Monetary Economics

A longstanding problem in macroeconomics is to formally incorporate money into the analytical framework. One reason why this is not so easily done in a convincing way is that modern currencies closely resemble fiat money (i.e. unbacked and intrinsically worthless objects that function as money). Thus, explaining why such objects have value often puts the level of analysis way above the undergraduate level.

Objects Serving as Money

1. Gold, silver, copper, salt, sea shells.

2. Certificates to gold or tobacco.

3. Modern paper money: US dollars.

1 and 2 are commodity monies, whereas 3 is fiat money (unback and intrinsically worthless objects)

Functions of Money

1. Medium of exchange.

2. Medium of account.

3. Store of value.

4. Standard of deferred payment.

[US dollars - serve in all four functions]

Physical Properties of Objects

1. Portability

2. Divisibility

3. Recognizability

4. Durability

Some argue that objects that have these properties are promising candidates for a useful media of exchange to be used in decentralized exchange.

One could argue that either US dollars or certificates to some underlying commodities could be made to be display these properties to a large degree.

See Stanley Jevons (1875) "Money and the Mechanism of Exchange" for historical monies, functions and properties of money.

Questions about Money

1. Are there potential gains to replacing a commodity money with fiat money?

2. Is there an arbitrage opportunity between T-bills and dollar bills?

3. Is money simply a creation of the State?

Tentative answers: 1. yes, 2. yes and 3. no

Economic Organization of a POW Camp

1200- 2500 prisoners per camp

Red Cross Pkg: Cigarettes, Milk, Chocolate, ...

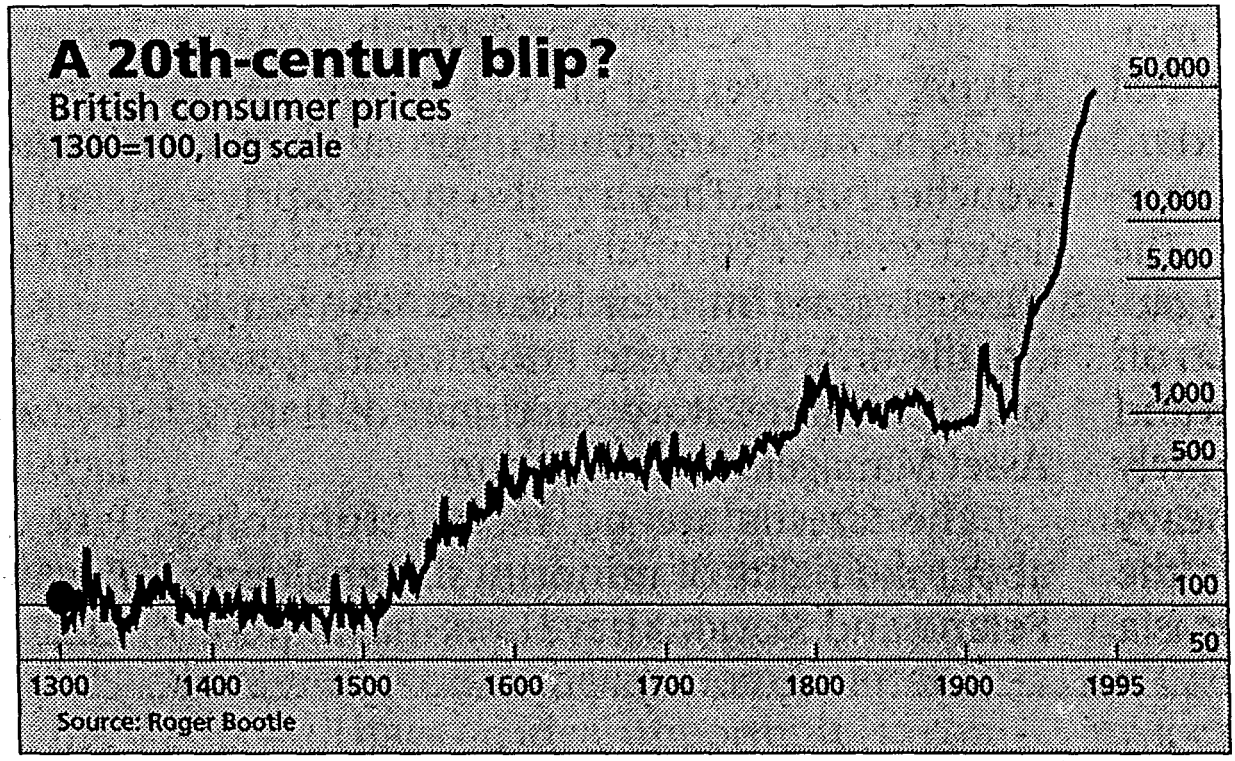
Economic Organization: free decentralized exchange

Issues: How is exchange transacted?

Upshot: Money arises endogenously.

Price Level: Theory and Empirics

Wikipedia credits David Hume and John Stuart Mill among others with developing a theory of the price level, now called the Quantity Theory of Money. They probably saw some version of the British price series data contained on the next slide. They developed an explanation for the pattern.


A 20th-century blip?
British consumer prices
1300=100, log scale
50,000
10,000
5,000
1,000
500
100
50
1300
1400
1500
1600
1700
1800
1900
1995
Source: Roger Bootle

Quantity Theory

$$MV = PY$$

Assume: V constant

M and V - money and velocity

P and Y - price and output

Quantity Theory: Implications

(1) P is proportional to M/Y since $P = \frac{MV}{Y}$

(2) $\Delta M/M \doteq \Delta P/P + \Delta Y/Y$

Both equations offer straightforward tests of the quantity theory simply by means of a scatter plot.

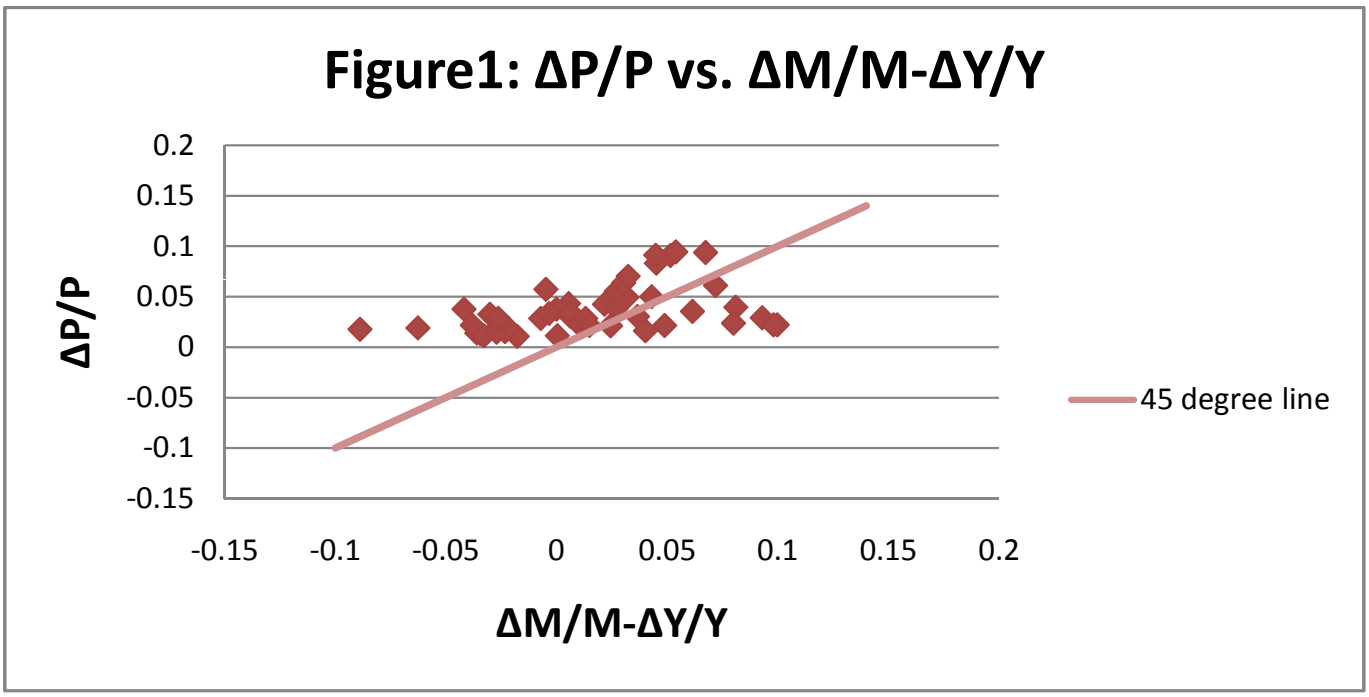


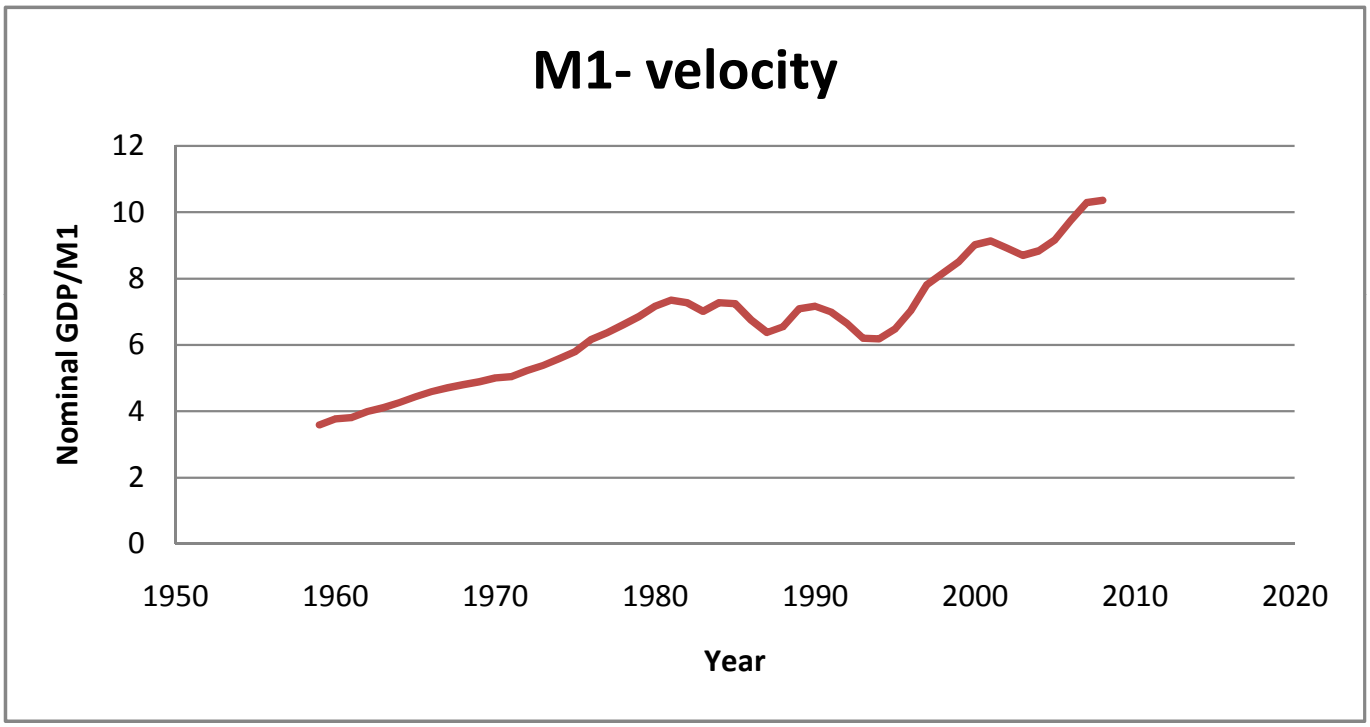
Figure1: ΔP/P vs. ΔM/M-ΔY/Y
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
ΔP/P
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
ΔM/M-ΔY/Y
45 degree line

Measuring Velocity

If we have an empirical measure of total money M, total output Y and the price level P, then one can "back out" velocity.

$$V = \frac{PY}{M}$$

How does such an empirical velocity measure move?


M1- velocity
Nominal GDP/M1
12
10
8
6
4
2
0
1950
1960
1970
1980
1990
2000
2010
2020
Year

Quantity Theory: A Simple Foundation

1. Each student is given M tokens.

2. Put candy ($Y = 10$ units) into vending machines and set price.

3. All students purchase candy with tokens.

4. End of day: collect tokens from own machine and remove rotten candy

Clarification:

It is understood that all students love candy and that acquiring tokens is the only way to get candy. This is one way for worthless tokens to have value. It is also understood that the sequence of events 2, 3 and 4 is repeated each day forever.

Question:

How should student's set the price of candy bars on their own vending machine?

Clearly, if a student sets the lowest price then that student sells out first. The highest price student will sell out last but may not sell all the candy.

Equilibrium: set price optimally, given others prices.

Equilibrium:

An equilibrium occurs when each student chooses the same price and the price satisfies the equation below:

$$P = \frac{M}{Y} = \frac{M}{10}$$

M - number tokens per student

Y - number candy bars per student

Two Questions:

1. What happens in this economy if Georgetown University doubles the number of tokens given to each student?

2. What happens if Georgetown University allows students to remove tokens twice per day - after lunch and after dinner?

Is Money A Veil?:

One might think that money is largely a veil in this candy bar economy. There is a long line of thought that views money as unimportant and as hiding the real workings of the economy. At the most extreme, some view money as neutral. Thus, changes in money or in the mechanism by which money works do not affect real quantities (e.g. GDP, real interest rates and real wage rates) but do affect nominal quantities.

Real and Nominal Interest Rates:

The gross nominal interest rate measures the number of units of money one receives next period for giving up 1 unit of money now.

The gross real interest rate measures the number of baskets of goods one receives next period for giving up 1 basket of goods now.

Real and Nominal Interest Rates:

How to figure out the real interest rate?

1. Start with 1 basket of goods.

2. Covert basket into p_t dollars - use CPI.

3. Convert p_t into $p_t(1 + i_{t+1})$ dollars tomorrow.

4. Convert $p_t(1 + i_{t+1})$ into $\frac{p_t(1+i_{t+1})}{p_{t+1}}$ goods!

Conclusion: real interest rate is given by equation 1. Fisher equation is equation 2.

1. $Gross\ real\ interest\ rate = 1 + r_{t+1} = \frac{p_t(1+i_{t+1})}{p_{t+1}}$

2. $(1 + i_{t+1}) = (1 + r_{t+1})(1 + \pi_{t+1})$

3. $(1 + \pi_{t+1}) = p_{t+1}/p_t = gross\ inflation\ rate$

Economists say that real interest rate is key for decision making

GOAL: We want to figure out whether or not money is a veil in the candy bar economy by "seeing" how changes in money impact the real and nominal interest rates.

Economy 1: Agents receive $Y = 10$ candy bars every period. Agents start out with M units of money per person. No additional money is added to the economy.

Economy 2: Agents receive $Y = 10$ candy bars every period. Agents start out with M units of money per person. Georgetown doubles the money every period.

Economy 1: Analysis

1. Prices: $P_t = \frac{M_t}{Y} = \frac{M}{10}$ all periods

2. Consumption: $C_t = 10$ all periods

3. MRS: $MRS_{t,t+1} = \frac{U_t}{U_{t+1}} = \frac{1}{\beta}\frac{c_{t+1}}{c_t} = \frac{1}{\beta}$

Utility: $U(c_1, c_2, ..., c_T) = \sum_{t=1}^{T} \beta^{t-1} \log(c_t)$

Marginal Utility: $U_j(c_1, c_2, ..., c_T) = \frac{\beta^{t-1}}{c_t}$

Economy 1: Analysis

At the beginning of the day, some students discuss the idea of loaning tokens. What should the nominal interest rate be? What should the real interest rate be?

Presumably, these rates should not end up changing the consumption of anyone if preferences for candy bars over time are the same for all students!

Economy 1: Analysis

Claim: If the gross nominal interest rate is $1 + i_{t+1} = \frac{1}{\beta}$, then there is no gain for anyone either to take out a loan or to give out a loan.

Proof: At this interest rate the budget line between periods is just tangent to the agents indifference curve that runs through the candy bar endowment.

Comment: Fisher eqn holds $(1 + i_{t+1}) = (1 + r_{t+1})(1 + \pi_{t+1})$. Thus, real and nominal int coincide and these rates are determined by the preference parameter β.

Economy 2: Analysis

1. Prices: $P_t = \frac{M_t}{Y} = \frac{2^{t-1}M}{10}$ all periods $t \geq 1$

2. Consumption: $C_t = 10$ all periods

3. MRS: $MRS_{t,t+1} = \frac{U_t}{U_{t+1}} = \frac{1}{\beta}\frac{c_{t+1}}{c_t} = \frac{1}{\beta}$

What should the nominal and real interest rate be?

Economy 2: Analysis

A good guess of the nominal interest rate is

$$(1 + i_{t+1}) = (1 + r_{t+1})(1 + \pi_{t+1}) = \frac{2}{\beta}$$

This nominal interest rate will imply that there is no gain for anyone either to take out a loan or to give out a loan.

Conclusion for Economy 1 and 2:

1. Changing the money supply changes prices and the nominal interest rate BUT does not change the real interest rate or GDP. The real interest rate is determined by preferences and the amount of candy bars.

2. Thus, money is a veil in this simple world. The quantity theory holds and the Fisher equation holds.

3. How could we change this simple model so that money matters?

Some Monetary Facts - McCandless and Weber

Goal: Document correlations between growth rates of money, prices and GDP.

Motivation:

1. Federal Reserve System estalished in 1913 to provide an "elastic currency and to supervise the banking system".

2. Employ Act (1946) + Full Employ Act (1978) put the Federal Reserve in charge of "price stability", "maximum employment" and "moderate long-term interest rates".

Looking at some "long-run" correlations is a first step towards developing an opinion of whether or not the Fed has the toods to do all of these things.

Some Monetary Facts - McCandless and Weber

1. 110 countries 1960-90

2. Geometric mean growth rate

3. Money: M0, M1, M2

4. Subsamples: Latin America and OECD

Some Monetary Facts - McCandless and Weber

Findings:

1. $Corr(\Delta M/M, \Delta P/P) \doteq 1$ for all measures of M

2. $Corr(\Delta M/M, \Delta Y/Y) \doteq 0$ but NOT for OECD

3. $Corr(\Delta P/P, \Delta Y/Y) \doteq 0$ all countries

Table 1

Correlation Coefficients for Money Growth and Inflation*

Based on Data From 1960 to 1990

Sample	Coefficient for Each Definition of Money		
	M0	M1	M2
All 110 Countries	.925	.958	.950
Subsamples			
21 OECD Countries	.894	.940	.958
14 Latin American Countries	.973	.992	.993

*Inflation is defined as changes in a measure of consumer prices.

Source of basic data: International Monetary Fund

Table 2

Previous Studies of the Relationship Between Money Growth and Inflation

Author (and Year Published)	Study Characteristics: Time Series: Money	Time Series: Inflation	Countries	Time Period	Data Frequency	Finding
Vogel (1974)	Currency + Demand deposits	Consumer prices	16 Latin American countries	1950–69	Annual	Proportionate changes in inflation rate within two years of changes in money growth
Lucas (1980)	M1	Consumer prices	United States	1955–75	Annual	Strong positive correlation: Coefficient closer to one the more filter stresses low frequencies
Dwyer and Hafer (1988)	n.a.	GDP deflator	62 countries	1979–84	Five-year averages	Strong positive correlation
Barro (1990)	Hand-to-hand currency	Consumer prices	83 countries	1950–87	Full-period averages	Strong positive association
Pakko (1994)	Currency + Bank deposits	Consumer prices	13 former Soviet republics	1992 and 1993	Four-quarter averages	Positive relationship
Poole (1994)	Broad money	n.a.	All countries in World Bank tables	1970–80 and 1980–91	Annual averages	Strong positive correlation
Rolnick and Weber (1994)	Various	Various	9 countries	Various	Long-period averages	Strong positive correlation for fiat money regimes

n.a. = not available

Table 3

Correlation Coefficients for Money Growth and Real Output Growth*

Based on Data From 1960 to 1990

	Coefficient for Each Definition of Money		
Sample	M0	M1	M2
All 110 Countries	–.027	–.050	–.014
Subsamples			
21 OECD Countries	.707	.511	.518
14 Latin American Countries	–.171	–.239	–.243

*Real output growth is calculated by subtracting changes in a measure of consumer prices from changes in nominal gross domestic product.

Source of basic data: International Monetary Fund

Table 4

Previous Studies of the Relationship Between Money Growth and Real Output Growth

	Study Characteristics					
	Time Series					
Author (and Year Published)	Money	Output	Countries	Time Period	Data Frequency	Finding
Kormendi and Meguire (1985)	M1	Real GDP	47 countries	1950–77	Period averages	Negative correlation
Geweke (1986)	M2, M1	NNP, industrial production	United States	1870–1978, Postwar period	Annual, monthly	Money superneutral
Dwyer and Hafer (1988)	n.a.	Real GDP and GNP	62 countries	1979–84	Five-year averages	Slight negative correlation (not statistically significant)
Poirier (1991)	M1	Real GDP	47 countries	1873	Annual	Money neutral in some countries, not in others

n.a. = not available

Table 5

Correlation Coefficients for Inflation and Real Output Growth*

Based on Data From 1960 to 1990

	Coefficient With Outlier**	
Sample	Included	Excluded
All 110 Countries	–.243	–.101
Subsamples		
21 OECD Countries	.390	.390
14 Latin American Countries	—	–.342

*Inflation is defined as changes in a measure of consumer prices. Real output growth is calculated by subtracting those inflation rates from changes in nominal gross domestic product.

**The outlier is Nicaragua.

Source of basic data: International Monetary Fund

Table 6

Previous Studies of the Relationship Between Inflation and Real Output Growth

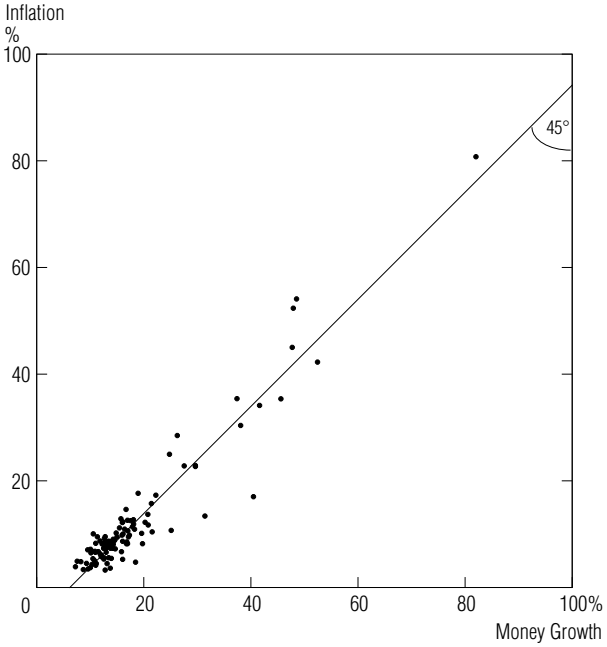
Author (and Year Published)	Study Characteristics: Time Series: Inflation	Study Characteristics: Time Series: Output	Study Characteristics: Number of Countries	Study Characteristics: Time Period	Study Characteristics: Data Frequency	Finding
Fischer (1983)	n.a.	n.a.	53	1961–73, 1973–81	Annual	Negative contemporaneous relationship; positive correlation with one lag
Kormendi and Meguire (1985)	Consumer prices	Real GDP	47	1950–77	Period averages	Negative correlation
Fischer (1991)	GDP deflator	GDP	73	1970–85	Annual	Negative relationship
Altig and Bryan (1993)	GDP deflator	Per capita GDP	54 and 73	1960–88	Annual	Negative correlation
Ericsson, Irons, and Tryon (1993)	GDP deflator	GDP	102	1960–89	Annual	Weak negative correlation
Barro (1995)	Consumer prices	Per capita real GDP	78, 89, and 84	1965–90	Five- or ten-year averages	Negative correlation

n.a. = not available

Chart 1

Money Growth and Inflation: A High, Positive Correlation

Average Annual Rates of Growth in M2 and in Consumer Prices During 1960–90 in 110 Countries

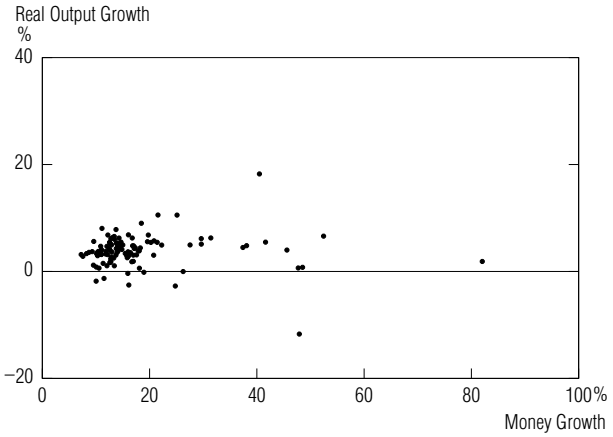


Source: International Monetary Fund

Chart 2

Money and Real Output Growth: No Correlation in the Full Sample . . .

Average Annual Rates of Growth in M2
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
During 1960–90 in 110 Countries

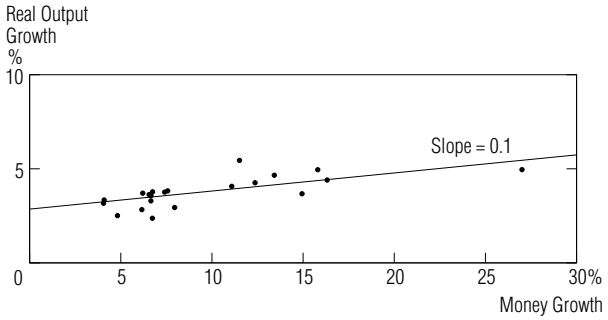


Source: International Monetary Fund

Chart 3

. . . But a Positive Correlation in the OECD Subsample

Average Annual Rates of Growth in M0
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
During 1960–90 in 21 Countries

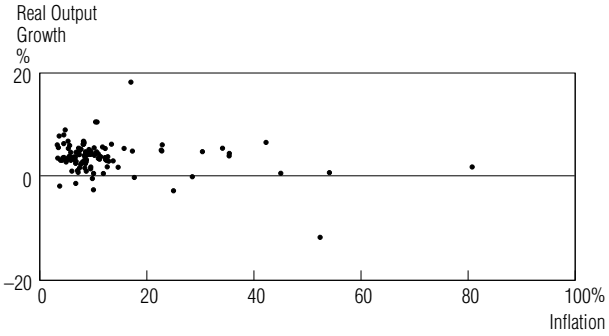


Source: International Monetary Fund

Chart 4

Inflation and Real Output Growth: No Correlation

Average Annual Rates of Growth in Consumer Prices
and in Nominal Gross Domestic Product, Deflated by Consumer Prices
During 1960–90 in 110 Countries



Source: International Monetary Fund

Money and Interest Rates - Monet and Weber

Central banks control money (e.g. Fed Funds) and often target interest rates (e.g. Fed Funds Rate). What is the relationship between money and interest rates?

1. Fisher Effect View: increased money growth leads to increased nominal interest rate.

2. Liquidity Effect View: increased money growth leads to decreased nominal interest rate.

Money and Interest Rates - Monet and Weber

Fisher Effect View:

a mechanism by which this view may hold is that money growth primarily affects inflation but not the real interest rate. Proponents of this view may say that the real interest rate is connected to the marginal rate of substitution of consumers, which may be little affected by inflation.

Money and Interest Rates - Monet and Weber

Liquidity Effect View:

a mechanism by which this view may hold is that surprise increases in money growth may have a short-lived decrease in interest rates if the demand curve for money is downward sloping in the interest rate.

Table 2

Measures of the Relationship Between Money and Interest Rates

Correlation Coefficients and Regression Slope Coefficients for Money Growth Rates† and Interest Rates in Developed and Developing Countries in Various Periods Between 1961 and 1998

			Coefficient for Interest Rate Sample		
			Short-Term: Money Market Rates	*Long-Term:* Government Bond Yields With Venezuela	
Type of Measure	Time Period	Type of Country		Excluded	Included
Correlation Coefficient	Long Run (1961–98)	All	.71	.79	.87
		Developed	.81	.70	.70
		Developing	.62	.66	.84
	Short Run				
	5-Year Periods (1964–98)	All	.52	.59	.68
		Developed	.52	.50	.50
		Developing	.49	.53	.69
	1-Year Periods (1961–98)	All	.24	.34	.41
		Developed	.22	.26	.26
		Developing	.23	.30	.41
Regression Slope Coefficient	Long Run (1961–98)	All	.68**	.60**	—
		Developed	.68**	.56**	—
		Developing	.66*	.51**	—
	Short Run				
	5-Year Periods (1964–98)	All	.63**	.44**	—
		Developed	.38**	.35**	—
		Developing	.50**	.44**	—

†Money growth is based on a series comparable to the U.S. M1 definition of the money supply.

*Statistic is significantly greater than zero, but not significantly less than one, at the 0.05 level.

**Statistic is significantly greater than zero and significantly less than one, at the 0.05 level.

Source of basic data: IMF, various dates, lines 34, 60b, 61

Charts 1–2

A Strong, Positive Relationship Across Countries in the Long Run

Money Growth Rates vs. Short- and Long-Term Interest Rates in Developed and Developing Countries,* 1961–98 Averages

● Developed Countries ■ Developing Countries

Chart 1 Money Growth vs. Money Market Rates

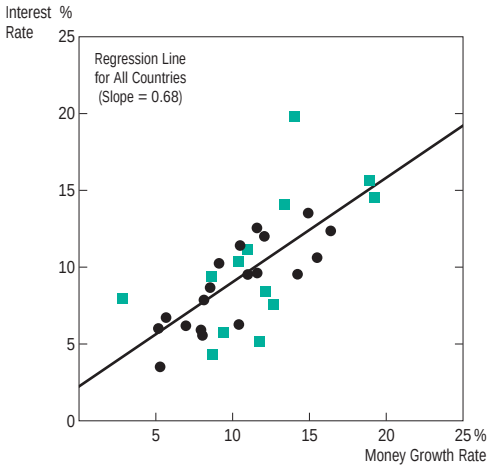
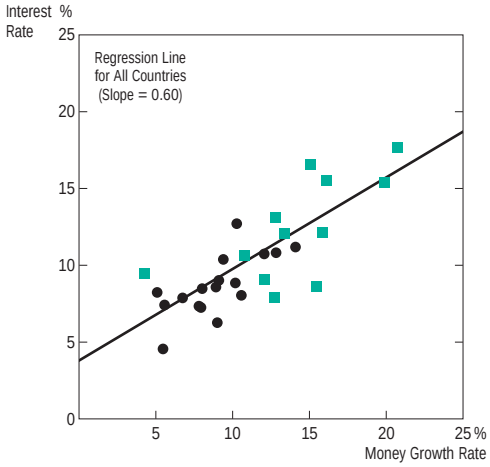


Chart 2 Money Growth vs. Government Bond Yields**



*For an identification of the countries in the two samples, see Table 1.

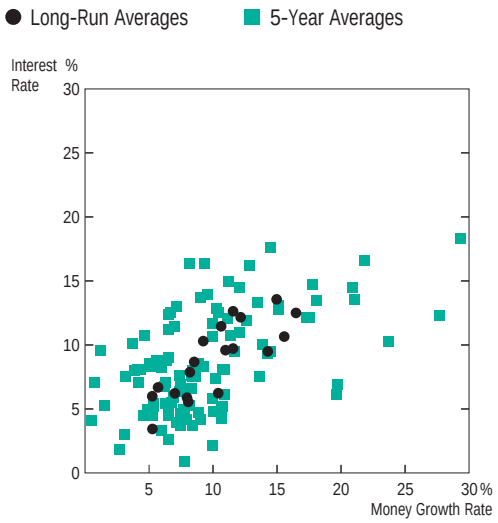
**This sample excludes Venezuela.

Source of basic data: IMF, various dates, lines 34, 60b, 61

Chart 3

A Weaker, But Still Positive Relationship in the Shorter Run

Money Growth Rates vs. Money Market Interest Rates in 19 Developed Countries
1961–98 Averages and 5-Year Averages Over 1961–98



Source of basic data: IMF, various dates, lines 34, 60b

Charts 4–5

A Similar Relationship in the United States

Money Growth Rates (M1) and Interest Rates (6-Month U.S. Treasury Bill Rates) in 1960–99

Chart 4 Strong and Positive in the Long Run

(Overlapping 10-Year Averages)

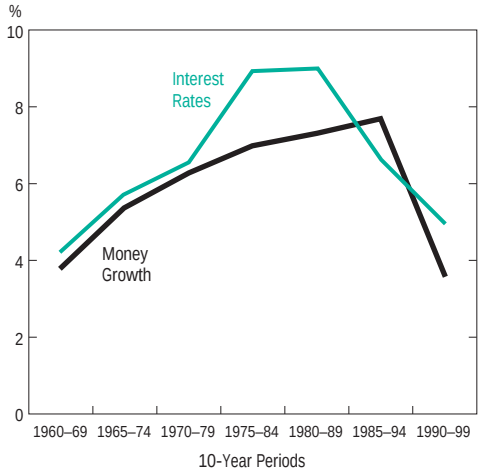


Chart 5 Weaker, But Still Positive in the Shorter Run

Sources of basic data: Federal Reserve Board of Governors, DRI-WEFA

Exchange Rates- Wallace

What determines the exchange rate between two currencies?

Neil Wallace argues that the exchange rate can be any positive number or zero within a theoretical model where (i) both currencies are unbacked and intrinsically worthless and where (ii) governments do not act to support a currency or restrict its use.

Exchange Rates- Wallace

Wallace seems to conclude that

(1) exchange rates are only pinned down by government restrictions.

(2) Restrictions have taken the form of fixed exchange rates in some periods of time or speculation on future government intervention (e.g. US greenback after the Civil War and the British pound after WWI).

Thought Experiment: One Currency

If there is an economy with a constant amount of fiat money and this fiat money has value, then the same economy with ten times the fiat money should have the same real outcome but where the price level is ten times higher. Thus, the usefulness of fiat money only depends on its real value and not on its quantity.

Thought Experiment: Two Currencies

M_1 and M_2 - country 1 and 2 money.

$M = M_1 + eM_2$ - world money

If there is one constant exchange rate between the two currencies, then any other exchange rate simply changes the world money supply. Increasing the money supply results (according to the one currency thought experiment) in a proportional increase in prices.

Comment:

1. Wallace's ideas can be restated to apply to the vending machine economies.

2. Determine what exchange rates are possible in these simple economies.