

Exercise: Please investigate factors related to investments in the USA, create visualization using the lattice package.

I. Data overview

1. Summary

The dataset is investments in the USA, an annual time series from 1963 to 1982 with 7 variables.

GNP	Investment	Price	Interest
Min. : 596.7	Min. : 90.9	Min. : 0.7167	Min. : 3.230
1st Qu.: 855.0	1st Qu.: 131.4	1st Qu.: 0.8167	1st Qu.: 4.500
Median : 1256.2	Median : 200.6	Median : 1.0288	Median : 5.685
Mean : 1487.1	Mean : 234.3	Mean : 1.1724	Mean : 6.565
3rd Qu.: 1979.7	3rd Qu.: 339.7	3rd Qu.: 1.4264	3rd Qu.: 7.553
Max. : 3073.0	Max. : 474.9	Max. : 2.0688	Max. : 13.420

RealGNP	RealInv	RealInt
Min. : 832.6	Min. : 126.8	Min. : -3.0566
1st Qu.: 1046.5	1st Qu.: 160.5	1st Qu.: 0.1742
Median : 1208.7	Median : 184.1	Median : 0.7210
Mean : 1198.3	Mean : 189.1	Mean : 0.9757
3rd Qu.: 1386.9	3rd Qu.: 219.3	3rd Qu.: 1.7463
Max. : 1513.8	Max. : 258.8	Max. : 5.0038
		NA's : 1

2. Variables

- **GNP (Gross National Product):** Gross national product, the market value of all final goods and services produced by citizens of a country, both domestic and foreign.
- **Investment:** Total investment in the economy
- **Price:** Price Index, used to measure the average change in prices in the economy over time.
- **Interest:** Nominal Interest Rate, the interest rate not adjusted for inflation.
- **RealGNP:** Real Gross National Product, which is GNP adjusted for inflation.
- **RealInv:** Real Gross Investment, which is Investment adjusted for inflation.
- **RealInt:** Real Interest Rate, which is Interest adjusted for inflation.

II. Data Processing

1. Create “year” column

Create an additional column “Year” to serve the purpose of building overtime reports

	GNP	Investment	Price	Interest	RealGNP	RealInv	RealInt	Year
1	596.7	90.9	0.7167	3.23	832.5659	126.8313	NA	1963
2	637.7	97.4	0.7277	3.55	876.3227	133.8464	2.01518767	1964
3	691.1	113.5	0.7436	4.04	929.3975	152.6358	1.85503367	1965
4	756.0	125.7	0.7676	4.50	984.8880	163.7572	1.27245831	1966
5	799.6	122.8	0.7906	4.19	1011.3838	155.3251	1.19364773	1967
6	873.4	133.3	0.8254	5.16	1058.1536	161.4975	0.75827979	1968
7	944.0	149.3	0.8679	5.87	1087.6829	172.0244	0.72098134	1969
8	992.7	144.2	0.9145	5.95	1085.5112	157.6818	0.58071782	1970

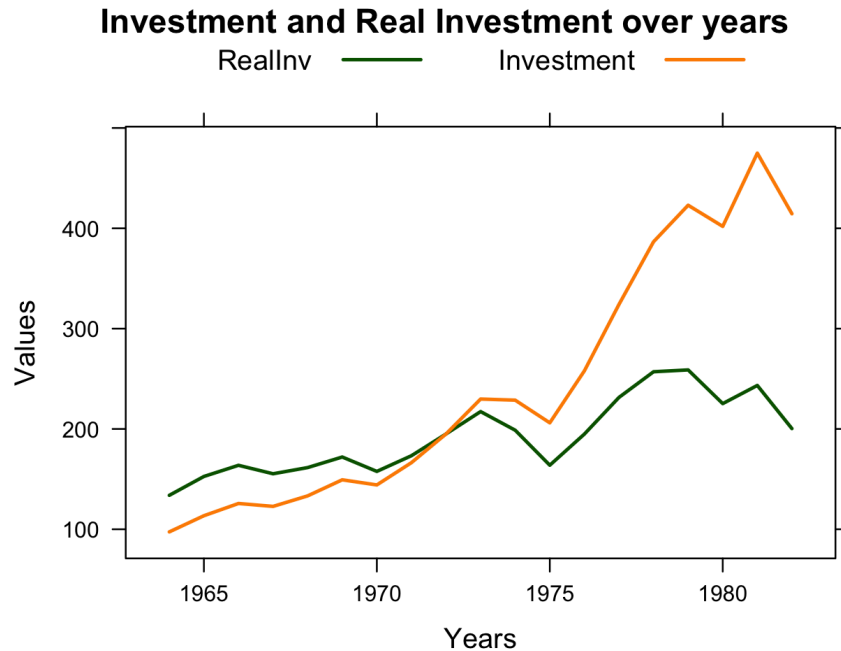
2. Handling missing data

Notice that the RealInt column has the first row with NA values, we can remove this row to avoid affecting the analysis.

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9	1077.6	166.4	0.9601	4.88	1122.3831	173.3153	-0.10633133	1971
10	1185.9	195.0	1.0000	4.50	1185.9000	195.0000	0.34418290	1972
11	1326.4	229.8	1.0575	6.44	1254.2790	217.3050	0.69000000	1973

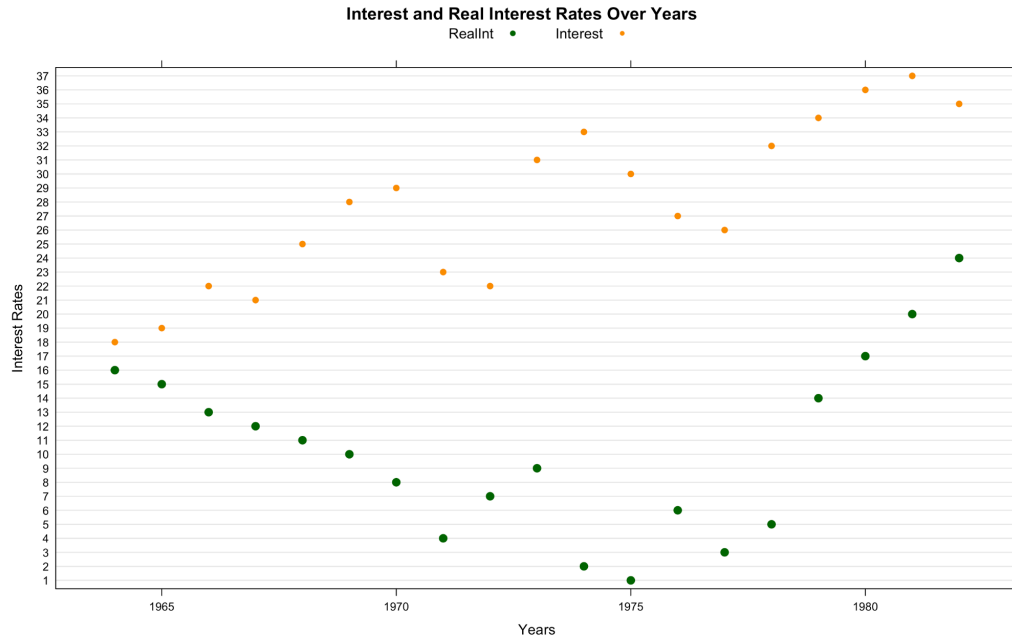
III. Data Analysis

1. Real Investment and Investment over years



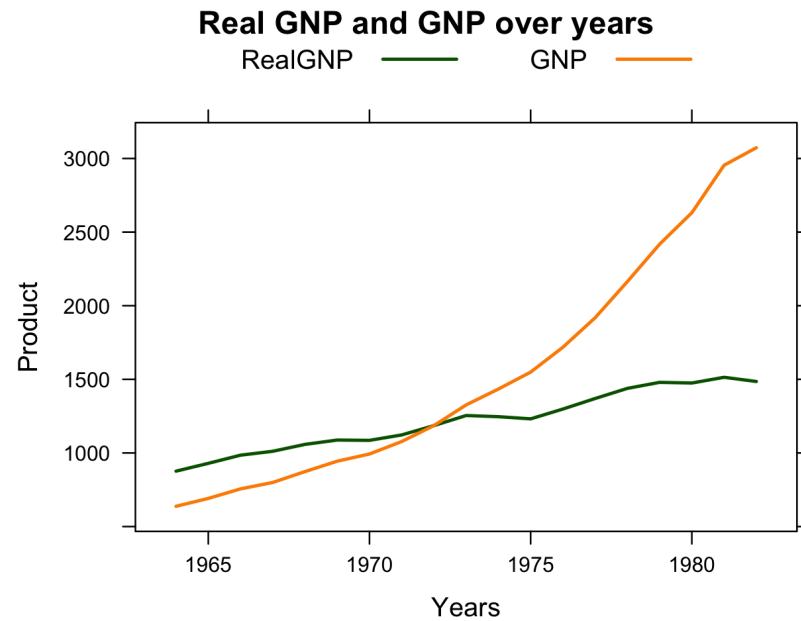
- In general, investment as well as real investment in the US tends to increase steadily over the years.
- The period 1973 - 1975 witnessed a rapid decrease in total real investment, but soon after that, it received a very high real investment and peaked in 1979.
- Notably, considering the period before 1975, the Investment and Real Investment value lines still had a small difference, the period after that witnessed a large difference between Investment and Real Investment, which shows that inflation in this period increased very quickly.

2. Real Interest Rate and Interest Rate over years



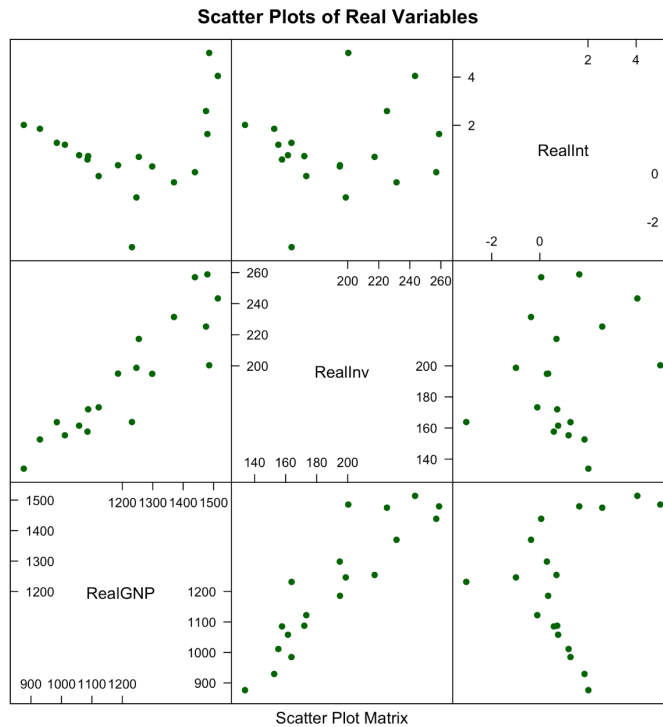
- It is noteworthy that the Nominal Interest Rate and Real Interest Rate recorded two different trends in the period from 1963 to 1982, which reflected the instability in the US economy, especially the large inflation.
- It can be seen that the real interest rate index in this period showed signs of decline and bottomed out in 1975. However, the following period witnessed the growth of real interest.

3. Real GNP and GNP over years



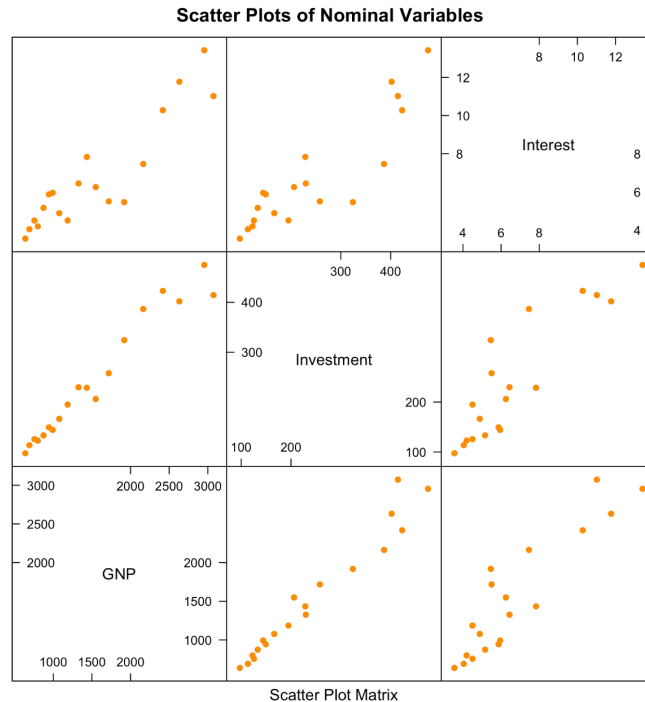
- The difference between nominal GNP and Real GNP is also seen in the above chart for the period 1963 - 1982
- In general, nominal GNP as well as Real GNP tended to increase during this period

4. Scatter Plot Matrix of Real Variables



- A positive correlation can be seen between Real GNP and Real Investment
- There does not appear to be a linear relationship between Real Investment and Real Interest

5. Scatter Plot Matrix of Nominal Variables



- A positive correlation can be seen between all three nominal variables.

⚠ Note:

We see that there is no linear relationship between Real Investment and Real Interest but there is a positive relationship (positive correlated) between Nominal Investment and Nominal Interest, which shows that:

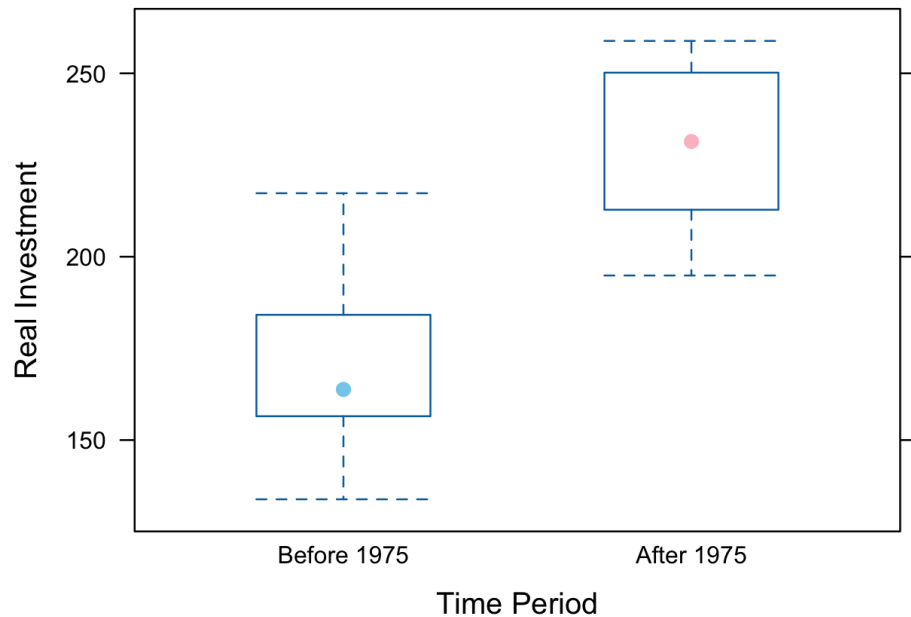
- The positive relationship between nominal interest rates and nominal investment does not reflect real economic efficiency, but is the result of the increase in monetary value due to inflation. Meanwhile, real investments (Real Investment) are only affected by real economic factors such as real cost of capital (Real Interest), economic growth, and real profit expectations.
- Inflation is the main factor causing the difference between these two relationships. When inflation increases, nominal indicators are often inflated and do not reflect reality.

6. Comparison of Real Investment Before and After the year 1975

Looking at the time series charts above, we can see that 1975 marks different trends in the variables Real Investment, Investment, Real Interest Rate, and Interest Rate. To clarify this, we can check by dividing the dataset into two periods:

- Before 1975
- After 1975

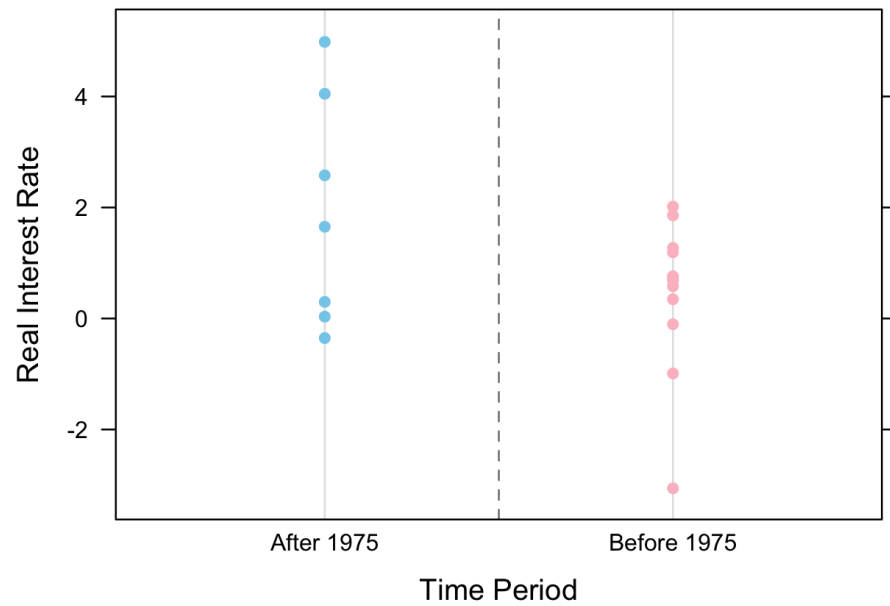
Comparison of Real Investment Before and After 1975



- The boxplots above show that the median and IQR of Real Investment in these two periods are completely different.

7. Comparison of Real Interest rate Before and After the year 1975

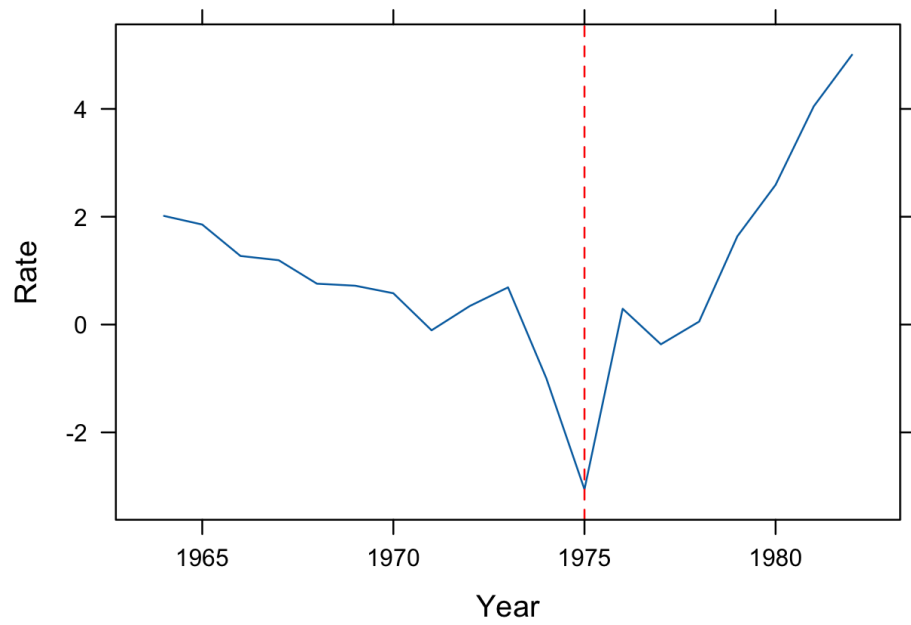
Real Interest Rates Before and After 1975



- It can be seen that the period after 1975, real interest rate are recorded higher than the period before 1975, which shows the recovery of the economics in the USA.

8. Real Interest Rate over years

Real Interest Rate Over Time



- It can be seen that 1975 was the year when the real interest rate of the United States hit rock bottom
- After 1975, the real interest rate had a remarkable growth