# Testing the quantity theory of money

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Hello everyone. Today I will talk about testing the quantity theory of money.

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I will introduce it in four parts from the basic of the theory to long run and short run application and finally I will share some of the problems arising from the analysis.

## Quantity Theory of Money Basics

Quantity theory of money:

$$P \times Y = M \times V$$

Transform it into a theory of inflation:

$$\%\Delta P + \%\Delta Y = \%\Delta M + \%\Delta V \quad (*)$$

$$\rightarrow \quad \pi = \%\Delta P = \%\Delta M + \%\Delta V - \%\Delta Y$$

Assuming V is constant:

$$\pi = \%\Delta M - \%\Delta Y$$

(*) Percentage Change in (x * y) = (Percentage Change in x) + (Percentage Change in y)

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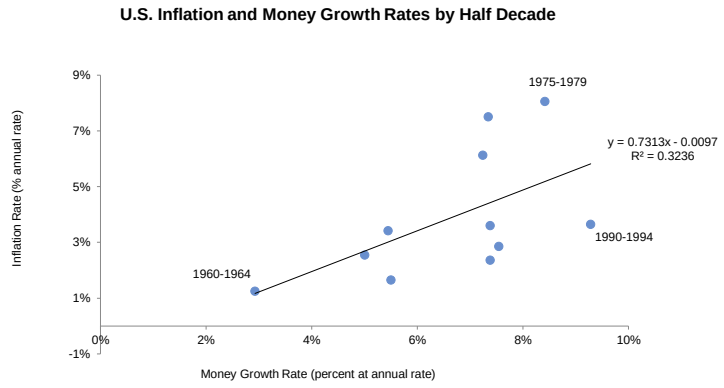
The first one is the Quantity Theory of Money Basics. It is represented as $P \times Y = M \times V$. We want to find how inflation can be represented, so we transform it as $\%\Delta P + \%\Delta Y = \%\Delta M + \%\Delta V$, because percentage change of P is pie, so it can be written as $\pi = \%\Delta M + \%\Delta V - \%\Delta Y$. Then we assume velocity is constant, so the percentage change in V is 0, and finally we get $\pi = \%\Delta M - \%\Delta Y$. This equation shows that the inflation rate equals the growth rate of the money supply minus the growth rate of aggregate output.

Now the quantity theory of money has been outlined, we may apply it to the test with actual data over the long and short runs.

## Quantity Theory of Money in the Long Run




Sources: Federal Reserve Bank of St. Louis, FRED database: http://research.stlouisfed .org/fred2/.

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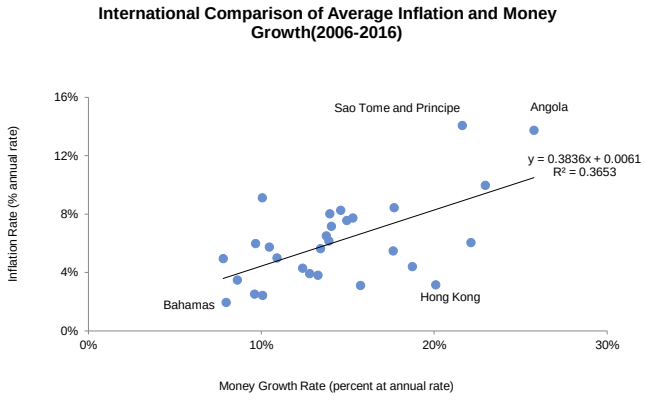
For the long run, I got the data of CPI and M2 of the US in the recent 60 years. This can be calculated for inflation and money growth rate. I made this figure after excluding 2 very extreme points like 2008. This figure plots 5-year averages of US inflation rates against the 5-year average of US money growth rates from 1960 to 2016. Because the growth rate of aggregate output Y over 5-year periods does not vary too much, it can be regarded as a constant. So the 5-year inflation rate should be the 5-year money growth rate minus a constant. This means that inflation and money growth rate should indicate a positive relationship and this figure shows that this is correct to a great extent. We can see that inflation rate is typically higher when money growth rate is also high.

To explain it specifically, I made a regression and the result is convincing as R-square is over 0.3. Also, the coefficient of money growth rate is 0.73. It's very close to 1 and the intercept of the line is about negative 0.01. This shows that average annual output growth rate is about 1% over the past 60 years for the US and this is also close to the true value. Moreover, periods when the US was experiencing high output growth rate, the point tend to be at downright like 1990-1994. Periods when the US was experiencing low output growth rate, the point tend to be at upleft, like 1975-1979.

## Quantity Theory of Money in the Long Run




Sources: International Financial Statistics. International Monetary Fund, http://www.imfstatistics.org/imf/.

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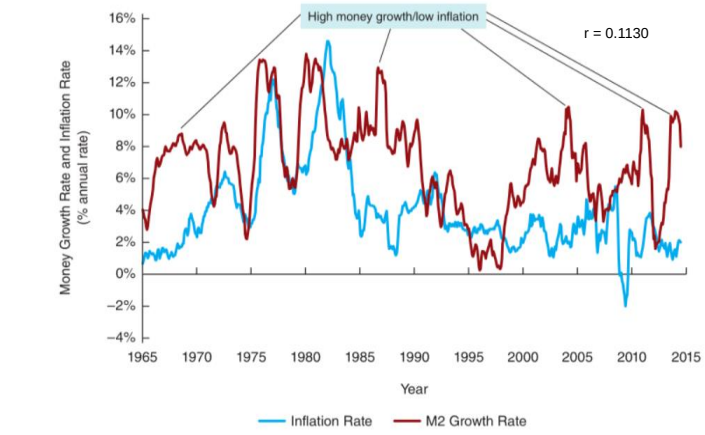
Here we come to other countries. The quantity theory not only applies to the US, but to other countries as well. I got the data of CPI and M2 of 30 countries provided by International Monetary Fund and excluded Switzerland because it is too extreme. Then I calculated inflation rate and money growth rate to make the figure. This figure plots the average inflation rate over the 10-year period from 2006-2016 against the 10-year money growth rate for several countries. This also shows that countries with higher money growth rates tend to have higher inflation rates.

I also made a regression for this figure. R-square here is also over 0.3 and it confirms such linear relationship. But the slope and intercept here are a little wired, and I will discuss it later.

## Quantity Theory of Money in the Short Run




Sources: Federal Reserve Bank of St. Louis, FRED database: http://research.stlouisfed .org/fred2/.

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For the short run, this figure plots the annual U.S. inflation rate from 1965 to 2014 against the annual money growth rate from two years before. The reason why money growth rate lags by two years is that it allows for the time people need to change their perception so that money growth can affect inflation. I just copy the figure from the textbook here. This figure provides evidence of the link between money growth and inflation in the short run. We can see that the relationship between inflation and money growth is not strong. I calculated the correlation coefficient of these two time-series data and it is just over 0.1. Moreover, there are many years in which money growth was high but inflation was low like 1965-1970, 1985-1990, and 2000-2005. So, it is hard to confirm a positive relationship.

## Quantity Theory of Money in the Short Run

- Long run √ short run╳
- "Inflation is always and everywhere a monetary phenomenon."
  ——Milton Friedman
- Why not short run?

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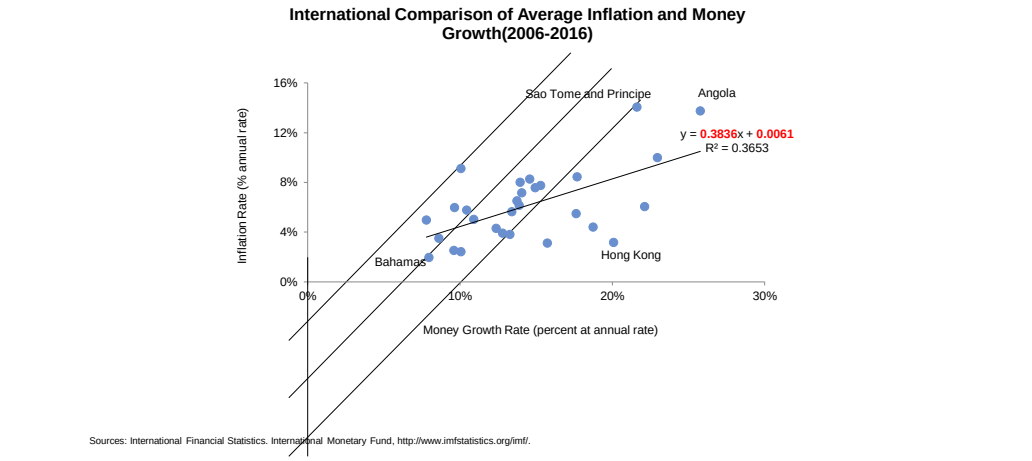
So we can conclude that the quantity theory of money is a good theory of inflation in the long run but not in the short run. And Milton Friedman once said "inflation is always and everywhere a monetary phenomenon." This saying in chapter 1 is accurate in the long run but is not supported by data for the short run. So, why doesn't this theory hold in the short run? Classical economists assume that wages and prices are completely flexible. But in reality, wages and prices need time to adapt to other changes and the time disparity can be different at different ages. So this may to some extent lead to the invalidation of quantity theory of money in the short run.

## Something More

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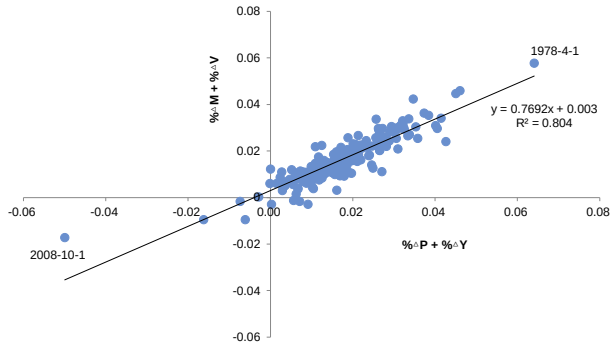
I have finished the main part, then I will just mention something more. This is the quantity theory of money in the long run in different countries. Just now I mentioned that for the regression line, the slope and intercept is a little wield. The slope is far from 1 and the intercept is above 0. It seems that output growth rate is below 0 for these countries. But that should not be the case. So I thought that maybe for countries with high money growth rate, its output growth rate is also high, so that when drawing a line with slope of 1 and cross the point, the intercept will be low. And, this figure is different from the US figure because for the US, output growth rate doesn't fluctuate too much in different years but the growth rate can be quite different across the world, so when I draw different lines with slope of 1, the intercept can vary a lot. Also we can see that the intercepts are all below zero, it means that output growth rate is positive for these countries and this is in line with the reality.

## Something More

Back to $\%\Delta P + \%\Delta Y = \%\Delta M + \%\Delta V$:




r = 0.89668

Sources: Federal Reserve Bank of St. Louis, FRED database: http://research.stlouisfed .org/fred2/.

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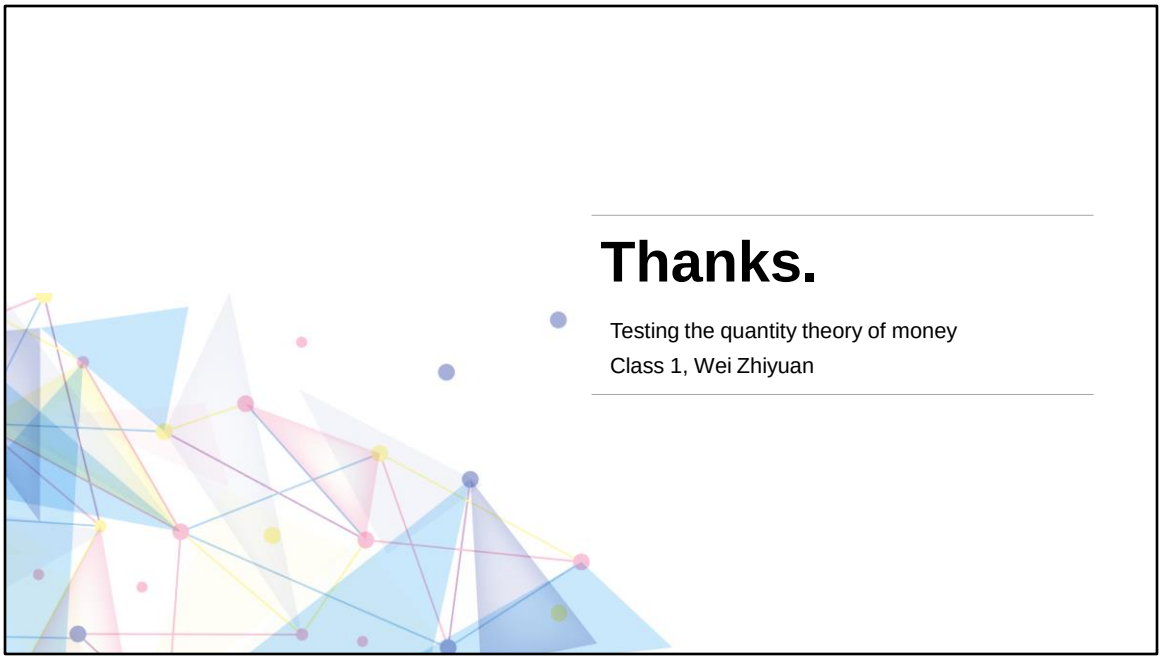
Now we back to the original equation, the graphs before all assume that percentage change of Y and V is constant so that they dismiss the fluctuations of percentage change of Y and V. But actually they are not that constant, so the graphs before all experience violent fluctuations. Now I add them back and get the quarter data of percentage change of CPI, GDP, M2 and M2 velocity. I plus the percentage change of CPI with that of GDP as one variable and plus percentage change of M2 with that of M2 velocity as another. After regression, the figure shows a very strong positive relationship between the two variables. The slope is close to one and the intercept is close to 0. Also the correlation coefficient is very close to1.




So that’s all for my statement, thank you for your watching.