797.000000
mean       7.721130
std        3.226492
min        2.650000
25%        5.250000
50%        7.360000
75%        9.370000
max       18.630000
```

```
# Check for missing values
missing_values = mortgage_rates.isnull().sum()
print("Missing Values:\n", missing_values)
```

```
Missing Values:
MORTGAGE30US    0
dtype: int64
```

```
# Checking the data types
housing_inventory.dtypes
```

```
ACTLISCOUUS    float64
dtype: object
```

```
# Get a summary of the dataset structure and data types
print(housing_inventory.info())
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 100 entries, 2016-07-01 to 2024-10-01
Data columns (total 1 columns):
#   Column          Non-Null Count  Dtype
---  -
0   ACTLISCOUUS    100 non-null    float64
dtypes: float64(1)
memory usage: 1.6 KB
None
```

```
# Get a statistical overview of numeric columns
print(housing_inventory.describe())
```

```

      ACTLISCOUUS
count    1.000000e+02
mean     9.001097e+05
std      3.124475e+05
min      3.465110e+05
25%      6.395675e+05
50%      8.967050e+05
```

```
75%    1.189005e+06
max     1.463007e+06
```

```
# Check for missing values
missing_values = housing_inventory.isnull().sum()
print("Missing Values:\n", missing_values)
```

```
Missing Values:
ACTLISCOUUS    0
dtype: int64
```

## Visualisation

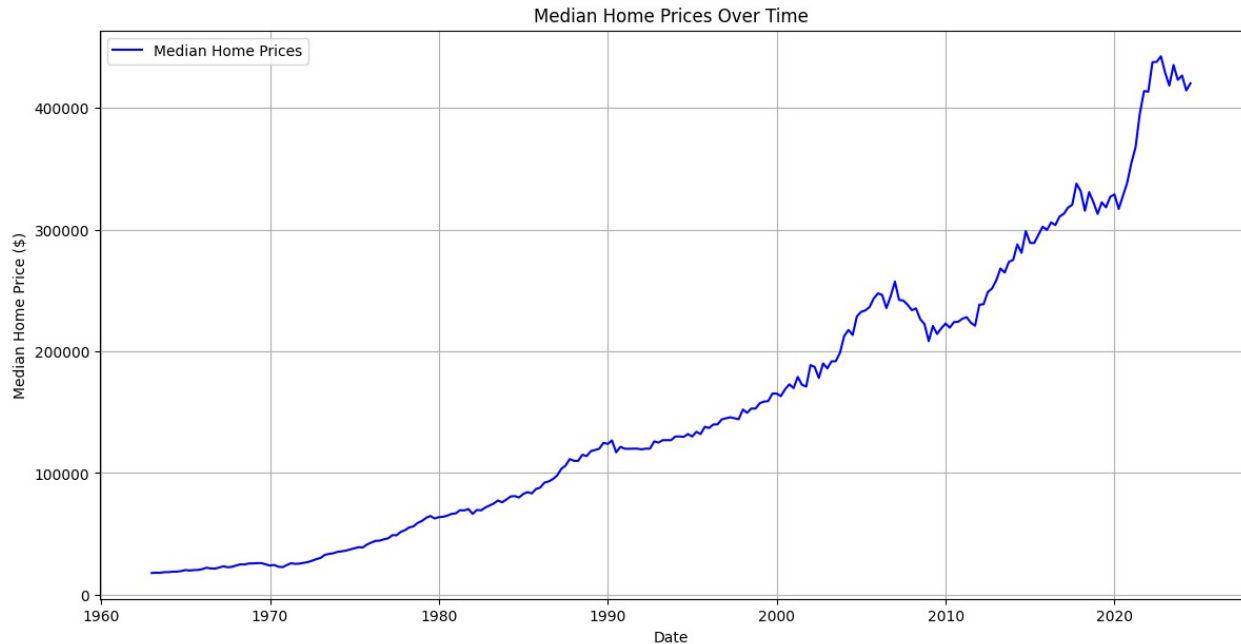
a. Line Charts (for each time series)

```
# Check the columns in the median home prices DataFrame
print(median_home_prices.columns)

Index(['MSPUS'], dtype='object')
```

Line Chart of Median Home Price over Time

```
plt.figure(figsize=(14, 7))
plt.plot(median_home_prices.index, median_home_prices['MSPUS'],
label='Median Home Prices', color='blue')
plt.title('Median Home Prices Over Time')
plt.xlabel('Date')
plt.ylabel('Median Home Price ($)')
plt.legend()
plt.grid()
plt.show()
```

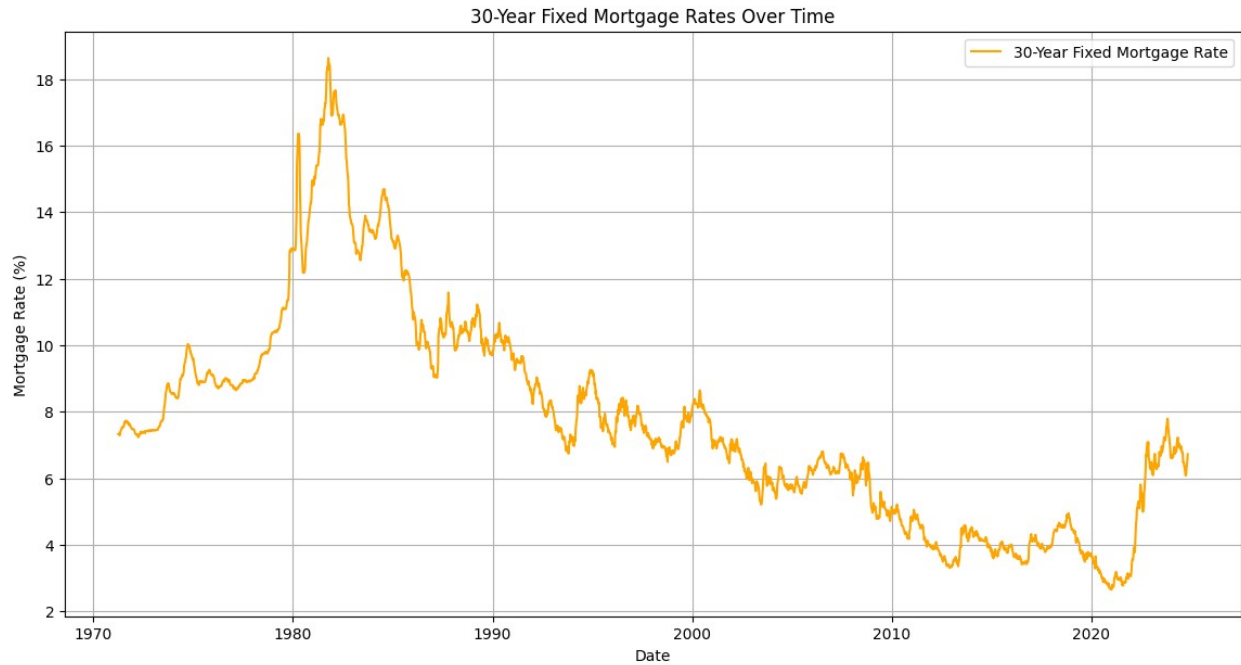


```
# Inspect the other datasets
print(mortgage_rates.columns)
print(housing_inventory.columns)

Index(['MORTGAGE30US'], dtype='object')
Index(['ACTLISCOUUS'], dtype='object')
```

Line Chart of 30-Year Fixed Mortgage Rates Over Time

```
plt.figure(figsize=(14, 7))
plt.plot(mortgage_rates.index, mortgage_rates['MORTGAGE30US'],
label='30-Year Fixed Mortgage Rate', color='orange')
plt.title('30-Year Fixed Mortgage Rates Over Time')
plt.xlabel('Date')
plt.ylabel('Mortgage Rate (%)')
plt.legend()
plt.grid()
plt.show()
```



Line Chart of Housing Inventory Over Time

```
plt.figure(figsize=(14, 7))
plt.plot(housing_inventory.index, housing_inventory['ACTLISCOUUS'],
label='Housing Inventory', color='green')
plt.title('Housing Inventory Over Time')
plt.xlabel('Date')
plt.ylabel('Number of Houses')
plt.legend()
plt.grid()
plt.show()
```



Line Chart of Comparison of Median Home Prices, Mortgage Rates, and Housing Inventory Over Time

```
fig, ax1 = plt.subplots(figsize=(14, 7))

# Plot Median Home Prices
ax1.set_xlabel('Date')
ax1.set_ylabel('Median Home Price ($)', color='blue')
ax1.plot(median_home_prices.index, median_home_prices['MSPUS'],
color='blue', label='Median Home Prices')
ax1.tick_params(axis='y', labelcolor='blue')

# Create a second y-axis for Mortgage Rates
ax2 = ax1.twinx()
ax2.set_ylabel('Mortgage Rate (%)', color='orange')
ax2.plot(mortgage_rates.index, mortgage_rates['MORTGAGE30US'],
color='orange', label='Mortgage Rates')
ax2.tick_params(axis='y', labelcolor='orange')

# Optionally add a third y-axis for Housing Inventory
ax3 = ax1.twinx()
ax3.spines['right'].set_position(('outward', 60)) # Move third axis
outward
ax3.set_ylabel('Housing Inventory', color='green')
ax3.plot(housing_inventory.index, housing_inventory['ACTLISCOUUS'],
color='green', label='Housing Inventory')
ax3.tick_params(axis='y', labelcolor='green')

# Adding title and show plot
```

```
plt.title('Comparison of Median Home Prices, Mortgage Rates, and  
Housing Inventory Over Time')  
fig.tight_layout()  
plt.show()
```

