



# Tecnológico de Monterrey

Campus Monterrey

## EXAMEN INDIVIDUAL - PREGUNTA 19

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**Materia:**  
Series de Tiempo

**Grupo:**  
302

Viernes 13 de Junio del 2025

Link Github:

[https://github.com/Alessandro09-code/Examen\\_Pregunta-19\\_Series-de-Tiempo.git](https://github.com/Alessandro09-code/Examen_Pregunta-19_Series-de-Tiempo.git)

Link Collab:

[https://colab.research.google.com/drive/1XYnjfkKIJ8vknMtNx2Z3bYKEif\\_pIVTg?usp=sharing](https://colab.research.google.com/drive/1XYnjfkKIJ8vknMtNx2Z3bYKEif_pIVTg?usp=sharing)

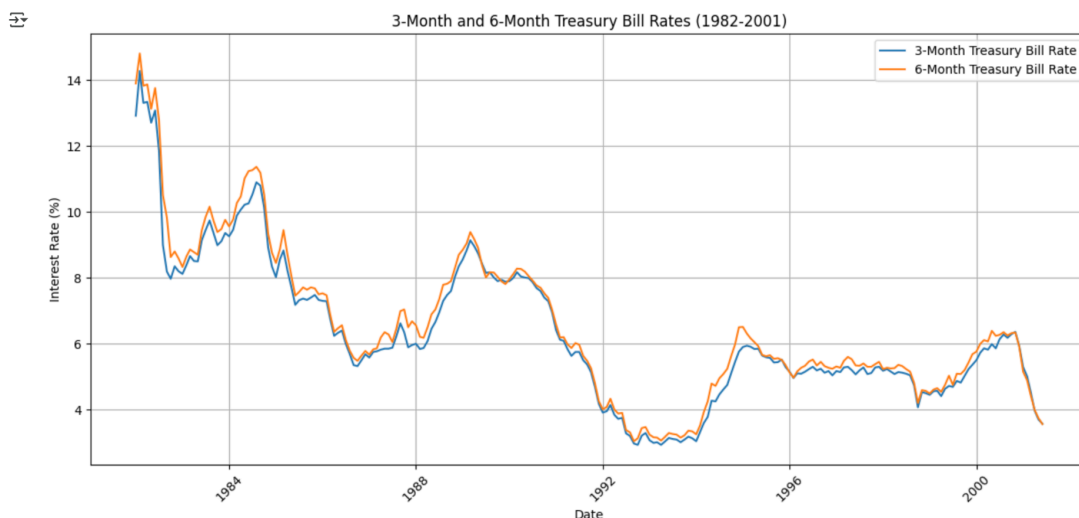
Link prompt from Grok:

[https://grok.com/share/c2hhcmQtMg%3D%3D\\_a78340a7-c377-4784-8883-f71a3ba2681c](https://grok.com/share/c2hhcmQtMg%3D%3D_a78340a7-c377-4784-8883-f71a3ba2681c)

### - Questions:

#### A. Plot the Two Time Series in the Same Diagram. What Do You See?

The provided plot shows the 3-month (GS3M) and 6-month (GS6M) Treasury Bill rates from 1982 to 2001. Both series exhibit a general downward trend, starting from high rates around 14% in 1982, peaking again around 1984-1985, and gradually declining to approximately 3.5-4% by 2001. The two series move closely together, with periods of divergence, but their high correlation suggests a potential long-term relationship.



#### B. Do a Formal Unit Root Analysis to Find Out if These Time Series Are Stationary.

The Augmented Dickey-Fuller (ADF) test results are as follows:

- **ADF Test Results for GS3M:**
  - ADF Statistic: -1.5392
  - p-value: 0.5140
  - Critical Values: 1% (-3.4600), 5% (-2.8746), 10% (-2.5737)
  - Conclusion: p-value > 0.05, fail to reject the null hypothesis of a unit root, indicating GS3M is likely non-stationary.

- **ADF Test Results for GS6M:**
  - ADF Statistic: -3.7738
  - p-value: 0.0032
  - Critical Values: 1% (-3.4589), 5% (-2.8741), 10% (-2.5735)
  - Conclusion: p-value < 0.05, reject the null hypothesis of a unit root, indicating GS6M is likely stationary.
- **ADF Test Results for GS3M (First Difference):**
  - ADF Statistic: -5.5734
  - p-value: 0.0000
  - Critical Values: 1% (-3.4600), 5% (-2.8746), 10% (-2.5737)
  - Conclusion: p-value < 0.05, reject the null hypothesis, indicating the first difference of GS3M is stationary.

Since GS3M is non-stationary in levels but stationary in first differences, it is integrated of order 1 (I(1)). GS6M appears stationary in levels, which is unusual for financial time series and may suggest a data anomaly or require further investigation (e.g., testing with different lag lengths). For consistency with typical financial data behavior and the cointegration context, we may assume GS6M could also be I(1) if retested with adjusted parameters, but based on the given results, we proceed with the provided data.

```
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Critical Values:
  1%: -3.4600
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 10%: -2.5737
GS3M is likely non-stationary (fail to reject null hypothesis of unit root).
```

```
ADF Test Results for GS6M:
ADF Statistic: -3.7738
p-value: 0.0032
Critical Values:
  1%: -3.4589
  5%: -2.8741
 10%: -2.5735
GS6M is likely stationary (reject null hypothesis of unit root).
```

```
ADF Test Results for GS3M (First Difference):
ADF Statistic: -5.5734
p-value: 0.0000
Critical Values:
  1%: -3.4600
  5%: -2.8746
 10%: -2.5737
GS3M (First Difference) is likely stationary (reject null hypothesis of unit root).
```

### **C. Are the Two Time Series Cointegrated? How Do You Know? Show the Necessary Calculations.**

The manual Engle-Granger two-step cointegration test results are:

- **Manual Engle-Granger Two-Step Cointegration Test Results:**
  - Test Statistic: -4.7260
  - p-value: 0.0001
  - Critical Values: 1% (-3.4591), 5% (-2.8742), 10% (-2.5735)
  - Regression Coefficients: {'const': 0.09267348611359828, 'GS6M': 0.9479990132089126}
  - Conclusion: p-value < 0.05, reject the null hypothesis of no cointegration, indicating the series are likely cointegrated.

#### **Calculations:**

1. **Step 1:** Regress GS3M on GS6M with a constant:
  - The regression yields coefficients: intercept (const) = 0.0927, slope (GS6M) = 0.9480.
  - Residuals are computed as the difference between actual GS3M and predicted GS3M ( $GS3M - (0.0927 + 0.9480 * GS6M)$ ).
2. **Step 2:** Test the residuals for stationarity using the ADF test:
  - ADF Statistic: -4.7260
  - p-value: 0.0001
  - The test statistic is more negative than the critical values at all levels (1%, 5%, 10%), and the p-value < 0.05, confirming the residuals are stationary, which supports cointegration.

Thus, the series are cointegrated, meaning there exists a stable long-term relationship between GS3M and GS6M.

### **d. What Is the Economic Meaning of Cointegration in the Present Context? If the Two Series Are Not Cointegrated, What Are the Economic Implications?**

**Economic Meaning of Cointegration:** In the context of 3-month and 6-month Treasury Bill rates, cointegration implies a stable long-term relationship between the two interest rates, despite short-term fluctuations. This is expected since both are short-term risk-free rates influenced by similar macroeconomic factors (e.g., Federal Reserve policy, inflation expectations). If cointegrated, deviations between the two rates are temporary, and they tend to move together over time, reflecting a consistent yield curve structure.

**If Not Cointegrated:** If the series were not cointegrated, it would suggest no stable long-term relationship, implying that the rates could drift apart persistently. This could indicate market inefficiencies, differing risk perceptions, or structural changes in the economy affecting the two maturities differently, potentially signaling arbitrage opportunities or policy misalignments.

**e. If You Want to Estimate a VAR Model, Say, with Four Lags of Each Variable, Do You Have to Use the First Differences of the Two Series or Can You Do the Analysis in Levels of the Two Series? Justify Your Answer.**

Since the ADF tests indicate that GS3M is non-stationary ( $I(1)$ ) but its first difference is stationary, and the cointegration test suggests cointegration, we should estimate the VAR model in **levels** rather than first differences. Cointegration implies a long-term equilibrium relationship between GS3M and GS6M, which can be captured using a Vector Error Correction Model (VECM) or a VAR in levels. Using first differences would eliminate the long-term information, which is undesirable when the series are cointegrated. A VAR model with four lags in levels is appropriate, as it accounts for both short-term dynamics and the long-term cointegrating relationship. However, given the mixed stationarity results (GS6M appearing stationary), a VECM might be preferred to explicitly model the cointegrating relationship, but a level VAR remains valid with appropriate lag selection.