



# "Engle-Granger Cointegration Model Applied To Private Debt In Mexico"

## *A Cointegration Case*

Based on <https://doi.org/10.6084/m9.figshare.14115731.v2>

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# Topics to cover

## **I. Theory**

*Abstract, a brief history of doom, story.*

## **II. Mathematical Approach**

*Series, cointegration 101, diagrams, data analysis.*

## **III. Stata Commands**

*Import, config, graph, reg, predict, estat dwatson, dfuller, VAR.*

## **IV. Notes**

*Where the model fails, issues we do not see.*

## **V. Ideas**

*Useful cases and final project.*

## **VI. State of the art**

*Beyond time series...and even econometrics.*

# I. Theory

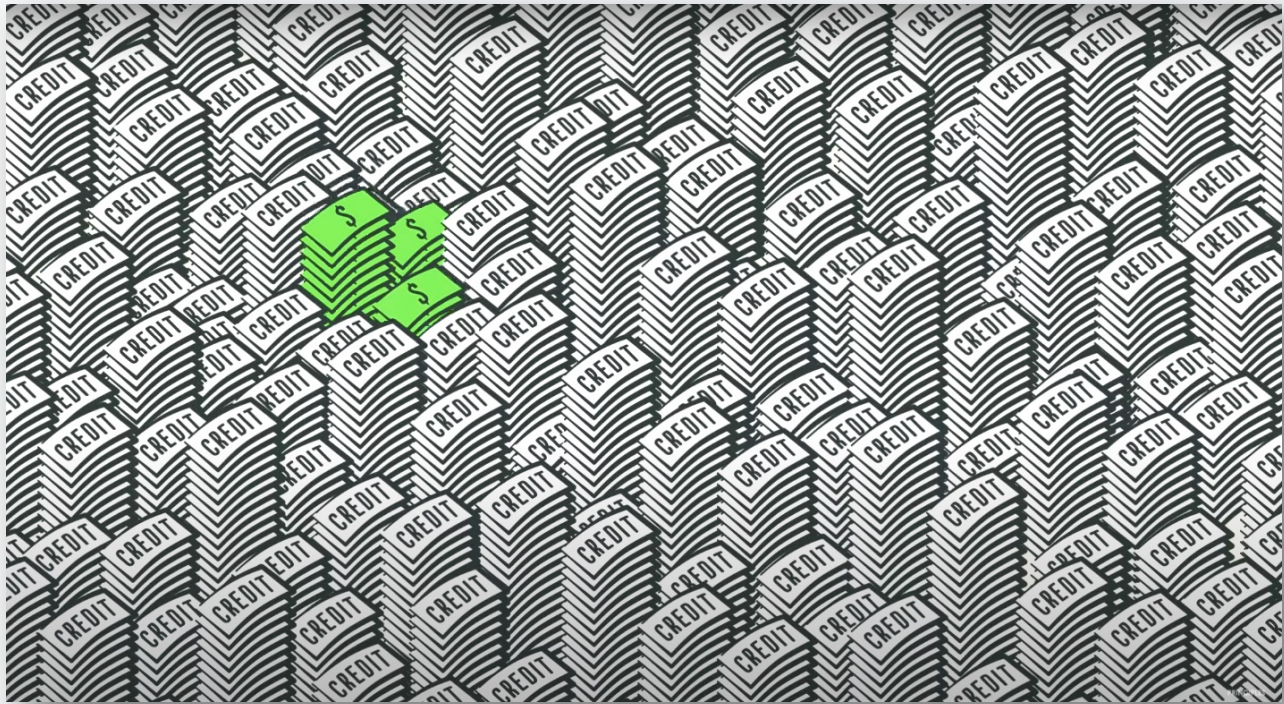
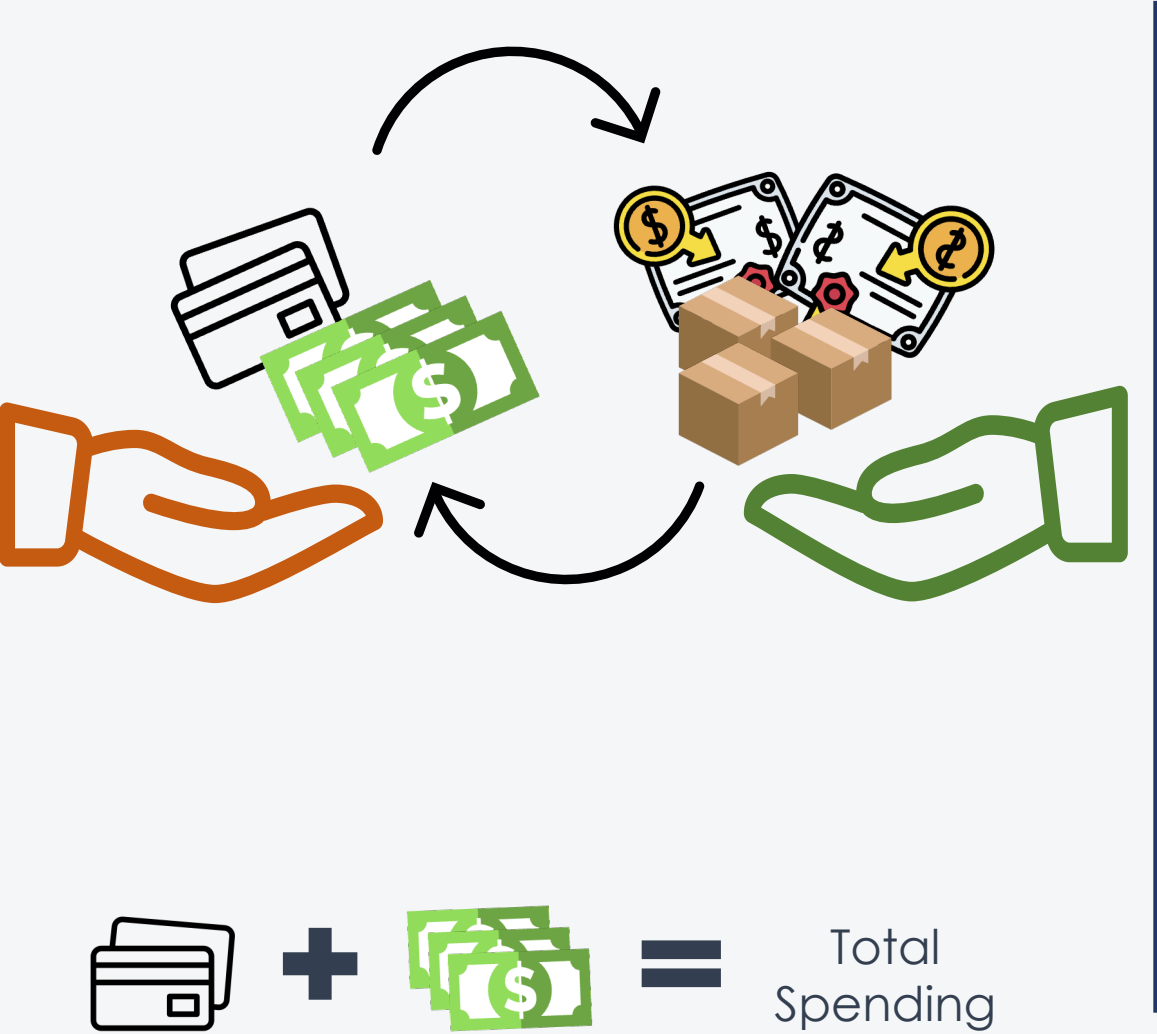
# Abstract

“In economics theory it is said that for every borrower that **pays interest and reduces spending** in the long term, there is a lender that **receives them** and because of that, its **spending increases**. In practice this tend **not to be true** since lenders **do not need to increase their spending by the same amount that borrowers cut back**. To prove this statement, we take three variables which are Mexico’s GDP, private debt, and unemployment rate. We use an Engle-Granger cointegration test to see whether they cointegrate in the long term or not”.



# Dalio's perspective

Based on <https://youtu.be/npoNbXXS4oQ>





# A better approach

## A Brief History of Doom

Two Hundred Years of Financial Crises

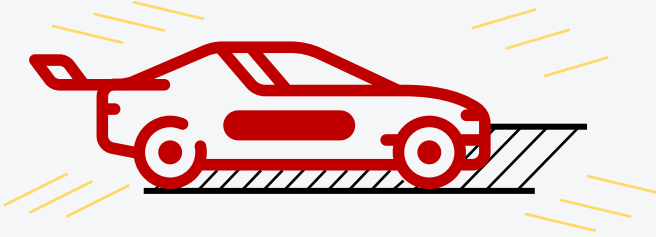


Richard Vague

- Private debt has been a factor in every crisis **since 200 years**...and people did not even take it into account **before 2008 crisis!**
- *Why have economist ignored private debt as a component? Maybe because most senior economist had been educated when private debt **was low**, or perhaps they neglect the role of private debt in **creating new money** and thus heightening demand.*

# The country of Oz

## I. The asset



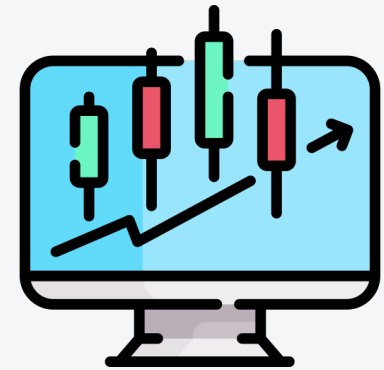
- Solar energy
- Ultralight materials
- Travel on monorails

## II. Entrepreneurs



- Air rights
- Right-of-ways
- Hire operators and technicians
- Service to customer

## III. Not enough



- Stock are not sufficient to provide capital...we need to borrow

# The country of Oz

## IV. Heavyweights



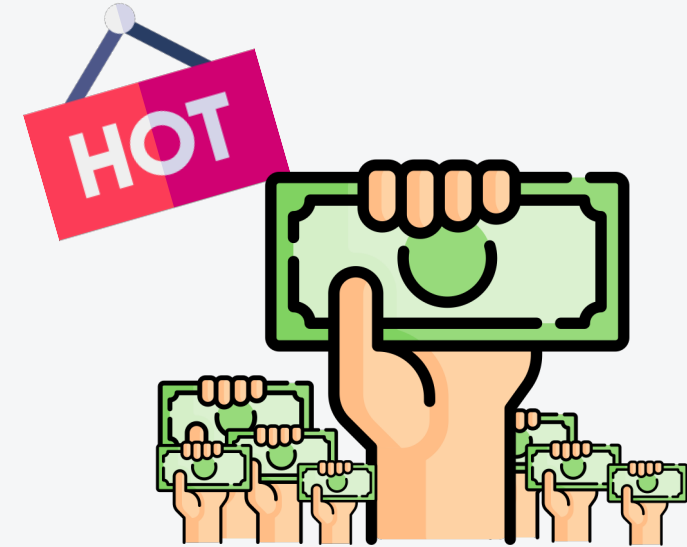
- Infrastructure Banks (IBs) & Ozian parliament
- 20 years earlier to aid capital-intensive LT infrastructure projects
- **Minimal capital requirements & tax advantages**
- Low regulation

## V. Irrational Exuberance



- Value of land grows
- As loan collateral increases, lending does
- IB stocks are hotter
- **Employment rises**
- **GDP thrives**
- Startups everywhere

## VI. Get in



- Everyone wants to get in
- Fear to lose it
- Survivorship bias
- Conventional Banks get in the lending game
- Mortgage lenders get in



# The country of Oz

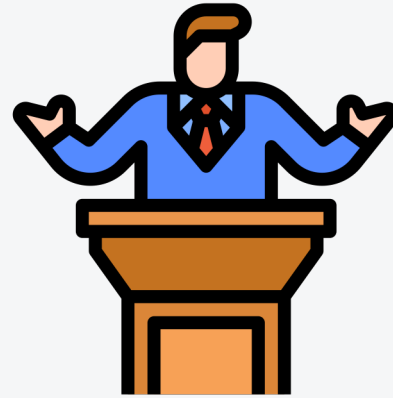
## VII. Projections



- Commercial Real Estate begins **building** major new office parks due to its growth



## VIII. Politicians



- Prime minister of Oz takes full credit caliming "Oz has entered a new era of prosperity due to policies and adminstration"
- Projections keep growing....



## IX. Pull back



- Concerns take place with one entity and goes from one to another
- Press take a big role
- Bondholders Pull back

# The country of Oz

## X. 2033



- Dissapointment follows dissapointment
- CRE and banks think any problem would be limited to heliocars...
- Were they diversified?

## XI. Not too big to fail



- “Yellow Brick Heliorail” discontinues operations due lack of strategic alternatives
- Smaller heliorail companies followed

## XII. Chaos



- Ozian 500 stock takes a tumble!
- Central Bank soon commits to stemming the damage!
- Acquisitions everywhere!
- Unemployment rate shoots up!
- Rising delinquency!
- Politicians take advantage on their side of the catastrophe!
- Economists thinks it was a “black swan” ....ha!

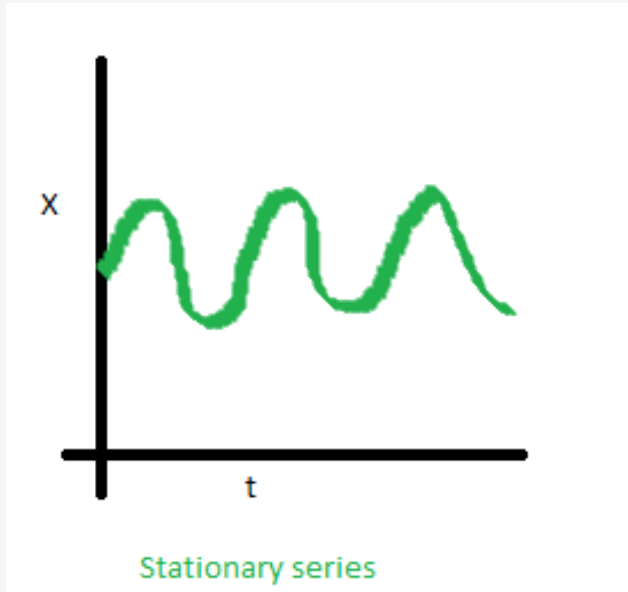
# The country of Oz

*Epilogue.  
10 years later, it happens once again*

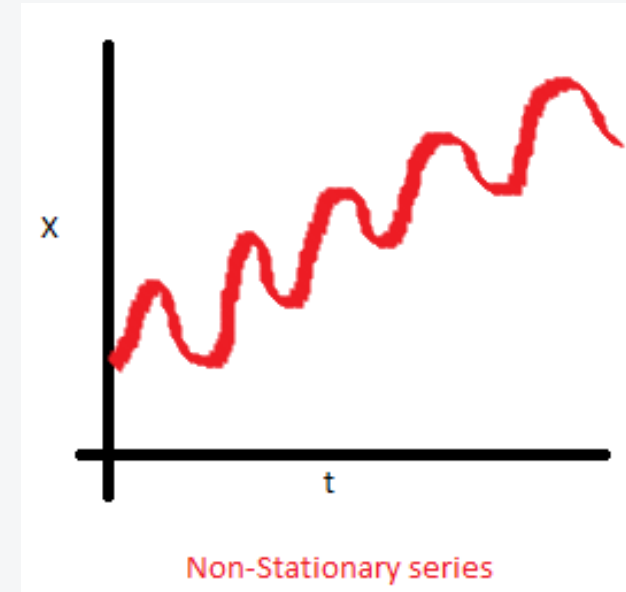


# **II. Mathematical Approach**

# Cointegration



- $I(0)$
- Flat looking series
- No trend
- Constant variance over time
- Constant autocorrelation structure over time
- No periodic fluctuations



- Pure random walk
- Random walk with drift
- Deterministic trend
- Random walk with drift and deterministic trend

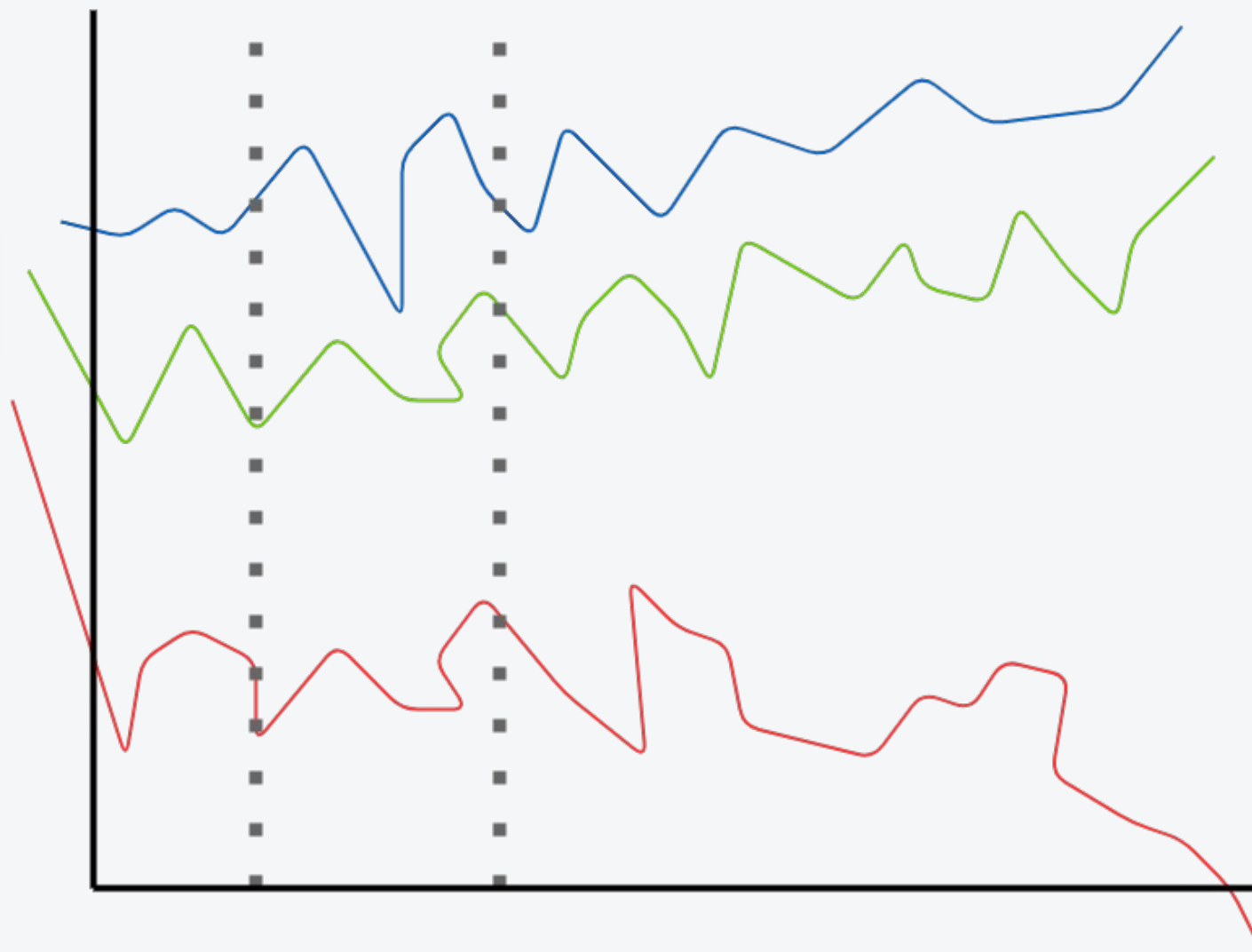


# Cointegration

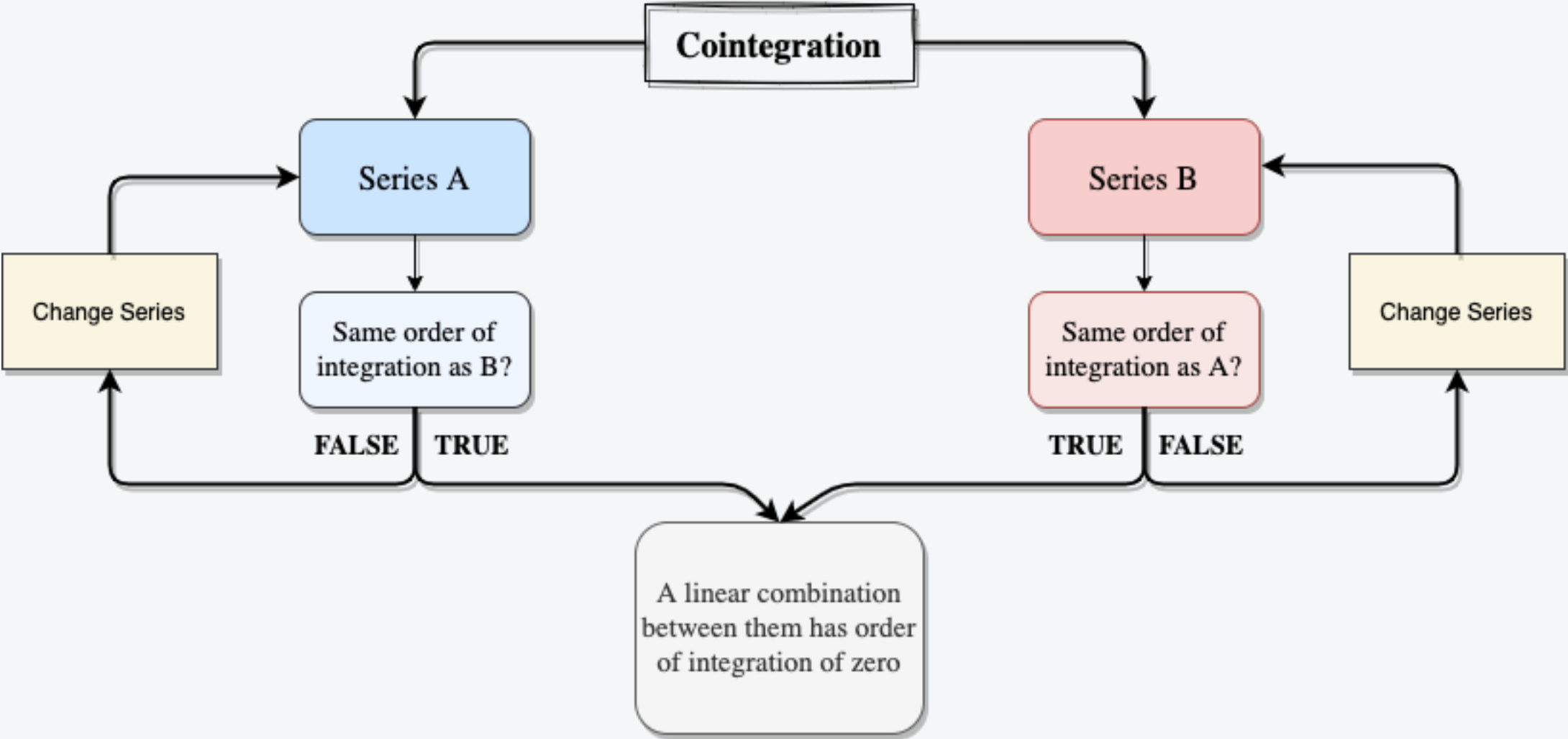
## *Why long term matters...*

### **A Drunk and Her Dog: An Illustration of Cointegration and Error Correction**

Michael P. MURRAY



# Cointegration



# Cointegration

**What is a linear combination series?** It can be the errors we get from both series A ( $X_t$ ) and series B ( $Y_t$ ) such that

$$X_t = \beta_0 + \beta_1 Y_t + U_t$$

$$Y_t = \beta_0 + \beta_1 X_t + U_t$$

Assume they have the same order of integration, then we have the error as a linear combination

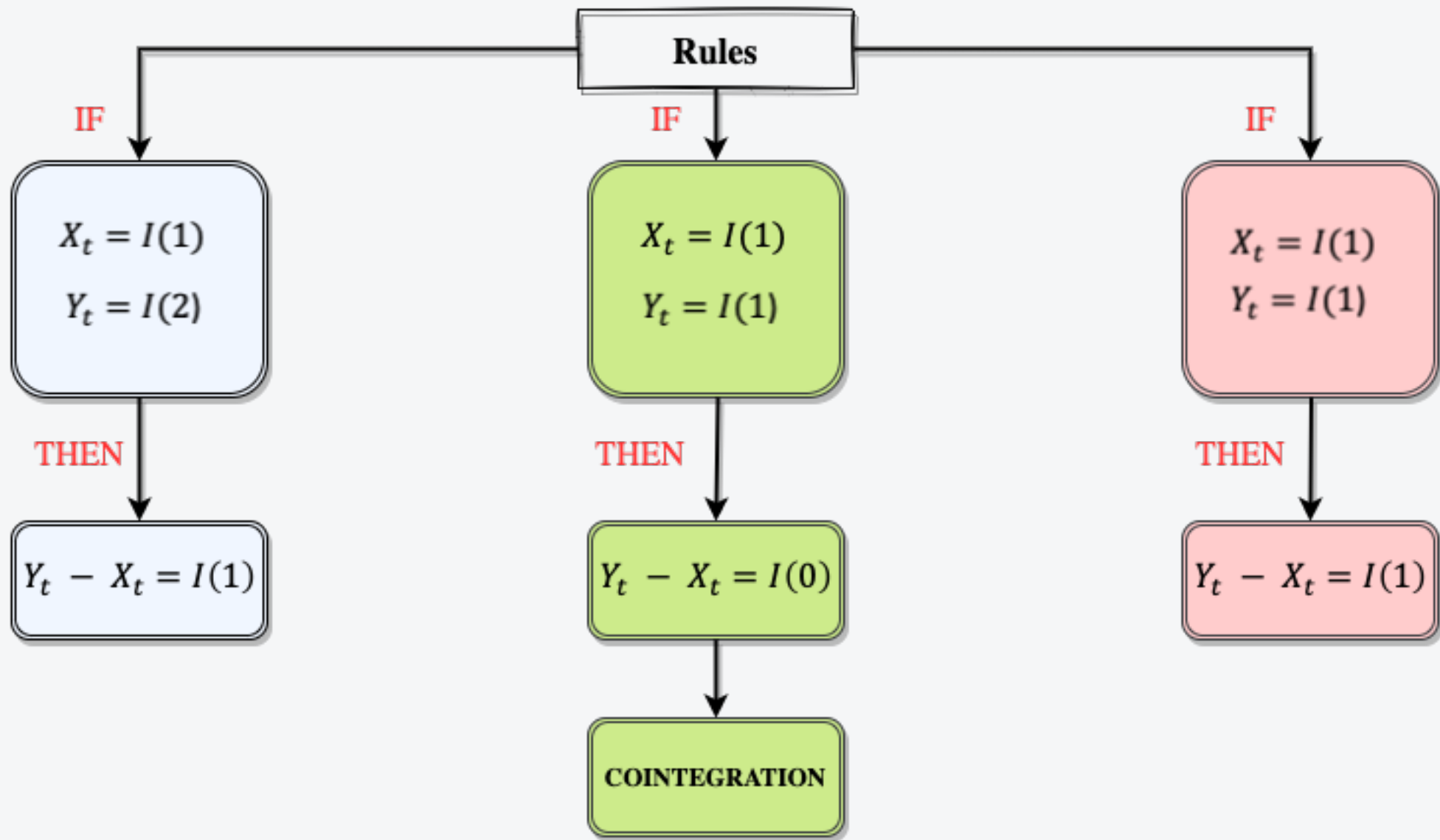
$$U_t = Y_t - (\beta_0 + \beta_1 X_1)$$

so it must be

$$U_t = I(0)$$

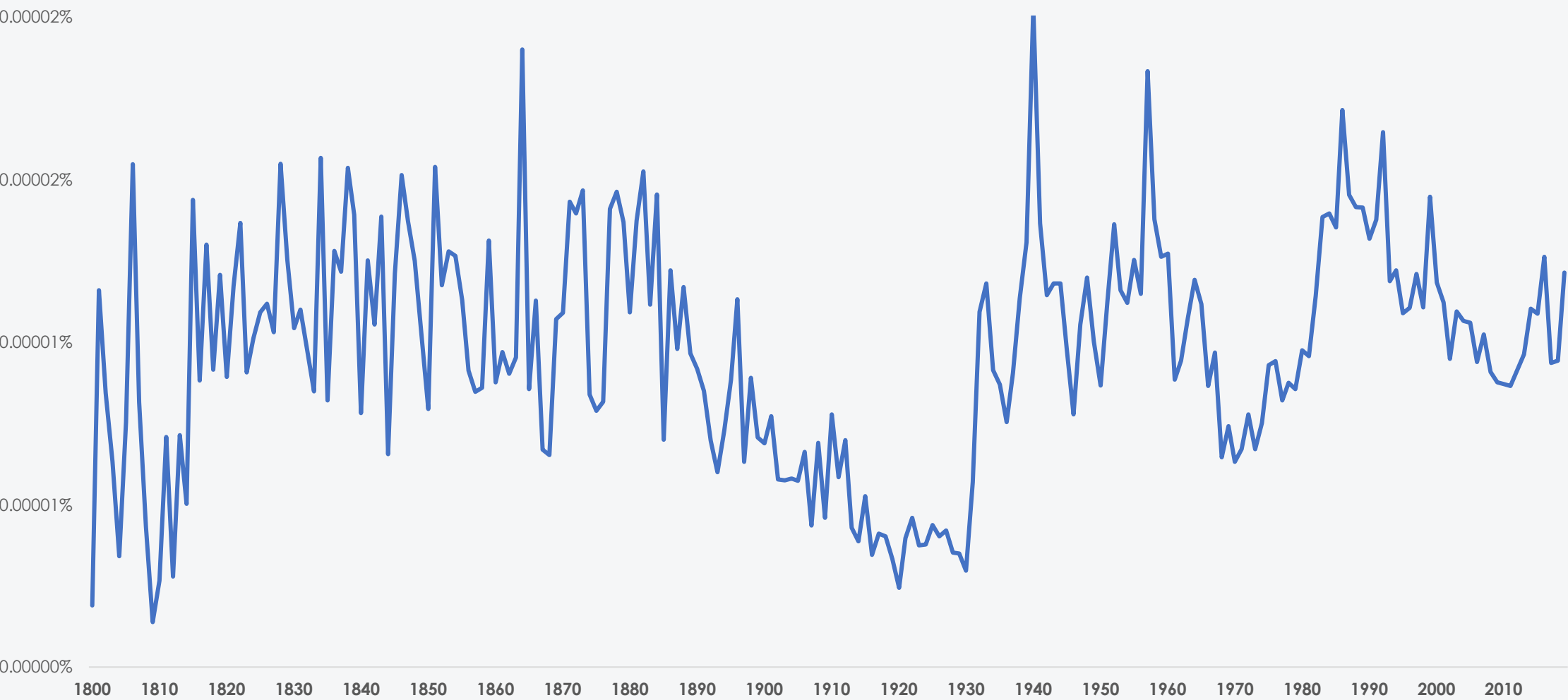
in order for A and B to be cointegrated

# Cointegration



# Data Analysis: Ngram

Google Ngram for "Private debt"  
English 2019

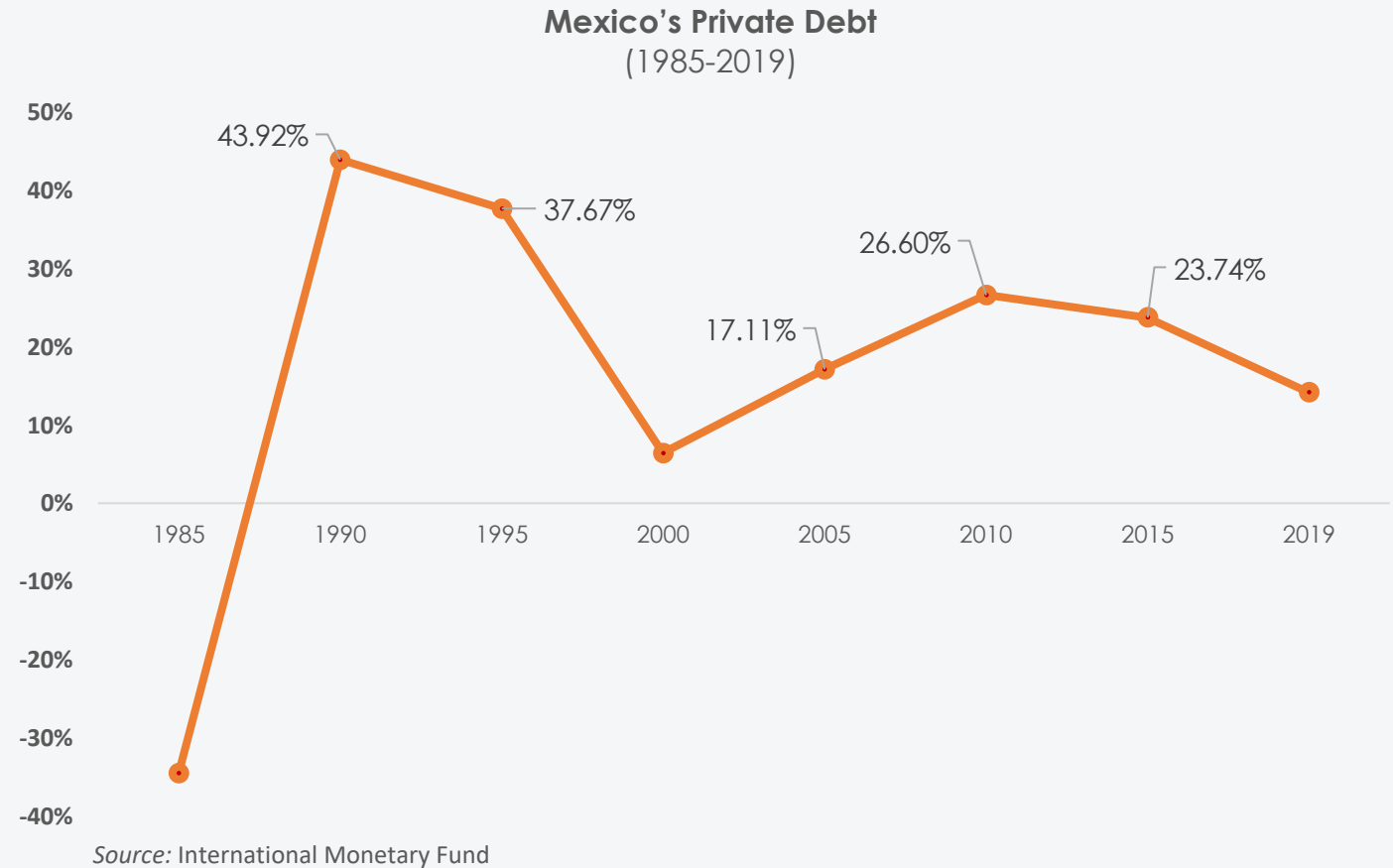


Source: Google Ngram, <https://tinyurl.com/yjx9sf4h>



## Data Analysis: Ratio

*“... a financial crisis is highly likely to happen if the ratio of private debt to GDP **grows by about 15 to 20 percentage point or more in a five-year period**, and the ratio of overall private debt of GDP reaches or exceeds 150 points”*



# **III. STATA commands**

# PD vs GDP

## I. Import and config

- File -> Import -> Excel Spreadsheet
- *Mark (Import first row as variable names)*
- `tsset year`

## II. Graph

- `gen lnpd = ln(pd)`
- `gen lngdp = ln(gdp)`
- `tsline lnpd lngdp`

## III. Regression

- `dfuller lnpd`
- `dfuller lngdp`
- `reg lnpd lngdp`
- `estat dwatson`
- **Note:** if  $R^2 > DW \Rightarrow$  Spurious regression

## IV. Error

- `predict error0, resid`
- `gen derror0 = D.error0`
- `reg derror0 L.error0`
- `estat dwatson`
- `dfuller error0, lag(1)`

## V. Correction

- `dfuller error0, lag(n)`
- `gen ten=_n`
- `reg lnpd lngdp ten`
- `predict error1, resid`
- `gen derror1 = D.error1`
- `reg derror1 L.error1`
- `dfuller error1, lag (n)`

$H_0$ : Unitary root (Non-Stationary)

$H_1$ : No unitary root (Stationary)

**Note:** if p.value small => strength of evidence againsts Null hypothesis increases

## II. Graph

- `tsline lnpg ur`

## III. Regression

- `reg lnpg ur`
- `estat dwatson`
- **Note:** if  $R^2 > DW \Rightarrow$  Spurious regression

## IV. Error

- `predict error2, resid`
- `gen derror2 = D.error2`
- `reg derror2 L.error2`
- `estat dwatson`
- `dfuller error2, lag(1)`

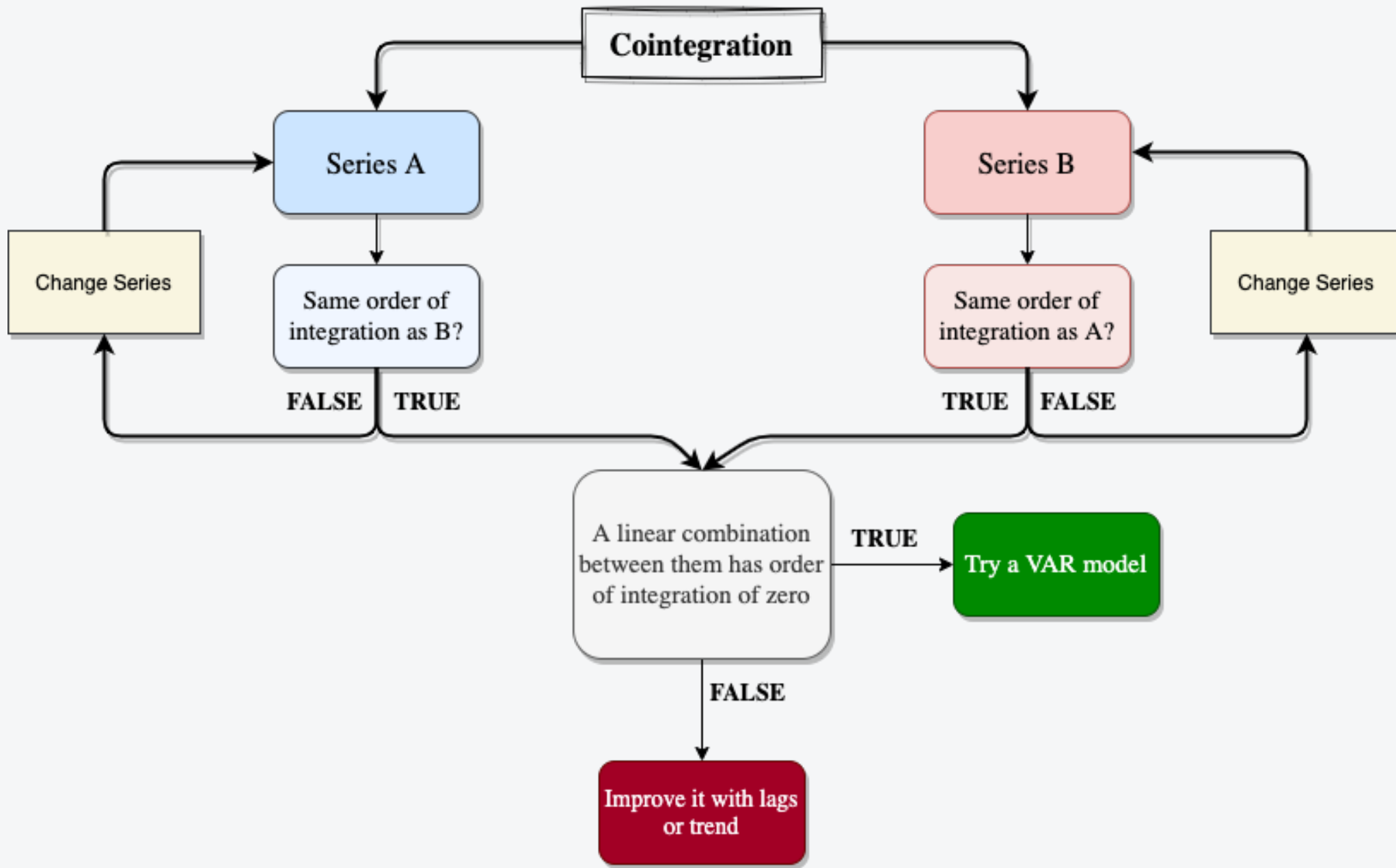
## V. Correction

- `dfuller error2, lag(n)`
- `gen ten=_n`
- `reg lnpg lngdp ten`
- `predict error3, resid`
- `gen derror3 = D.error3`
- `reg derror3 L.error3`
- `dfuller error3, lag (n)`



## Engle Granger test

- `ssc install egranger`
- `egranger lnrd lngdp`
- `egranger lnrd ur`
- `egranger lnrd lngdp ur`



# VAR

- `varsoc lnpg lngdp`
- `varbasic lnpg lngdp, lags(1) step(4)`
- `varstable, graph`
  
- `varsoc lnpg ur`
- `varbasic lnpg ur, lags(2) step(4)`
- `Varstable, graph`

# IV. Notes

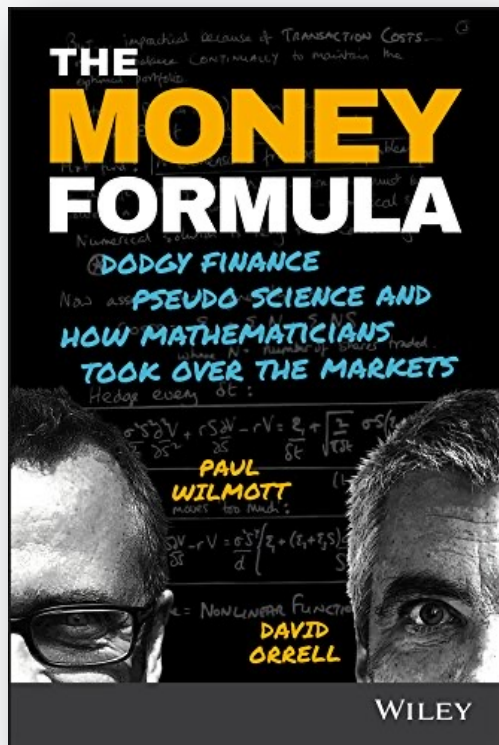
## Where the model fails...

- *As we have seen the model needs to take over 11-12 lags to be cointegrated, which is quite difficult if there is not a large dataset as our example.*
- *Perhaps it shows a cycle, but still in doubt...*
- *According to Richard Vague, there are more parameters we can take into account to understand private debt and crisis, but our task is to ask ourselves on parsimony and frugality.*
- *Richard Vague takes countries like US, UK, Japan, Germany, France, China, Spain, Korea, and Austria Hungary, so the question is whether his theory can rely on countries from Latin America*

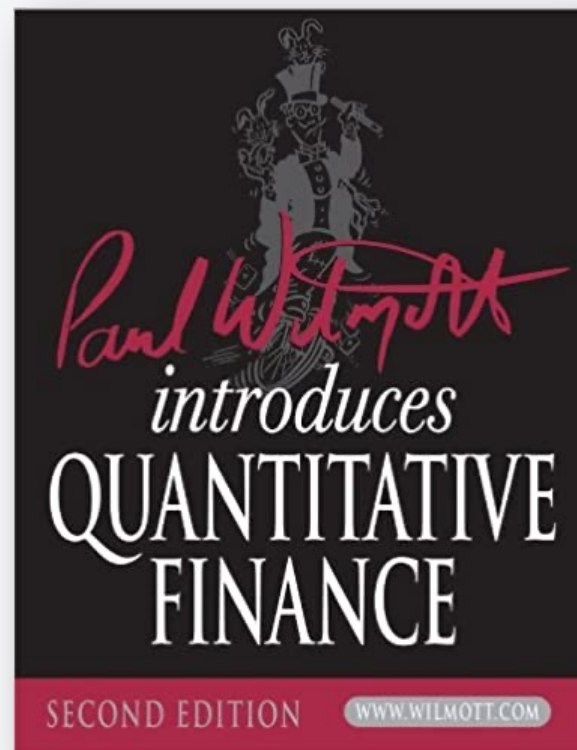


# V. Ideas

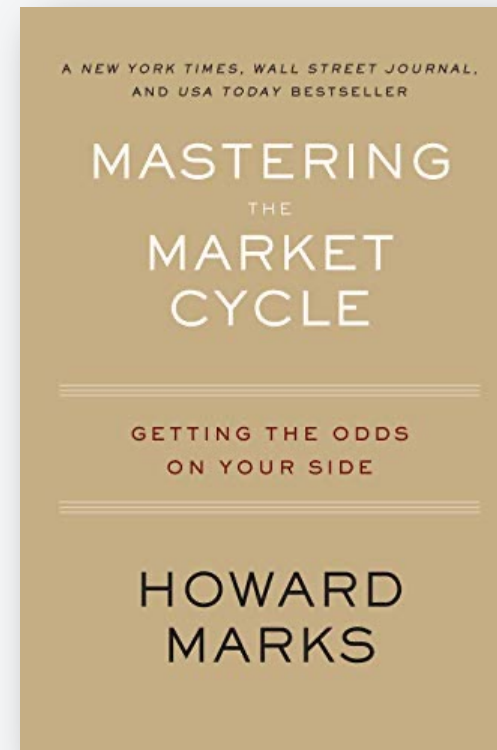
## Further Reading:



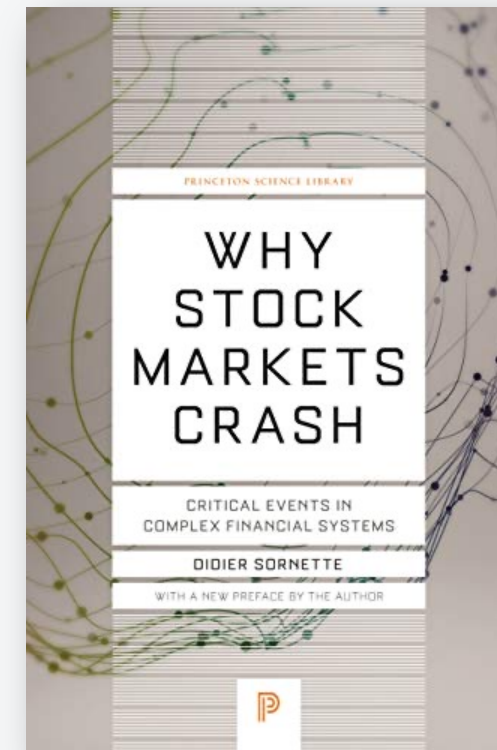
**Chapter 2:** “Going Random”



**Pages 283, 454:**  
Correlation vs. Cointegration,  
Derivatives, CAPM and MPT



**Pages 48-54:** Economic trends, population, cycles

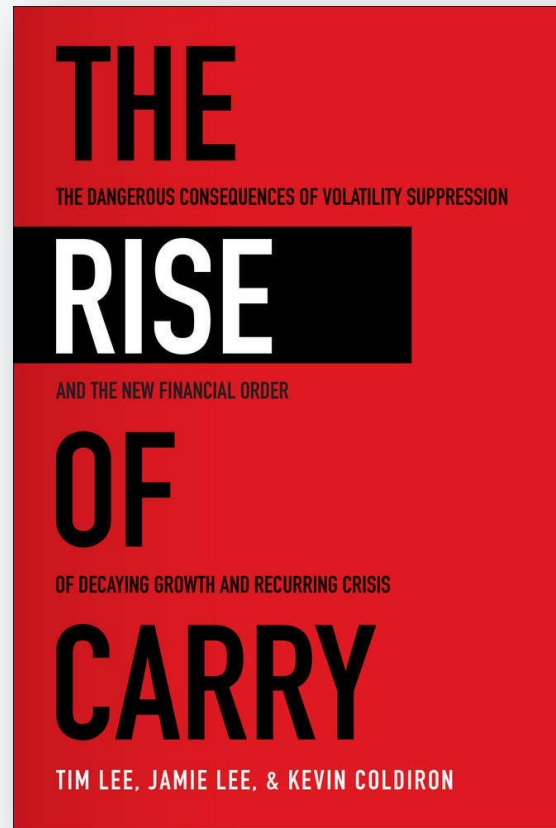


**Chapter 1, pages 5-6:**  
Factors that affect the market

## Further Reading:



**Chapter 1, pages 14-15:** Leverage and diversification (check out Yardeni's website)



*Cointegration of volatility-selling, leverage, liquidity, profitability, companies' balance sheet*

## China set to report first population decline in five decades

Officials are preparing response to census data that should have been released weeks ago

Source: <https://on.ft.com/3AiY2RQ>

## The severe cost of the world's baby bust

The chemicals that are contributing to the decline in fertility must be banned

Source: <https://on.ft.com/3hiDlqO>

## Letter: China's population decline hurts its global ambitions

From Ira Sohn, Emeritus Professor of Economics and Finance, Montclair State University, Upper Montclair, NJ, US

Source: <https://on.ft.com/3gZUr3q>

## Chinese economy: Beijing's war on the credit boom

A campaign led by vice-premier Liu He to reduce the danger of uncontrolled lending could strangle the private sector

Source: <https://on.ft.com/3dojVVL>

# References:

- Vague, R. (2019), “*A brief history of doom*”, University of Pennsylvania Press, USA
- National Institute of Standards and Technology, “*Stationarity*”, Engineering Statistic Handbook, in: <https://www.itl.nist.gov/div898/handbook/pmc/section4/pmc442.htm>
- Murray, M. (1994), “A drunk and her dog: An illustration of Cointegration and Error Corection”, American Satistical Association, in: <http://www-stat.wharton.upenn.edu/~steele/Courses/434F2005/Context/Co-integration/Murray93DrunkAndDog.pdf>