On the Stability of Money Demand

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A simple (old fashion!) theoretical framework

- Let us start with the quantity equation

$$M_{t+1}\upsilon_{t+1} = y_{t+1}P_{t+1}$$

- ..in growth rates

$$\mu_{t+1} + g^{\upsilon}_{t+1} = g^{y}_{t+1} + \pi_{t+1}$$

- Assume

$$\upsilon_t = k_t e^{\gamma i_t}$$

where i_t is the nominal interest rate and k_t is a stochastic process.

- I will interpret k_t as *exogenous* shocks to velocity (or real money demand).

- I assume that k_t is stationary with a lung run average of k

- This is the general case, and I will have much to say about it.

- However, for the time being, let me set $\gamma = 0$, so $\upsilon_t = k_t$.

- Then

$$g_{t+1}^{\upsilon} = \ln \frac{k_{t+1}}{k_t}$$

- Thus, we obtain

$$\pi_{t+1} = \mu_{t+1} + g^k_{t+1} - g^y_{t+1}$$

- Clearly, inflation and money growth will not be the same period by period, due to the shocks. However, taking averages over time

$$\frac{1}{T}\sum_{t=0}^{T}\pi_{t+1} = \frac{1}{T}\sum_{t=0}^{T}\mu_{t+1} - \frac{1}{T}\sum_{t=0}^{T}g^k_{t+1} + \frac{1}{T}\sum_{t=0}^{T}g^y_{t+1}$$

- as T grows,

$$\frac{1}{T}\sum_{t=0}^{T} g_{t+1}^{y} \longrightarrow g^{y}$$

where g^y is the long run growth rate of output and

$$\frac{1}{T}\sum_{t=0}^{T} g_{t+1}^{k} \longrightarrow 0$$

since k_t is seasonally stationary.

- Then, as we average money growth and inflation, the data should line-up around the line

$$\pi = \mu - g.$$

- These three variables are observable.

- How do we test this theory?

- Look at the ”long run”!!

- Vogel (1974), Lucas (1980), Barro (1990), Rolnick and Weber (1994), McCandless and Weber (1995), Benatti (2005), Sargent and Surico (2011), etc.

- Let me show you one more: Nicolini 2012

- We use data from IFS for inflation (CPI) and monetary growth (Monetary Base).

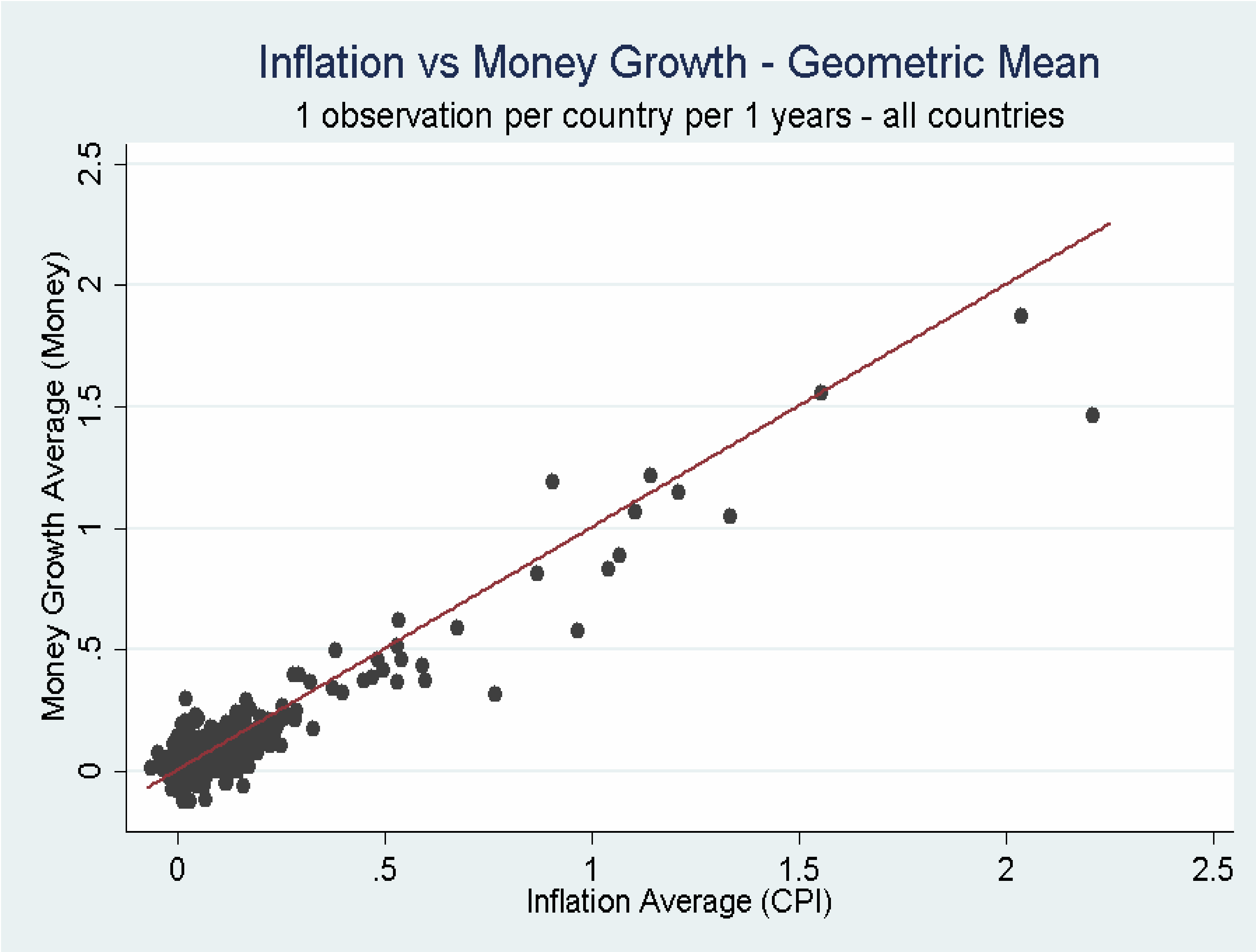
- Quarterly data from 1955.1 to 2005.4. Non-seasonally adjusted.

- Includes countries with own currency and more than 10 years of consecutive data.

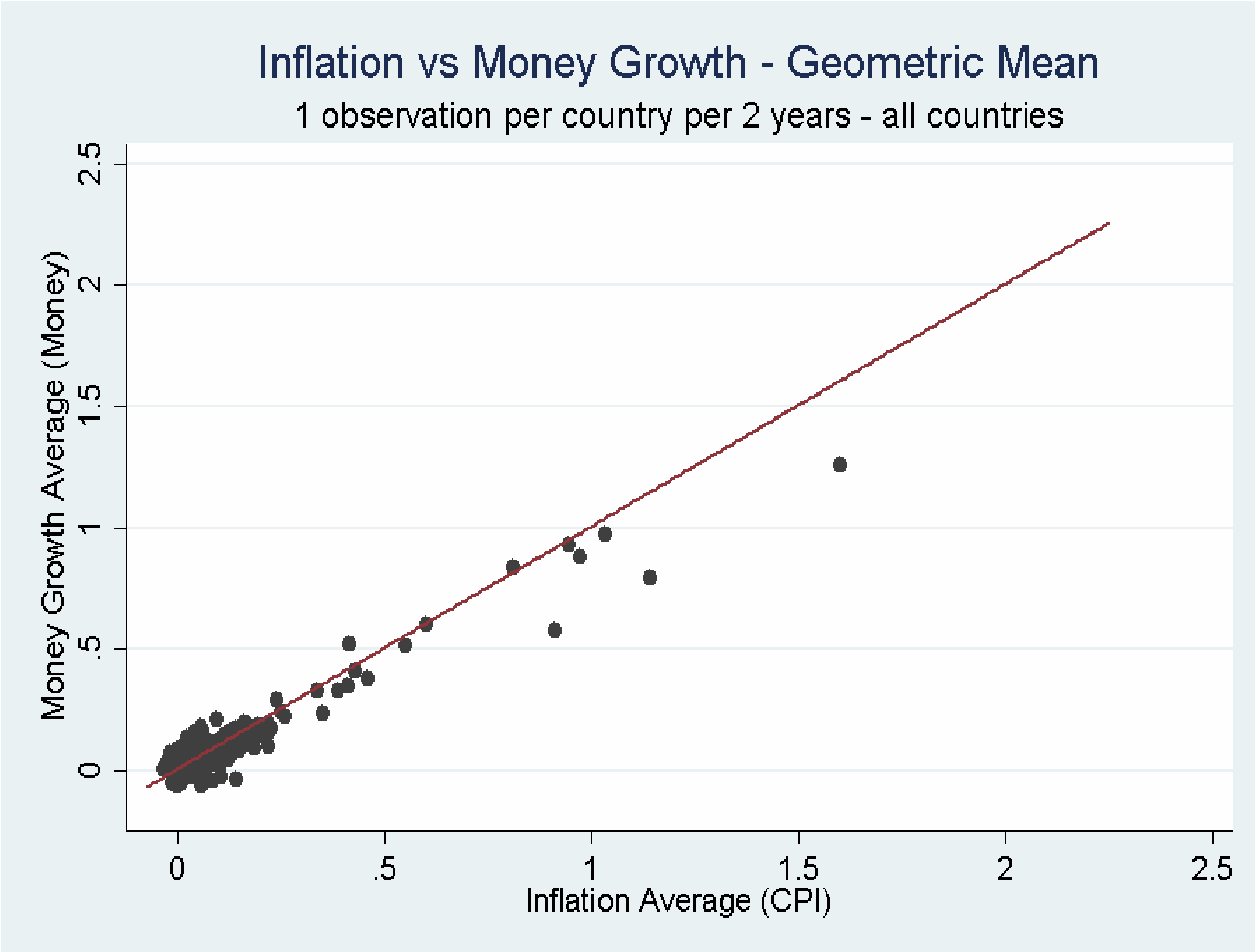
- A look at the long run behavior

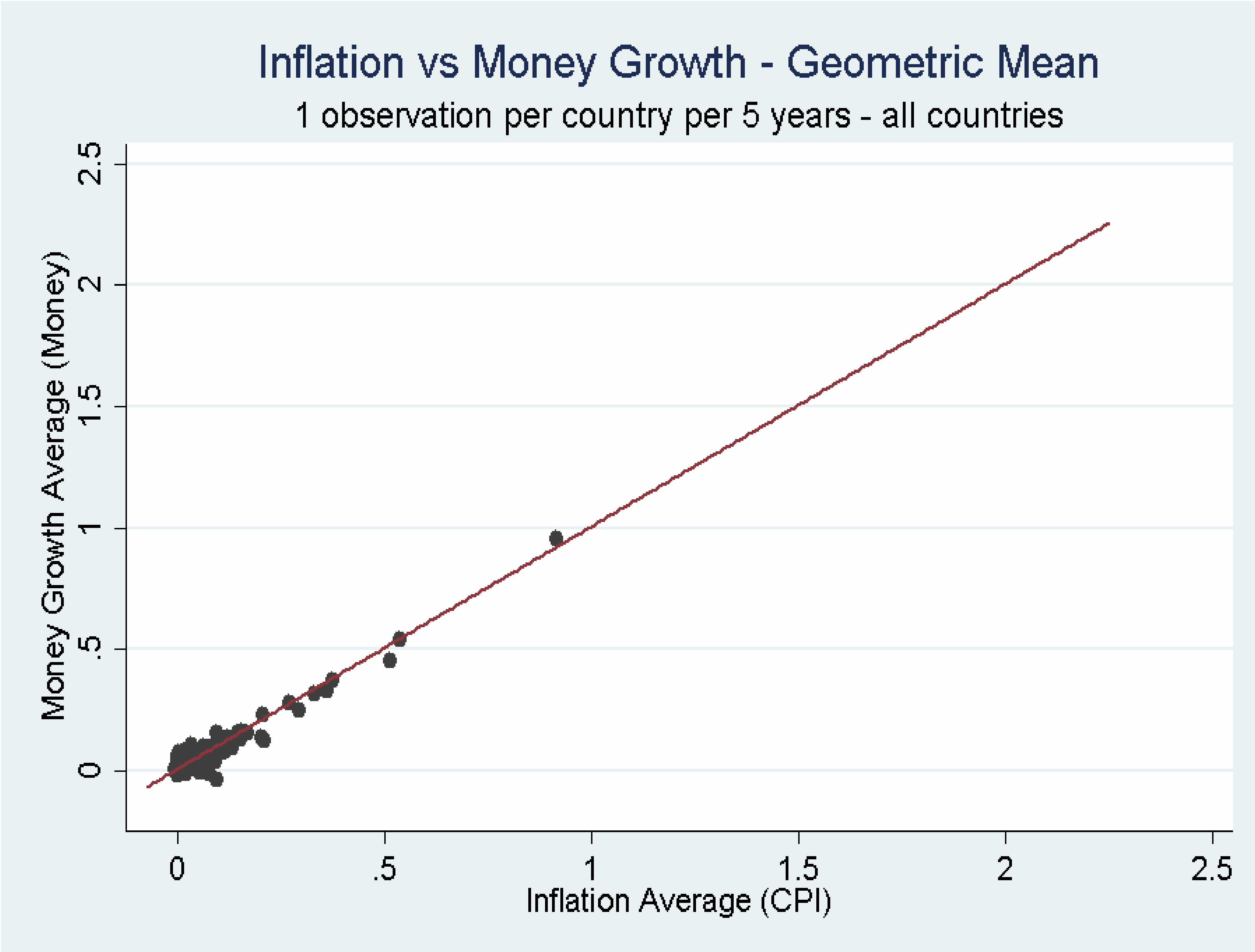
  1. 1 observation per country per 1 year.
  2. 1 observation per country per 2 years.
  3. 1 observation per country per 5 years.
  4. Country average

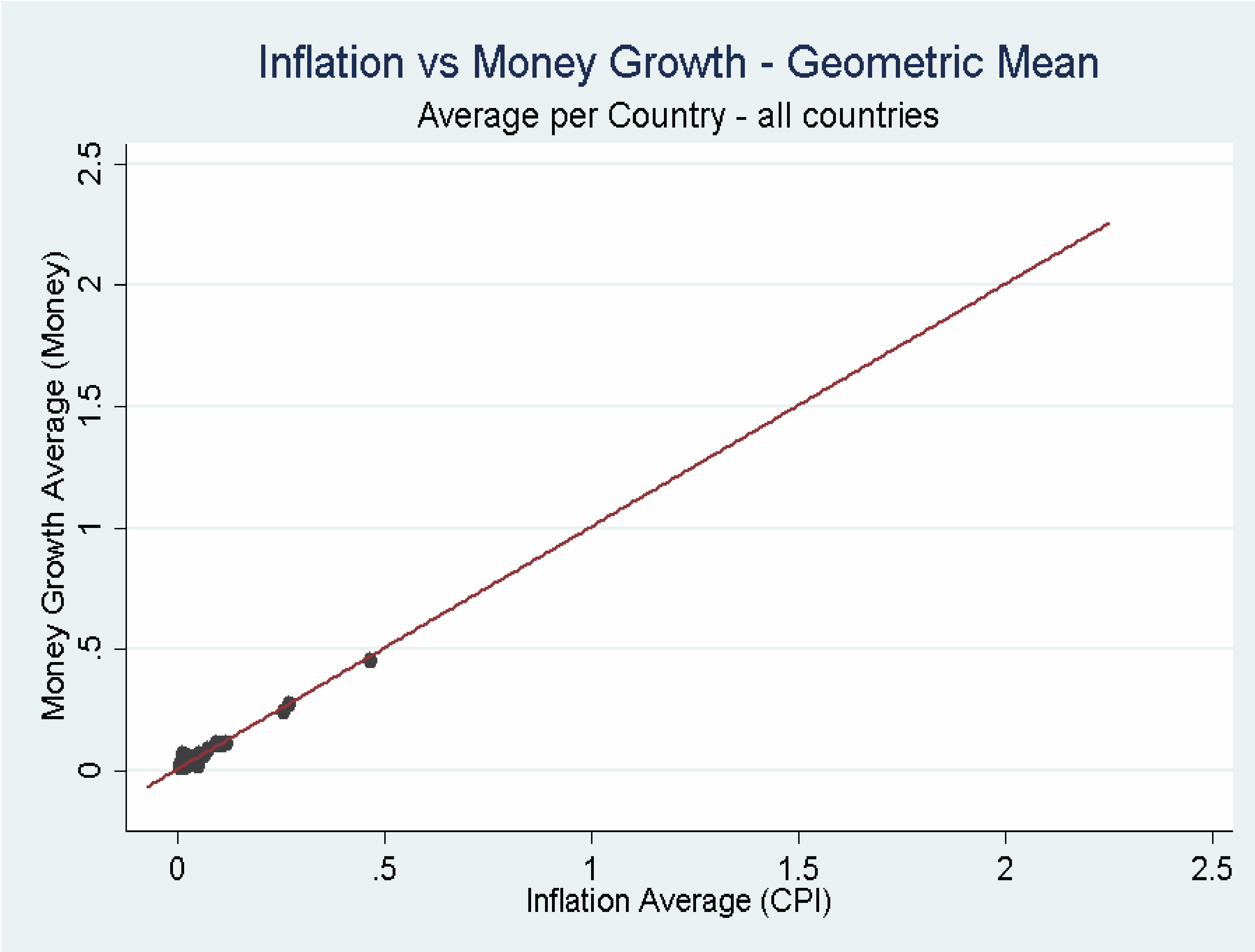
- We also plot a 45 degree line with slope -0.0075.



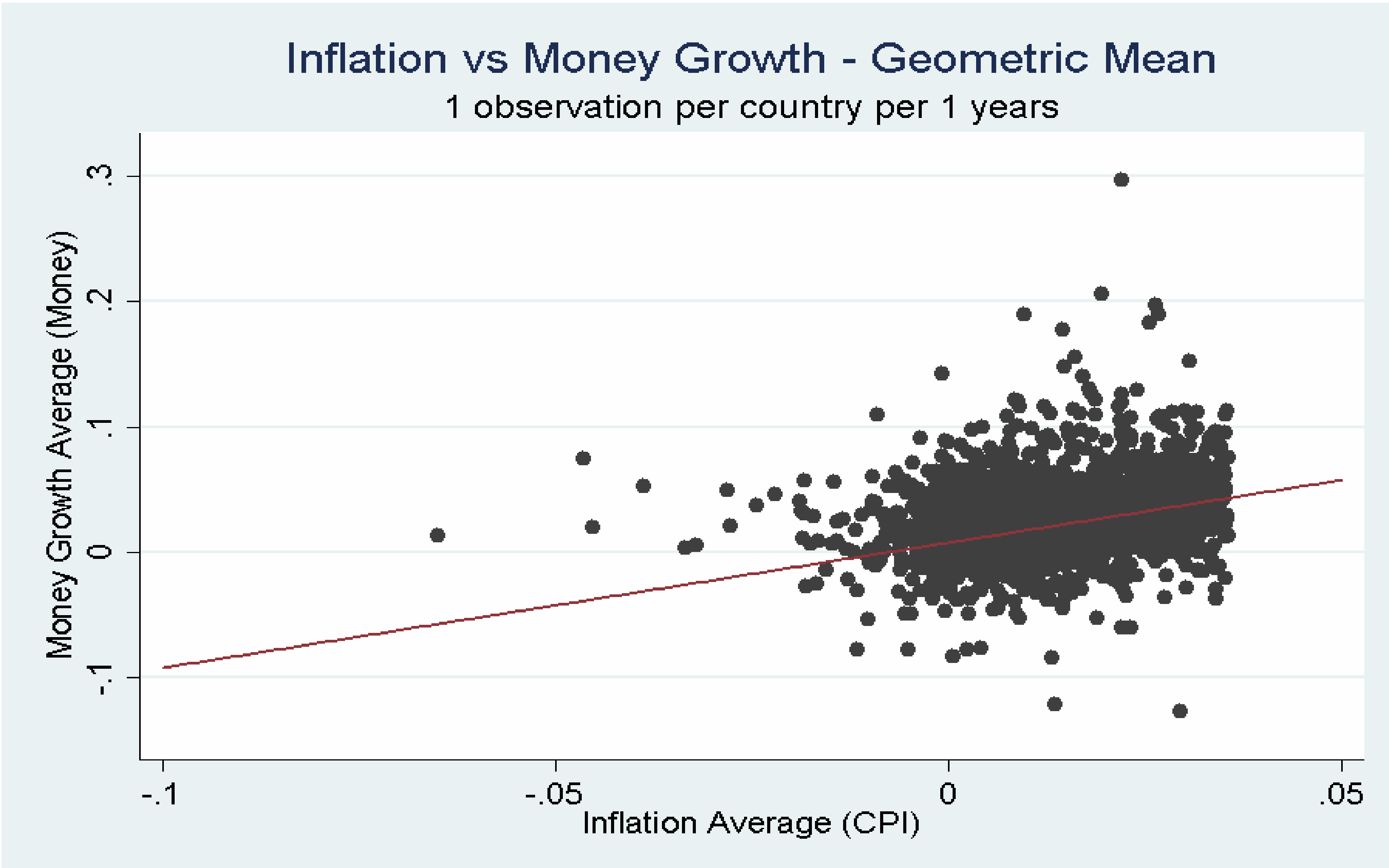
Inflation vs Money Growth - Geometric Mean
1 observation per country per 1 years - all countries
Money Growth Average (Money)
0
.5
1
1.5
2
2.5
0
.5
1
1.5
2
2.5
Inflation Average (CPI)

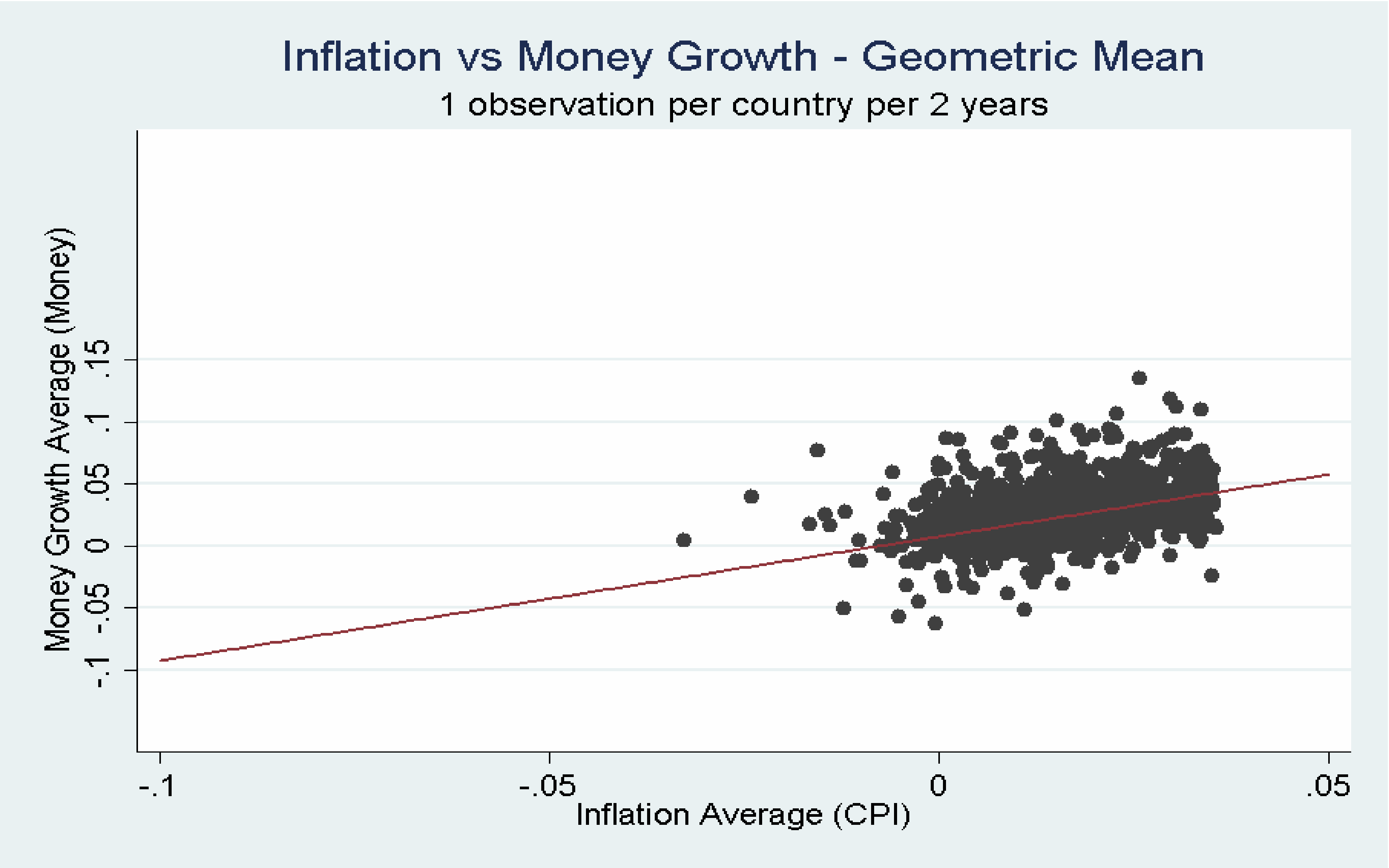

Inflation vs Money Growth - Geometric Mean
1 observation per country per 2 years - all countries
Money Growth Average (Money)
0
.5
1
1.5
2
2.5
Inflation Average (CPI)

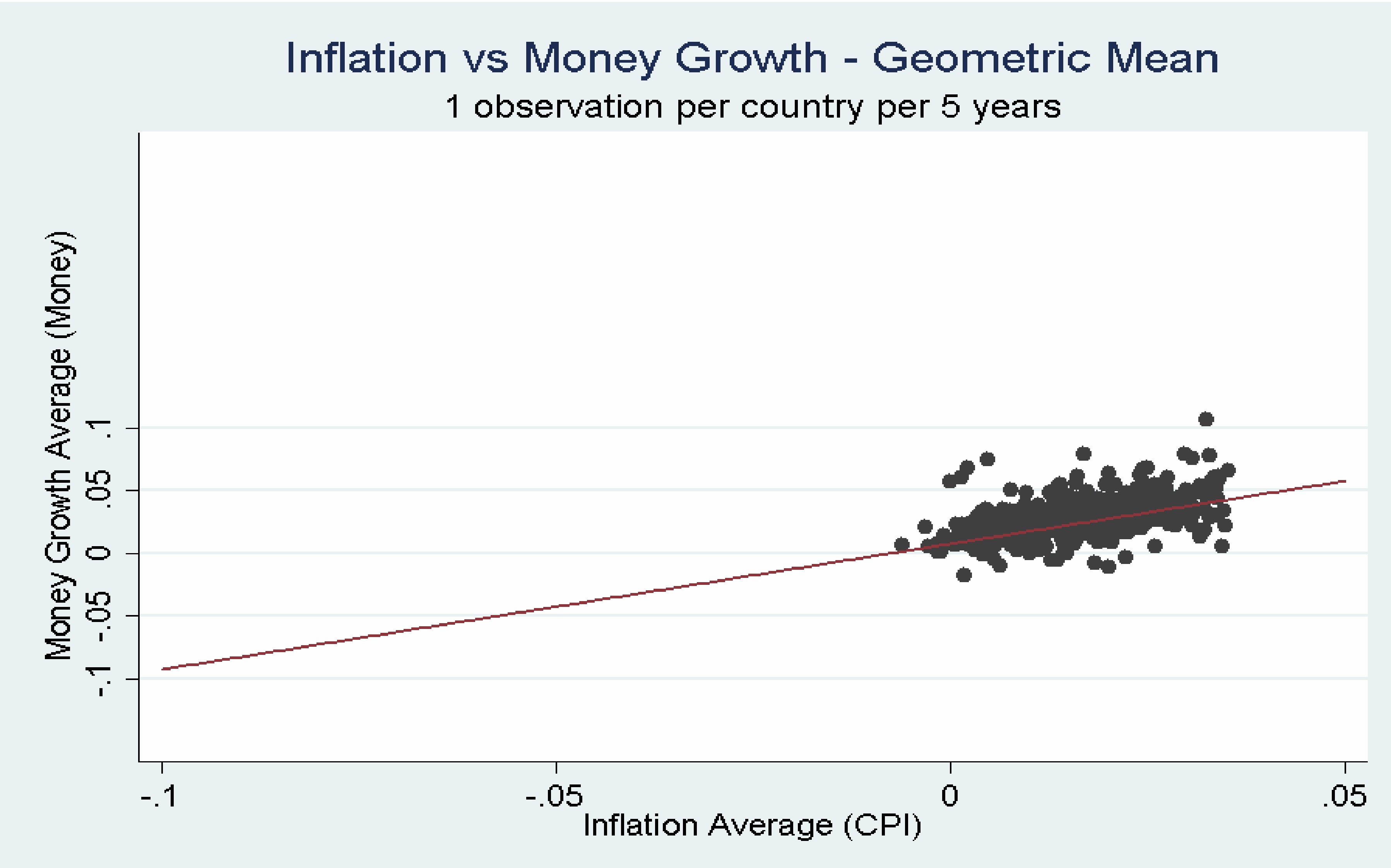

Inflation vs Money Growth - Geometric Mean
1 observation per country per 5 years - all countries
Money Growth Average (Money)
0
.5
1
1.5
2
2.5
Inflation Average (CPI)
0
.5
1
1.5
2
2.5

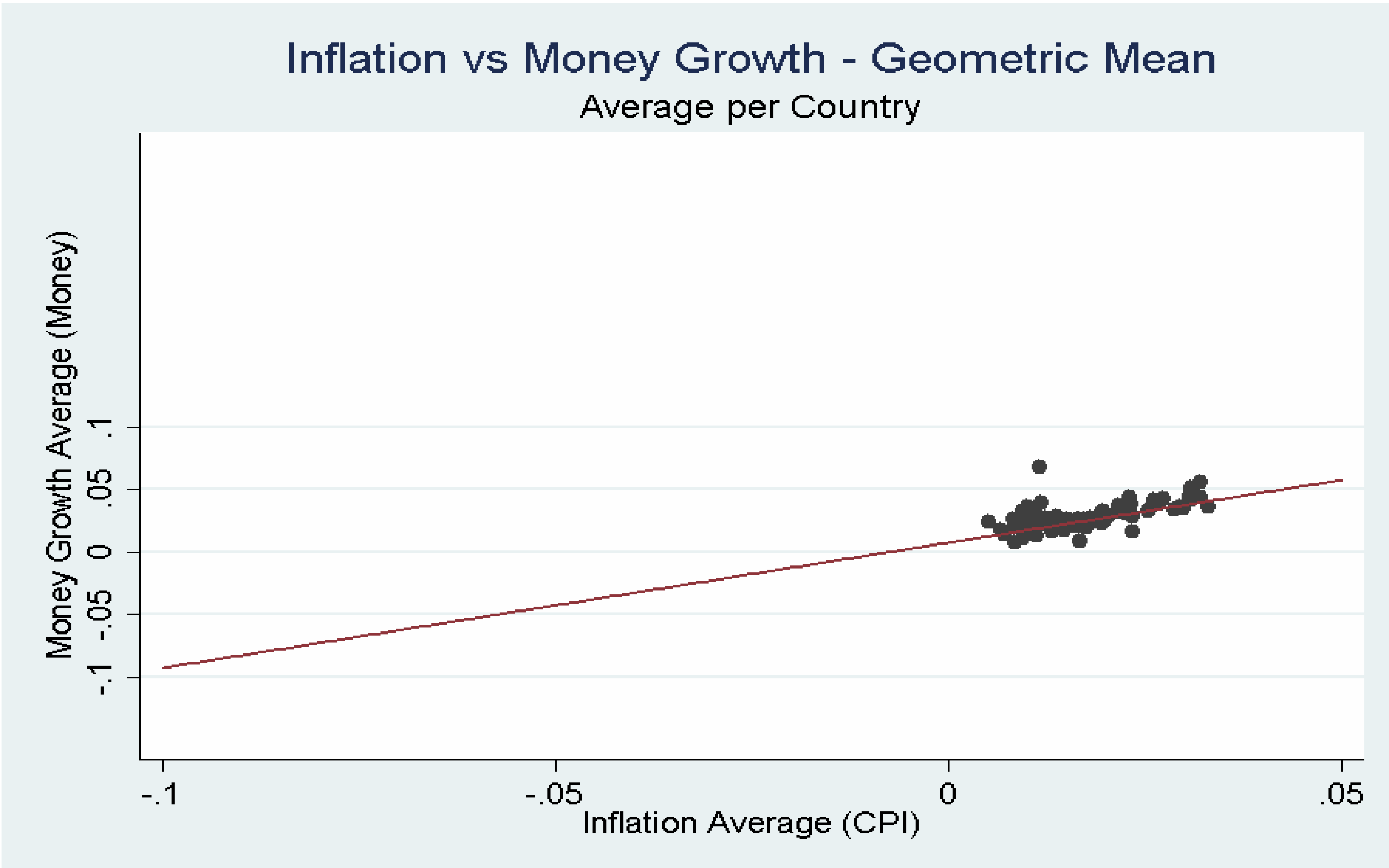

Inflation vs Money Growth - Geometric Mean
Average per Country - all countries
Money Growth Average (Money)
0
.5
1
1.5
2
2.5
0
.5
1
1.5
2
2.5
Inflation Average (CPI)

Is this an artifact of the high inflation countries?

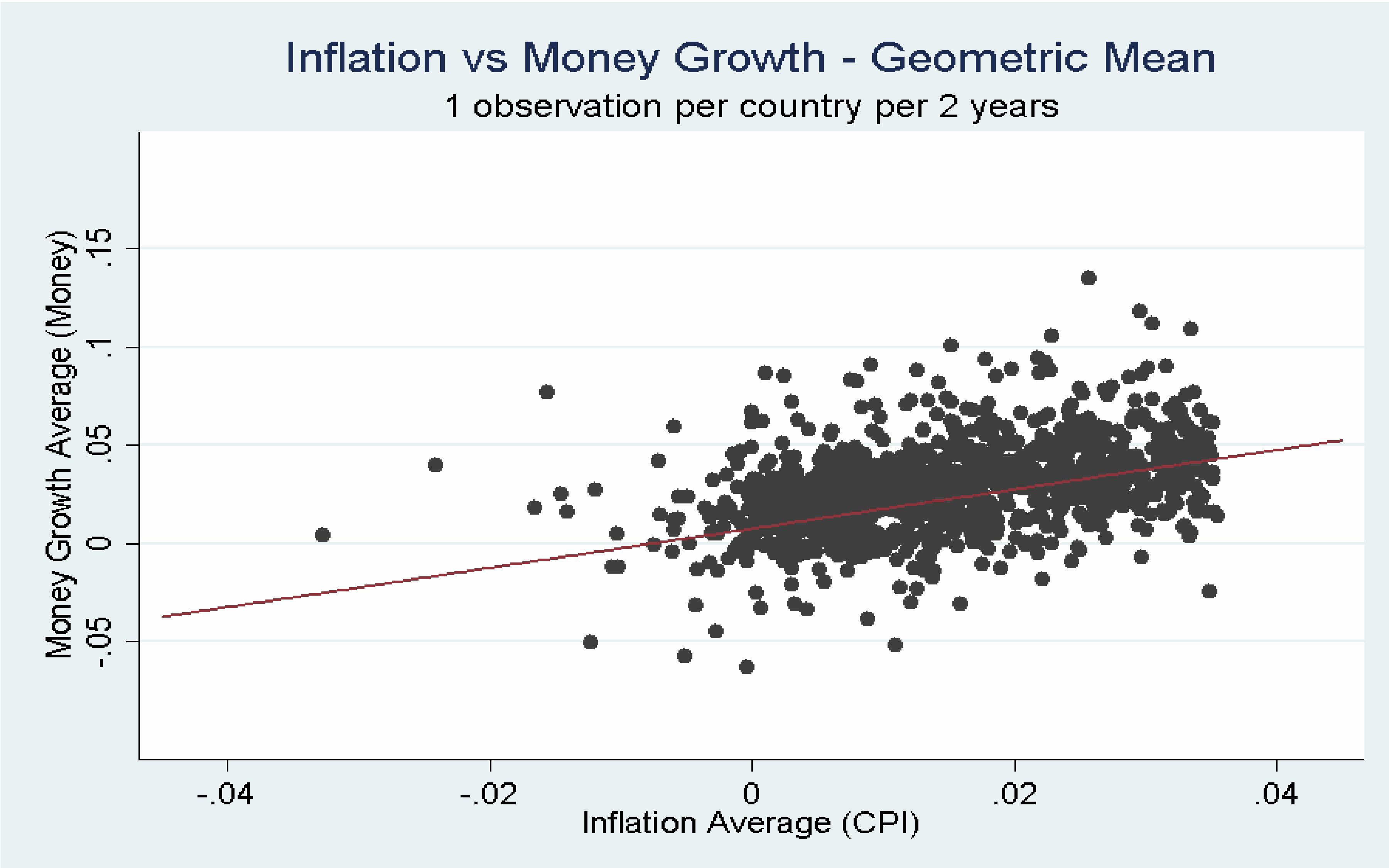


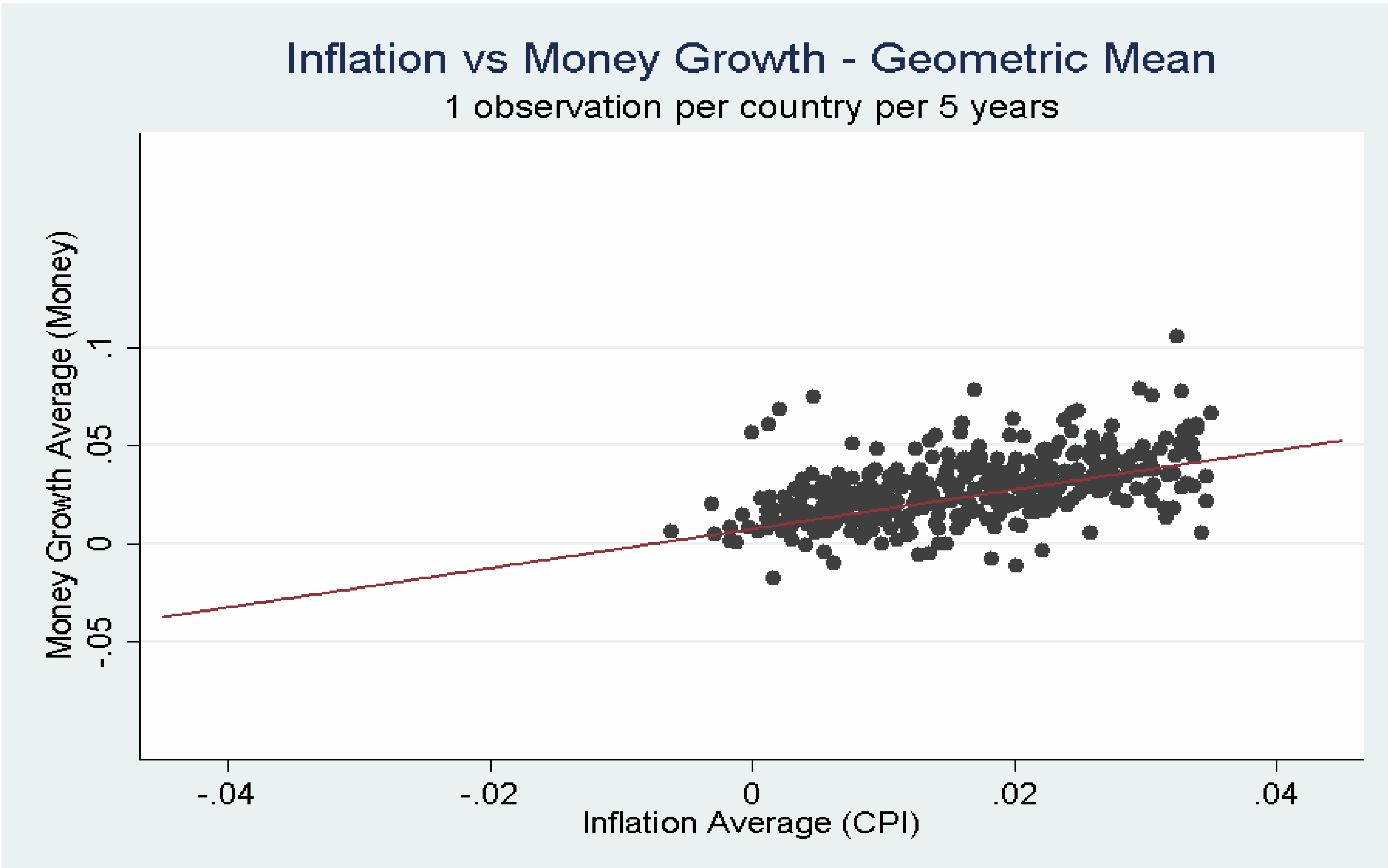

Inflation vs Money Growth - Geometric Mean
1 observation per country per 2 years
Money Growth Average (Money)
-.1
-.05
0
.05
.1
.15
-.1
-.05
0
.05
Inflation Average (CPI)


Inflation vs Money Growth - Geometric Mean
1 observation per country per 5 years
Money Growth Average (Money)
-.1
-.05
0
.05
.1
-.1
-.05
0
.05
Inflation Average (CPI)

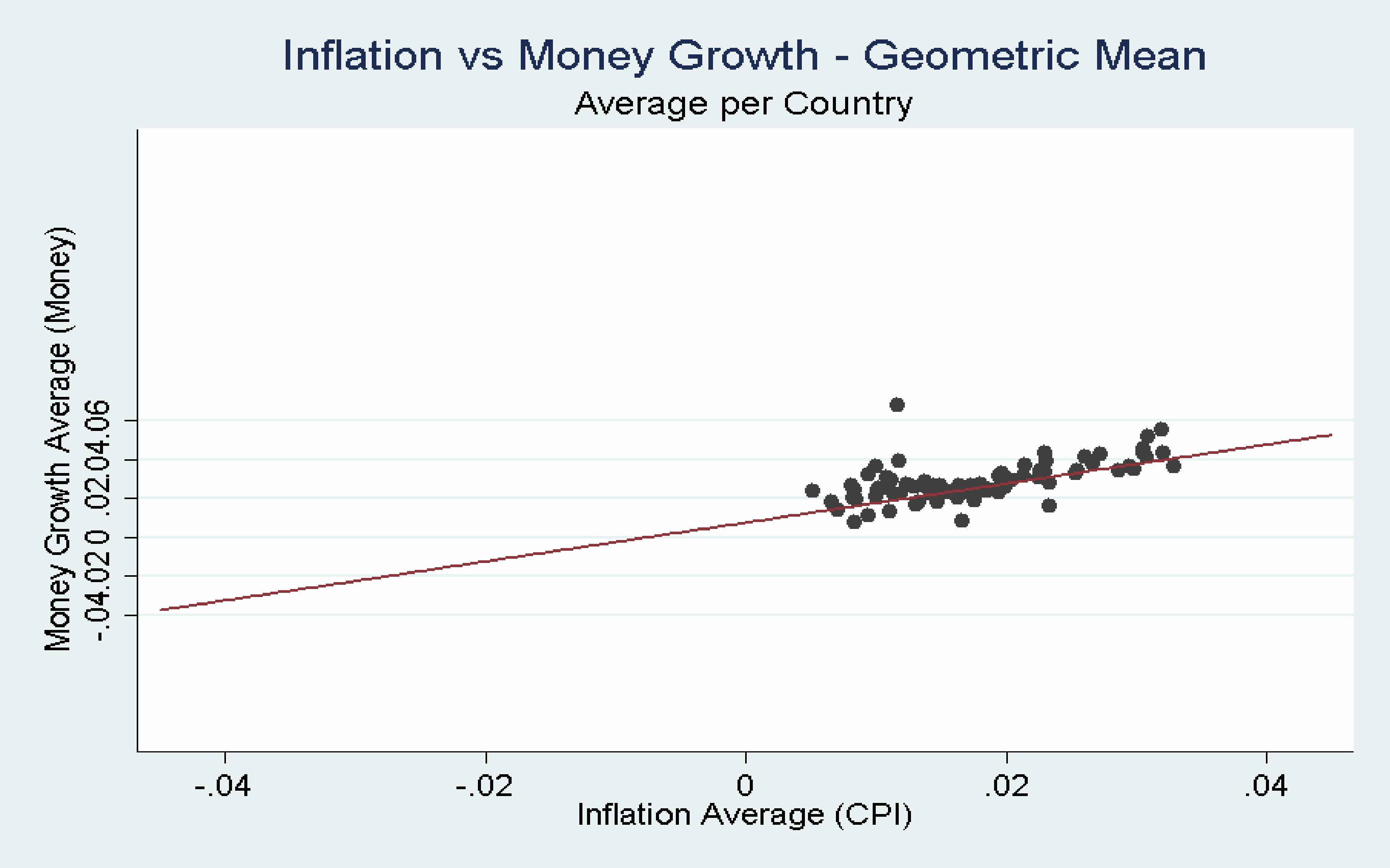

Inflation vs Money Growth - Geometric Mean
Average per Country
Money Growth Average (Money)
-.1
-.05
0
.05
.1
-.1
-.05
0
.05
Inflation Average (CPI)

Am I cheating with the scale?





Inflation vs Money Growth - Geometric Mean
1 observation per country per 5 years
Money Growth Average (Money)
-.05
0
.05
.1
-.04
-.02
0
.02
.04
Inflation Average (CPI)



Inflation vs Money Growth - Geometric Mean
Average per Country
Money Growth Average (Money)
-.04
-.02
0
.02
.04
.06
-.04
-.02
0
.02
.04
Inflation Average (CPI)

- The data lines-up around the lines because average inflation varied across countries.

- Otherwise, the data should converge to a point.

- To detect the QT in the data in a time series, we need variation of inflation over time.

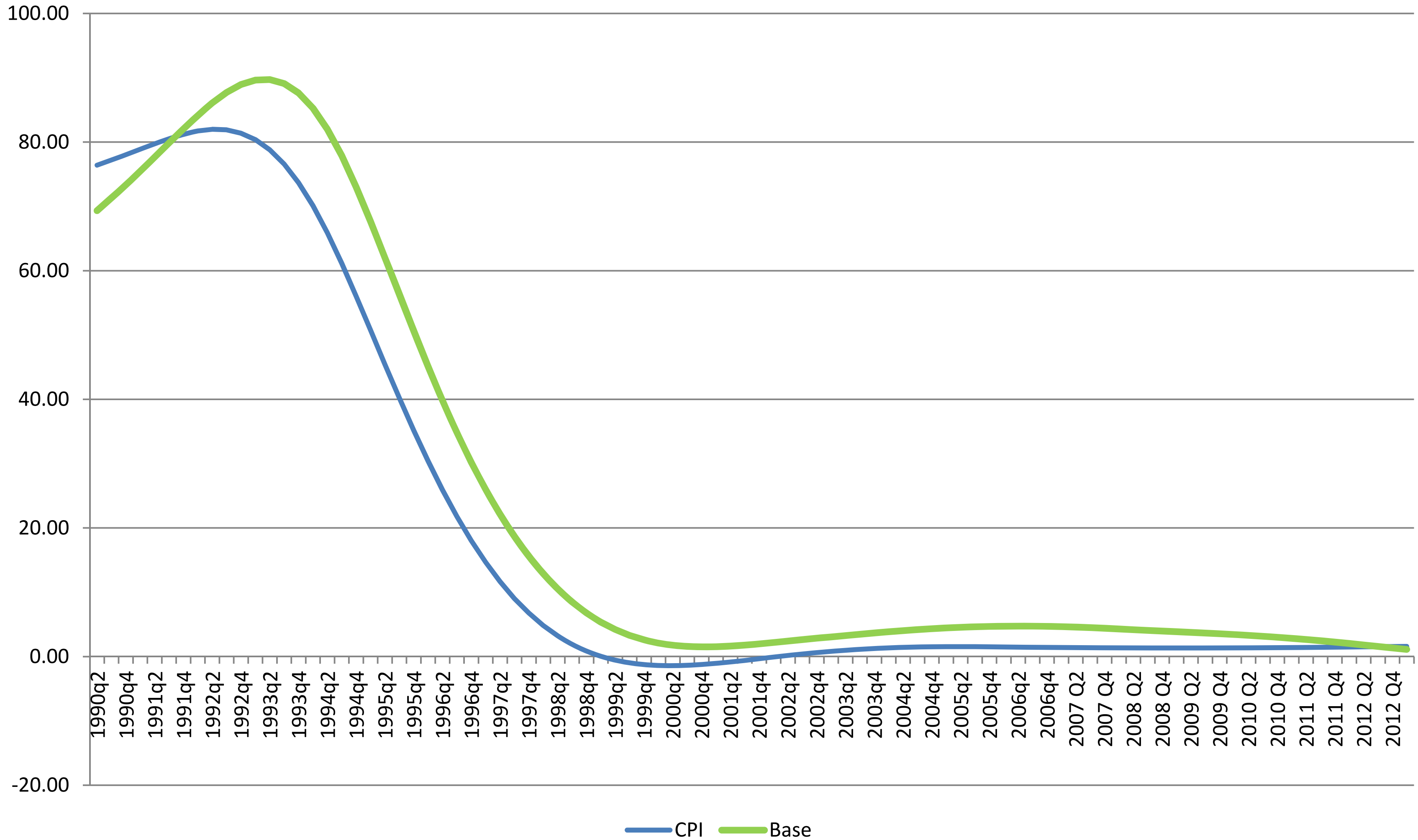
- Before that, how about the ”short-run”?

- See Nicolini 2012.....

Further evidence

- Average money growth and inflation for countries where inflation varied over time.
- Examples: Chile, Colombia, Peru, Argentina, Brazil, Turkey.

Brazil


100.00
80.00
60.00
40.00
20.00
0.00
-20.00
1990q2
1990q4
1991q2
1991q4
1992q2
1992q4
1993q2
1993q4
1994q2
1994q4
1995q2
1995q4
1996q2
1996q4
1997q2
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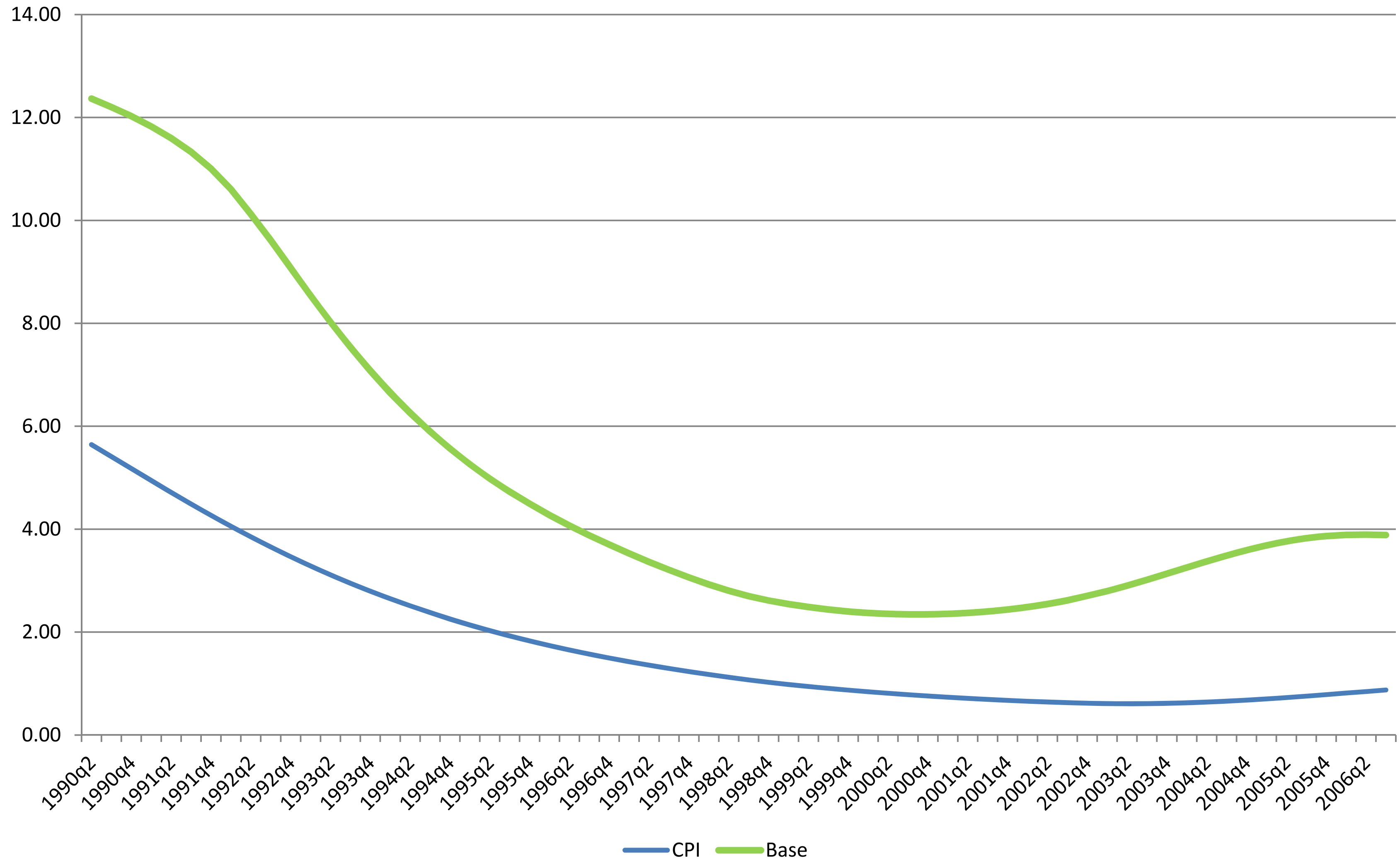
2004q2
2004q4
2005q2
2005q4
2006q2
2006q4
2007 Q2
2007 Q4
2008 Q2
2008 Q4
2009 Q2
2009 Q4
2010 Q2
2010 Q4
2011 Q2
2011 Q4
2012 Q2
2012 Q4
CPI
Base

Chile


14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1990q2
1990q4
1991q2
1991q4
1992q2
1992q4
1993q2
1993q4
1994q2
1994q4
1995q2
1995q4
1996q2
1996q4
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2000q2
2000q4
2001q2
2001q4
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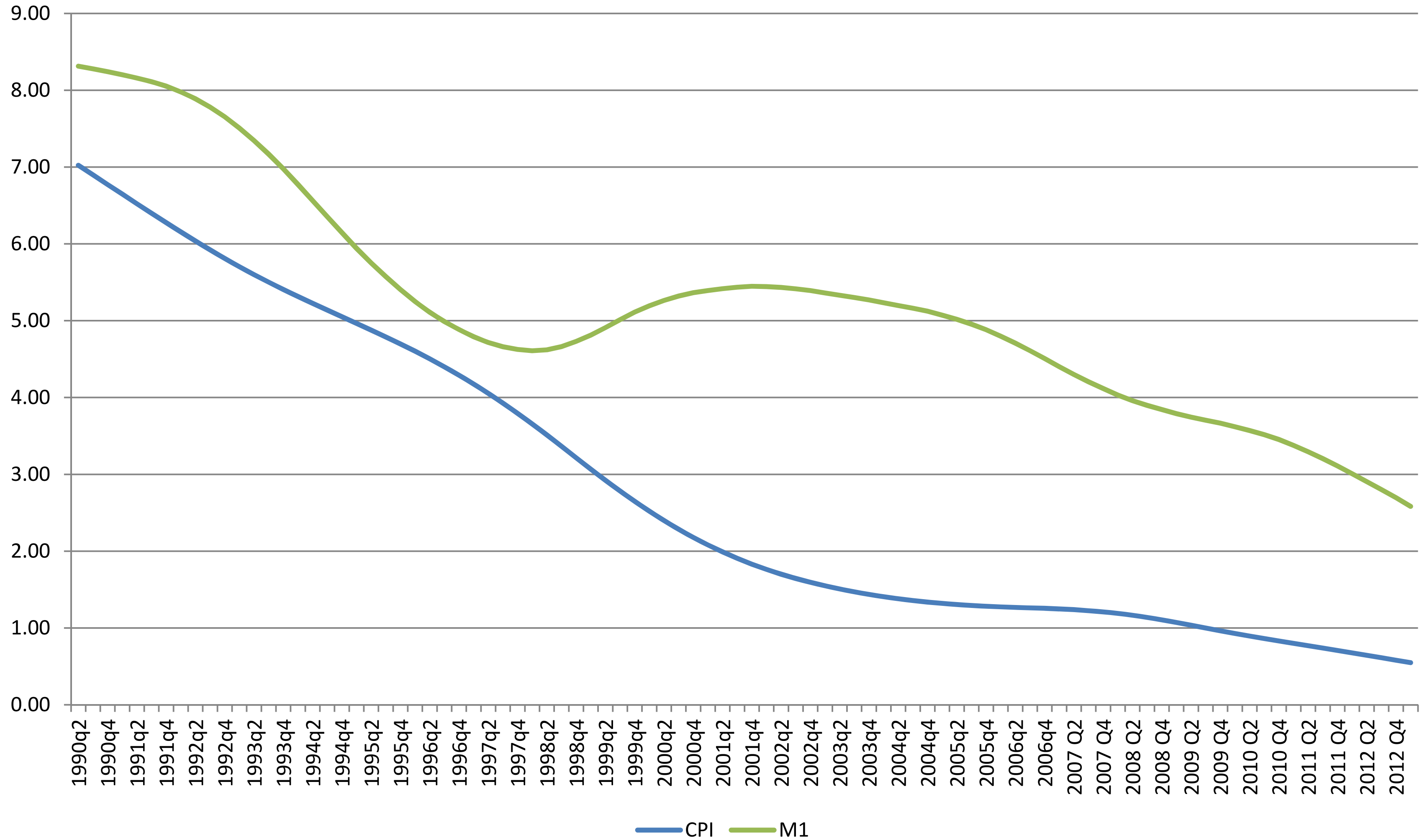
2002q4
2003q2
2003q4
2004q2
2004q4
2005q2
2005q4
2006q2
CPI
Base

Colombia



9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1990q2
1990q4
1991q2
1991q4
1992q2
1992q4
1993q2
1993q4
1994q2
1994q4
1995q2
1995q4
1996q2
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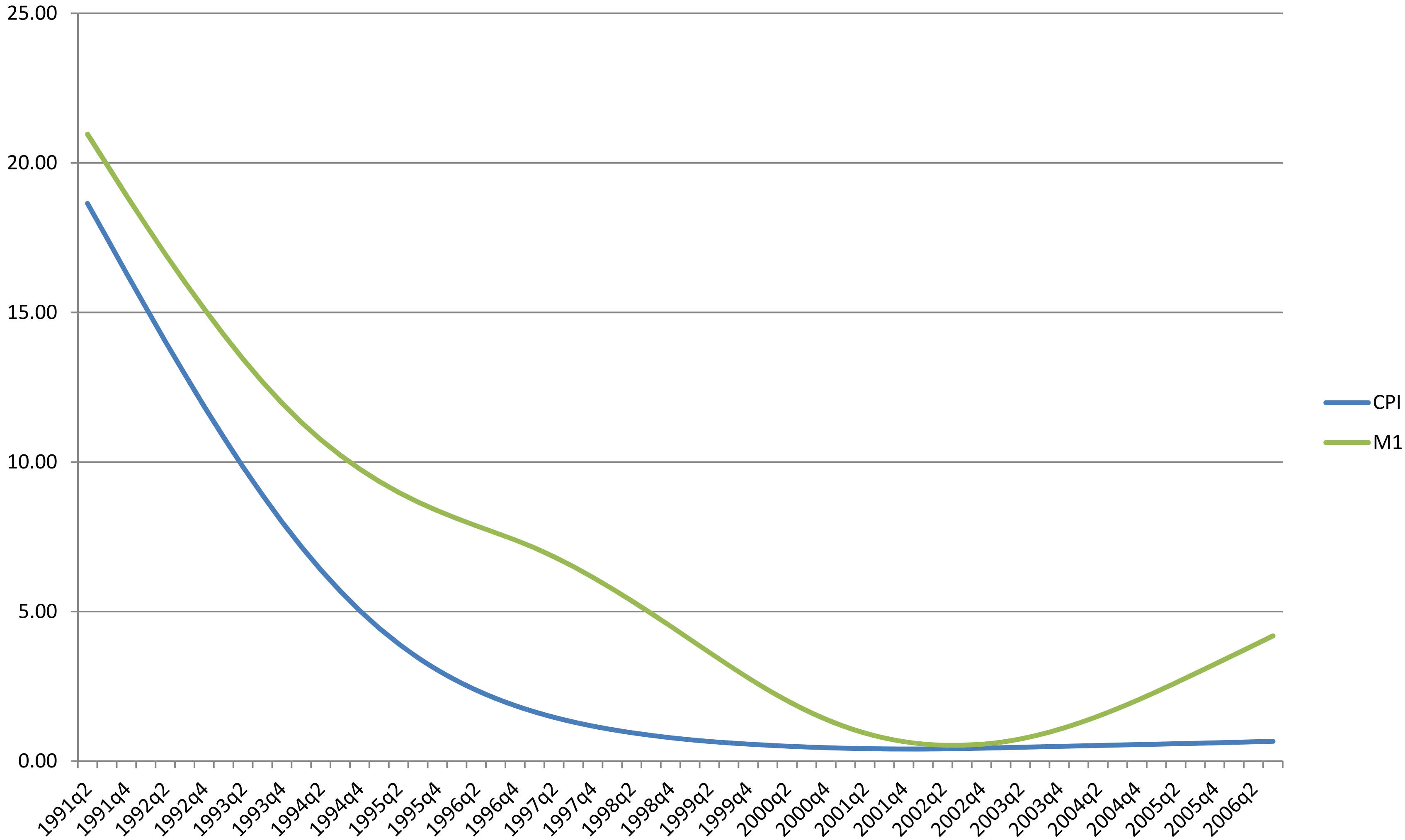
2004q2
2004q4
2005q2
2005q4
2006q2
2006q4
2007 Q2
2007 Q4
2008 Q2
2008 Q4
2009 Q2
2009 Q4
2010 Q2
2010 Q4
2011 Q2
2011 Q4
2012 Q2
2012 Q4
CPI
M1

Peru



25.00
20.00
15.00
10.00
5.00
0.00
1991q2
1991q4
1992q2
1992q4
1993q2
1993q4
1994q2
1994q4
1995q2
1995q4
1996q2
1996q4
1997q2
1997q4
1998q2
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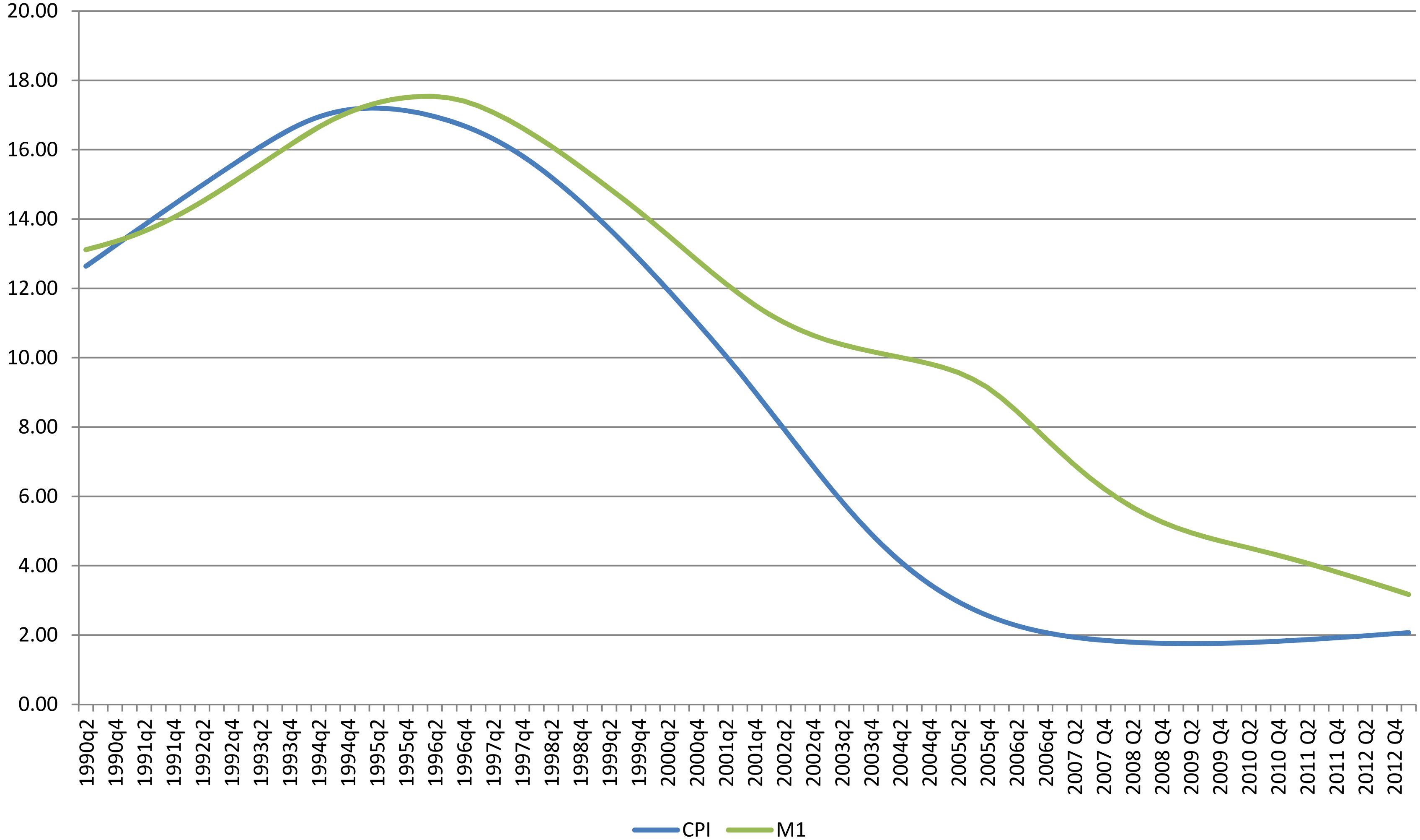
2000q2
2000q4
2001q2
2001q4
2002q2
2002q4
2003q2
2003q4
2004q2
2004q4
2005q2
2005q4
2006q2
CPI
M1

Turkey



20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
1990q2
1990q4
1991q2
1991q4
1992q2
1992q4
1993q2
1993q4
1994q2
1994q4
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2005q4
2006q2
2006q4
2007 Q2
2007 Q4
2008 Q2
2008 Q4
2009 Q2
2009 Q4
2010 Q2
2010 Q4
2011 Q2
2011 Q4
2012 Q2
2012 Q4
CPI
M1

- **A more serious analysis of velocity**

- By setting $\gamma = 0$ in the equation

$$v_t = k_t e^{\gamma i_t}$$

  I treated velocity as purely exogenous.

- However, a long literature pioneered by Baumol and Tobin served as the theoretical framework for a series of empirical papers, mainly by Meltzer (1962) and Lucas (1988).

- Both theory and data supported a negative relationship between real money balances and the short term interest rate.

- In the US, this conceptual framework was abandoned as a tool to understand the relationship between monetary policy and inflation some time in the late 80's or early 90's.

- By the late 90's, a new conceptual framework, the New Keynesian model, became the workhorse in central banking theory and practice.

- But the failure of Lehman Brothers in 2008 was a challenge: it led the Fed to increase the level of bank reserves from some $40 b. $800 b. in 4 months.

- None of the **leading models**—including the New Keynesian model in use by the Fed itself—had anything to contribute to the Fed's response to the liquidity crisis.

- By the time of the outburst of the crisis, a broad consensus was reached that no measure of "liquidity" in an economy was of any value in conducting monetary policy.

- There were good reasons behind this consensus.

- Long standing empirical relations connecting monetary aggregates to movements in prices and interest rates began to fall apart in the 1980s and have not been restored since.

- Our first objective in this paper is to offer a diagnosis of this empirical breakdown.

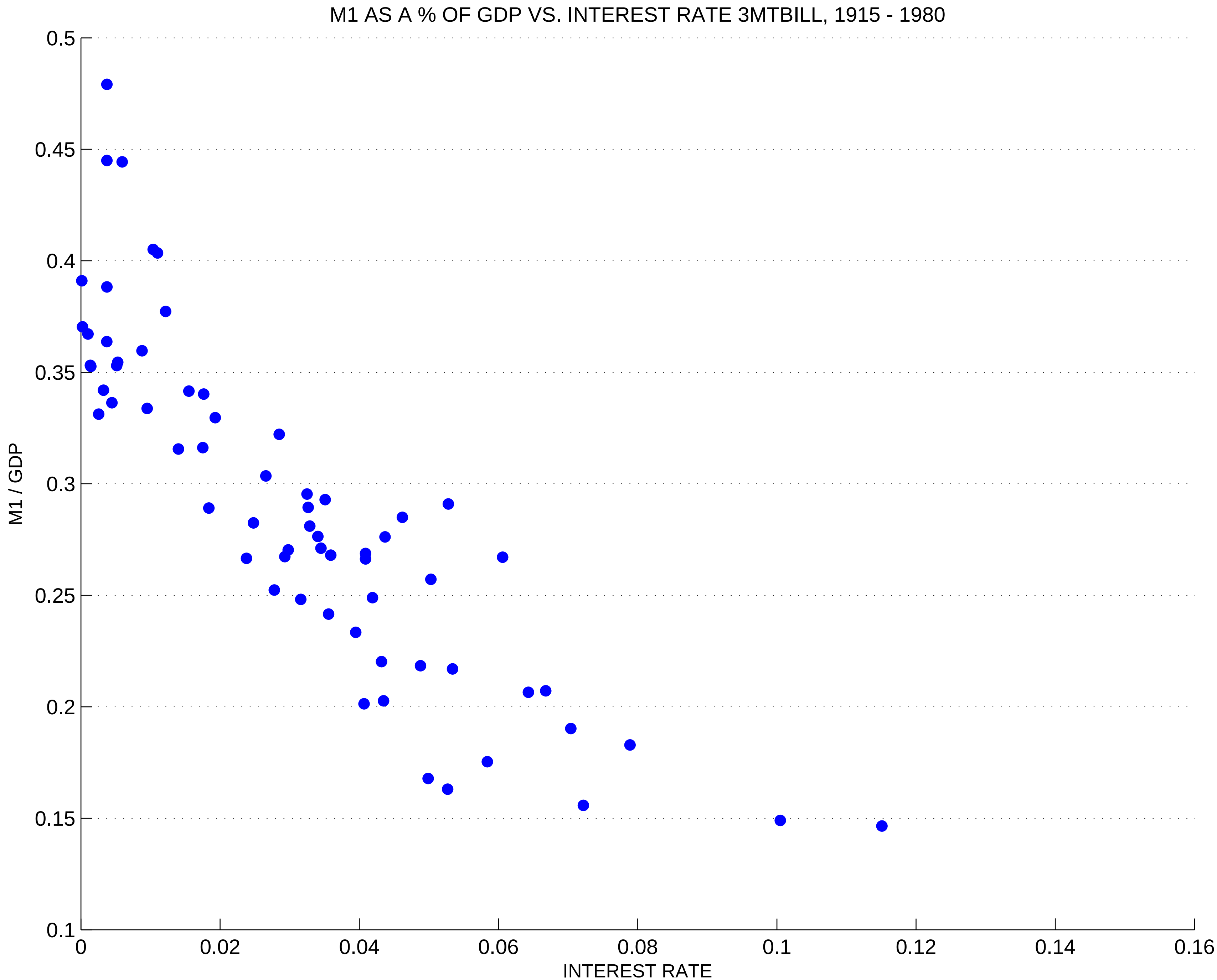
- Changes in the regulation of interest payments on commercial bank deposits in 1980 and 1982. (Teles and Zhou (2005)).

- Our second is to propose a fix.

- We evaluate the effects of these policy changes using a simple inside-money model and propose a monetary aggregate the offers a unified treatment of monetary facts preceding and following 1980.

Plan

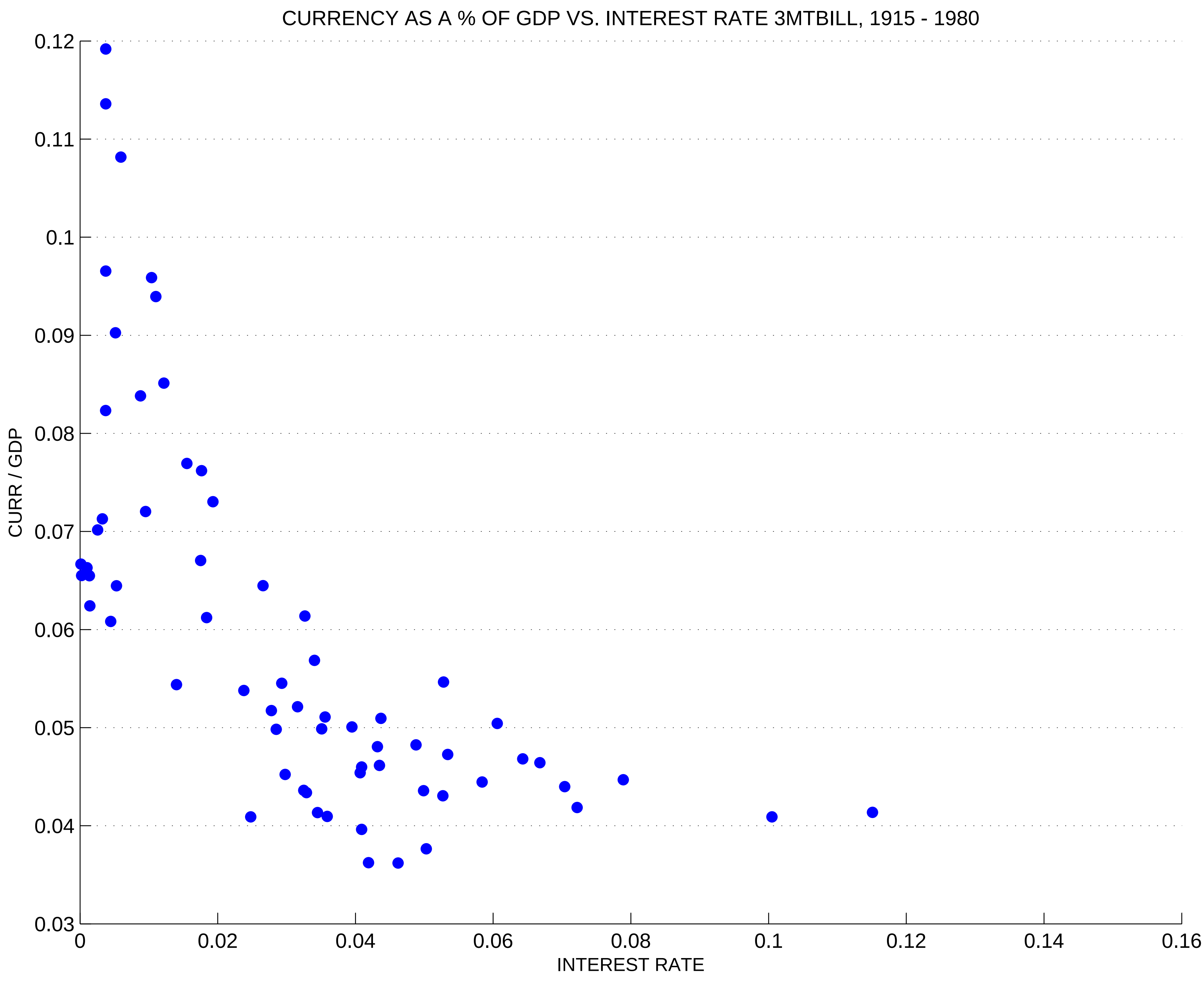
- Document the empirical break-down.
- Discuss changes in regulation.
- Briefly discuss the model.
- Show the performance of the model.
- Discuss the implications of the model for the evolution of inflation in the US.


M1 AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1915 - 1980
M1 / GDP
INTEREST RATE
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

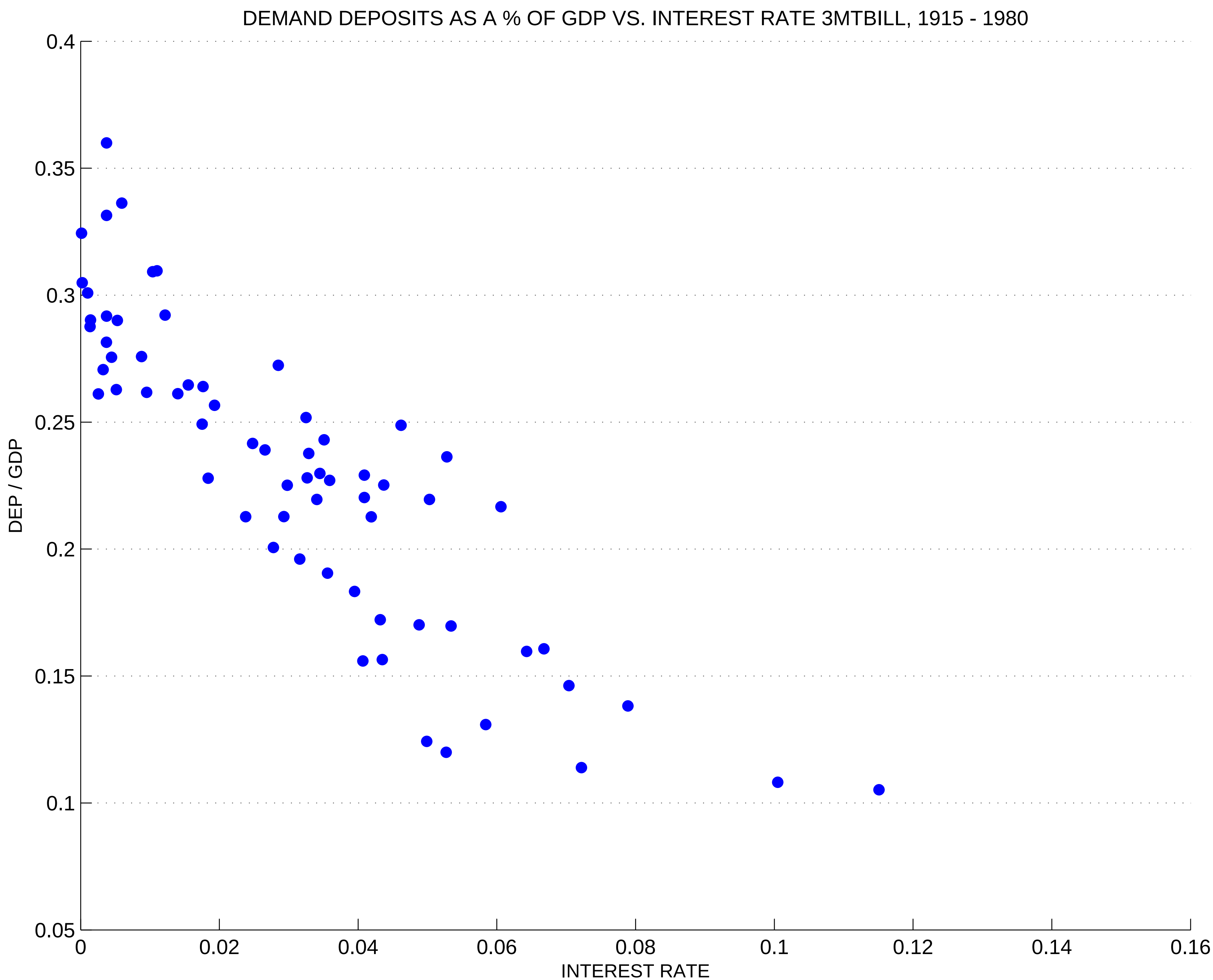
- Why $M1$?

- No theoretical attempts at modeling the households decision between the components.

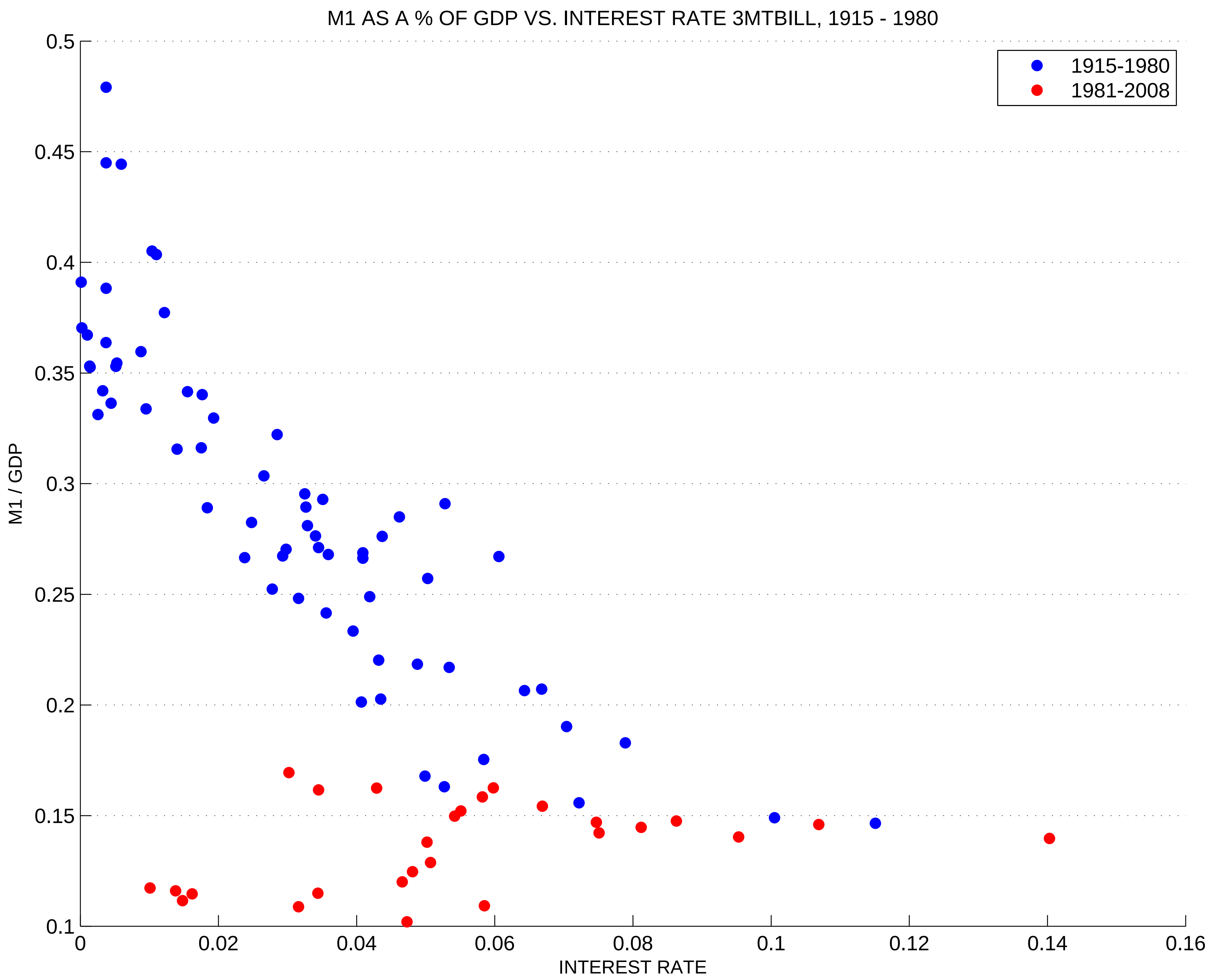
- No apparent need to: some ”proportions” did not seem to change much over time.



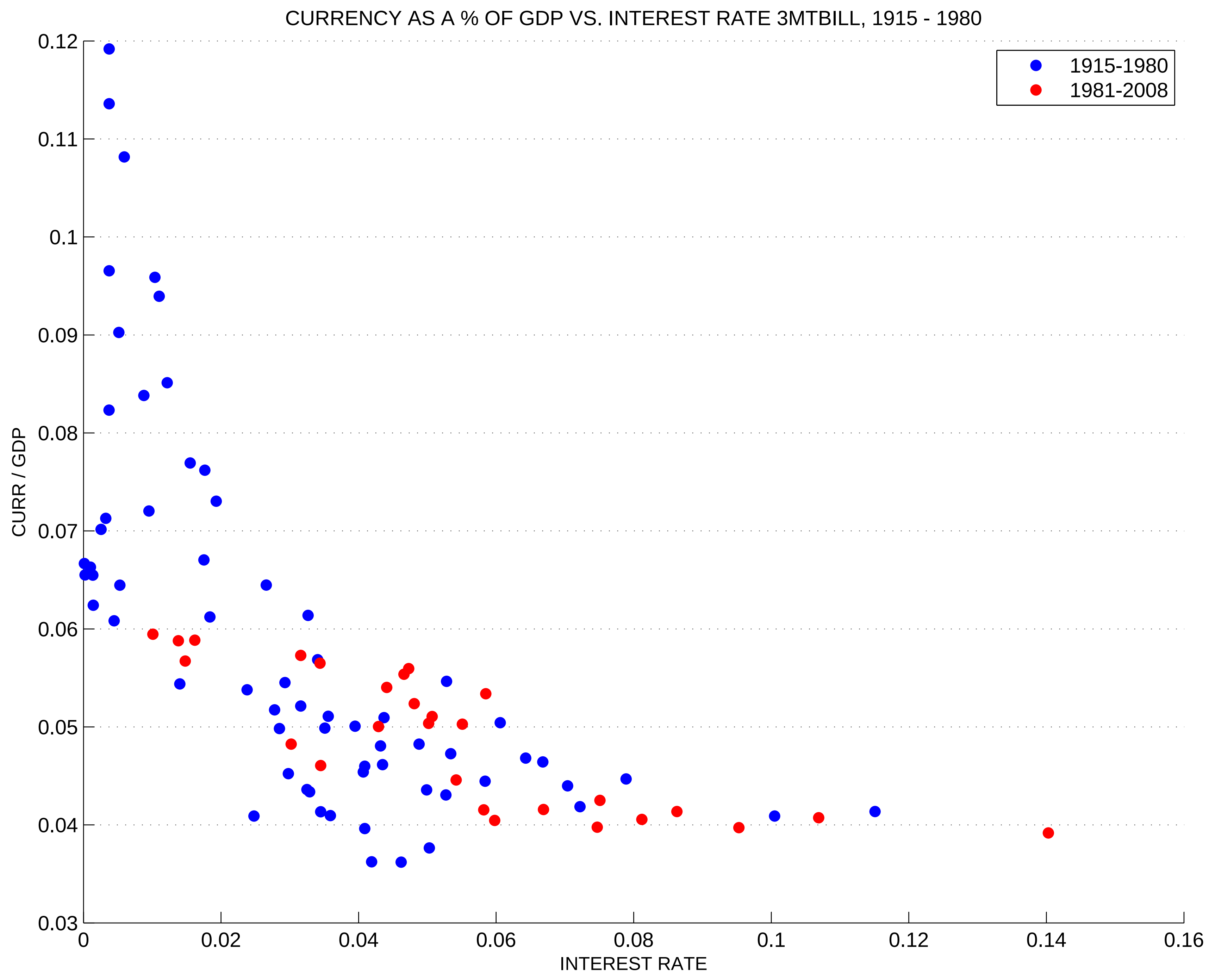
CURRENCY AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1915 - 1980
CURR / GDP
INTEREST RATE
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16


DEMAND DEPOSITS AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1915 - 1980
DEP / GDP
INTEREST RATE
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

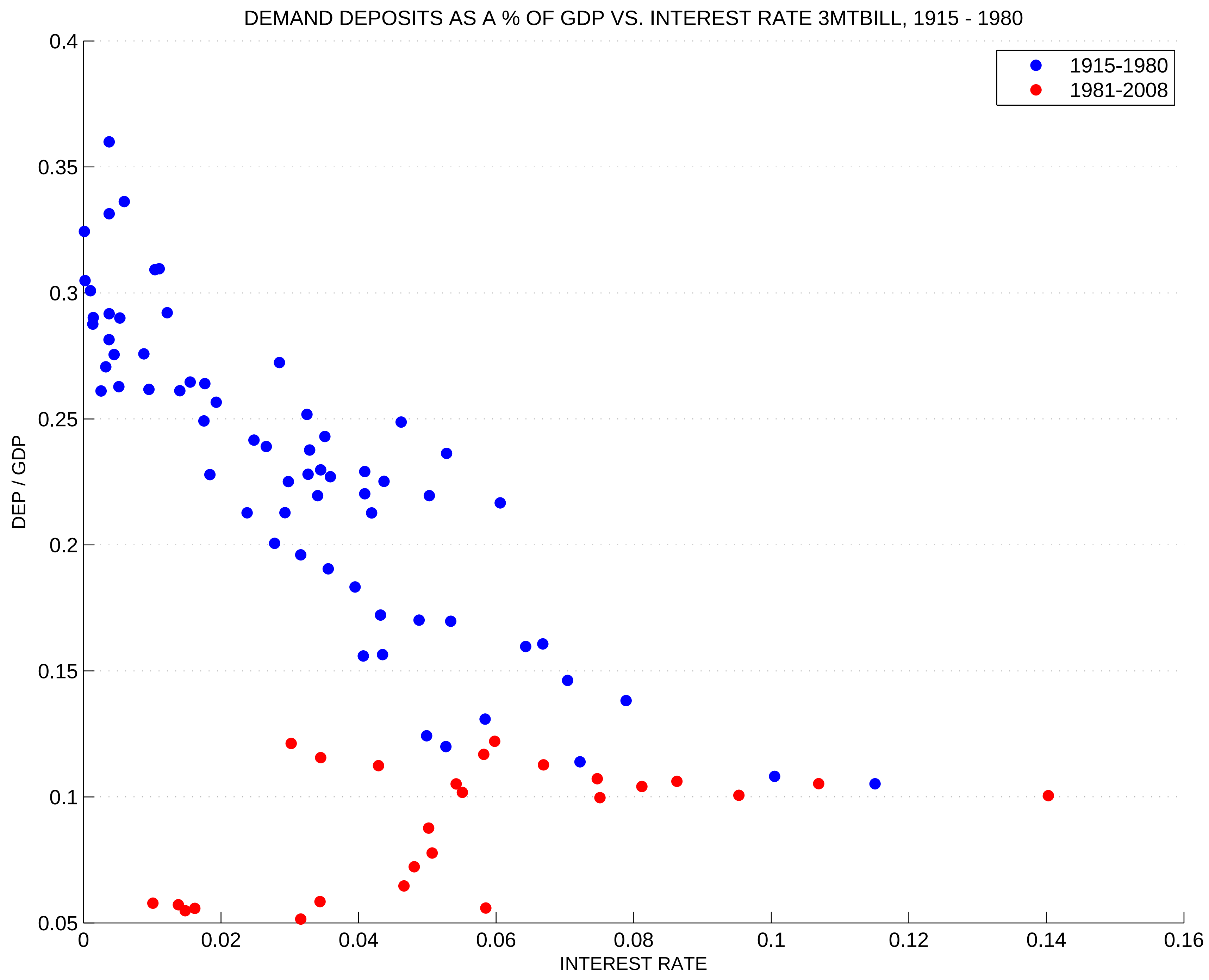
Evidence since 1980.



M1 AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1915 - 1980
1915-1980
1981-2008
M1 / GDP
INTEREST RATE
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16



CURRENCY AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1915 - 1980
1915-1980
1981-2008
CURR / GDP
0.12
0.11
0.1
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
INTEREST RATE



DEMAND DEPOSITS AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1915 - 1980
1915-1980
1981-2008
DEP / GDP
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
INTEREST RATE

Key changes in legislation

- After Great Depression, Regulation Q: Prohibited Commercial Banks paying interest rates on checking accounts.

- Regulation Q was relaxed in early 80's.
  - In 1980, *noncommercial* checking accounts (NOW) that pay interests were allowed. Included in M1. We will treat demand deposits and NOW accounts as a single aggregate.
  - A new Act in 1982 allowed for Money Market Deposit Accounts (Restricted checking accounts). NOT included in M1.

- How did this change affected households decisions regarding the "components" of M1?

- We need a model to answer this question.

- In the 90's, introduction of Sweep technology. We will ignore this change in our analysis - and will pay a price for that!

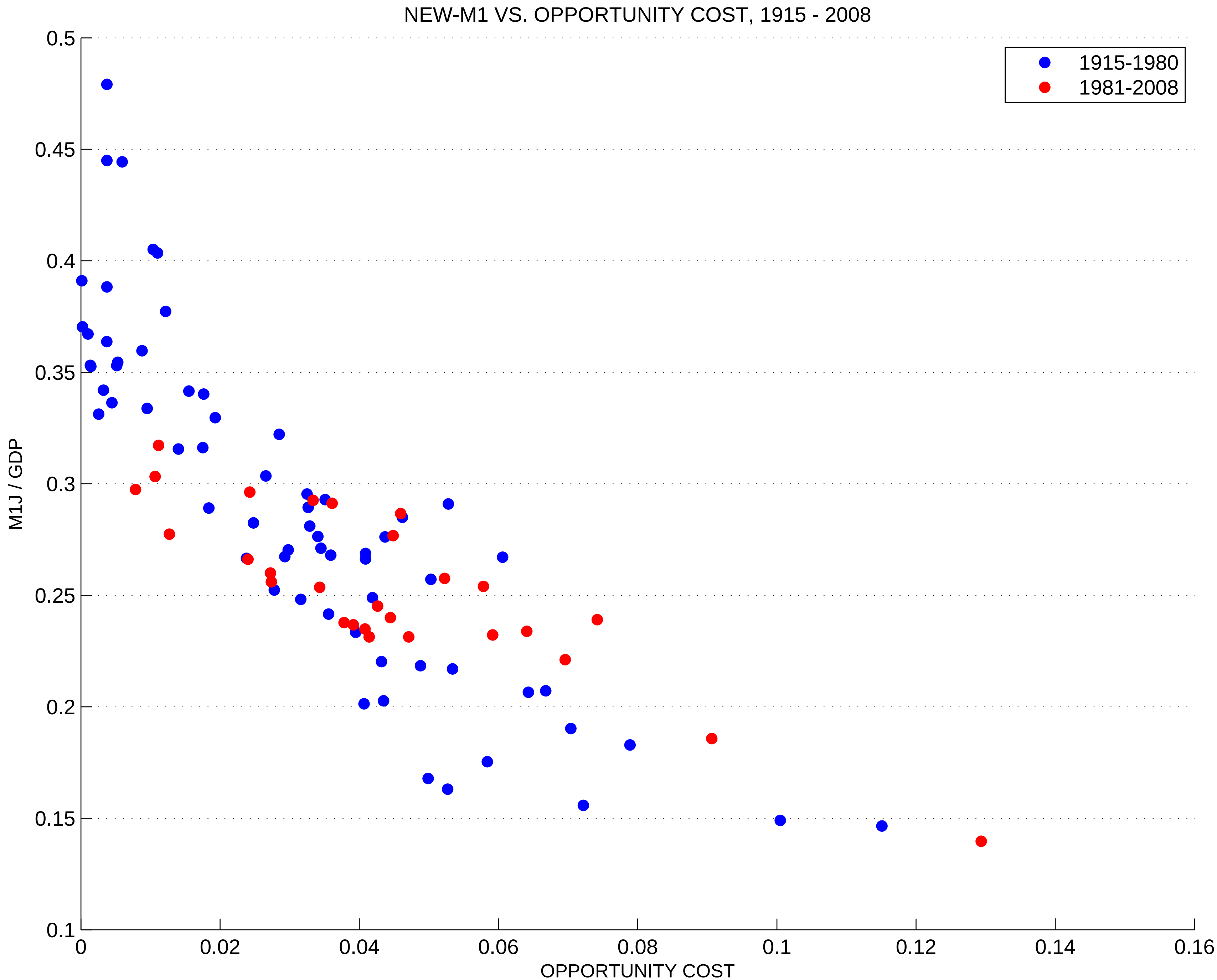
- Natural candidate theory given the evidence: regulation changes in the early 80's increased the availability of close substitutes for deposits, but not for cash.

- Once the close substitutes are allowed, they should be added to cash and demand deposits.

- This is what the simple model implies.

- As a preview of the results, we reproduce the previous figures we did for M1, but adding the newly created deposits

$$NewM1 = M1 + MMDA.$$


NEW-M1 VS. OPPORTUNITY COST, 1915 - 2008
M1J / GDP
OPPORTUNITY COST
1915-1980
1981-2008
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

The model

- Prescott (1987) and Freeman and Kydland (2000).
- Application of Baumol-Tobin to inside money.
- It is a theory of the "money multiplier".

- Households consume a continuum of different perishable goods in fixed proportions.

- Goods come in different “sizes“, $z \in [0, \infty)$ with production costs and prices that vary in proportion to size.

- We let $f(z)$ be the size distribution of goods and $F(z)$ the corresponding CDF.

- There are three payment technologies available to agents.

- One is cash (currency) C, which pays no interest. But there is no fixed cost of dong transactions.

- D (demand deposits) pay some interest rate but there is a **fixed** cost to make transactions.

- A (money market deposit accounts) pay a higher interest rate but are less liquid than demand deposits.

- We interpret this relative illiquidity with a higher fixed cost of transactions.

- We will look for equilibria with two cutoff sizes $0 \leq \gamma \leq \delta$, such that

  1. transactions lower than γ are paid for with C.

  2. transactions lager than γ but lower than δ are paid for with D.

  3. transactions larger than δ are paid for with A.

- Households also choose the number n of "trips to the bank" they take during a period.

- In each trip they replenish cash and deposits.

- Each trip to the Bank costs ϕ units of time, as in Baumol-Tobin.

- We solve for steady states, where the nominal interest rate (and therefore inflation and the growth rate of the monetary base) are all constant.

- There are two relevant margins

  1. How many trips to the Banks per period (choice of n): The higher r, the higher the number of trips to the bank and the lower the real money balances.

  2. The portfolio decision between the three asset types: the higher r, the larger the use of deposits.

- Note that the second effect implies changes in the money multiplier.

- The theoretical counterpart to observables are

$$\frac{m}{px} = \frac{A}{n(r)} \ , \quad \frac{C}{D} = c(r) \ , \ \frac{D}{A} = d(r)$$

- A is a parameter that makes the units of real money holdings consistent with our choice of yearly interest rates.

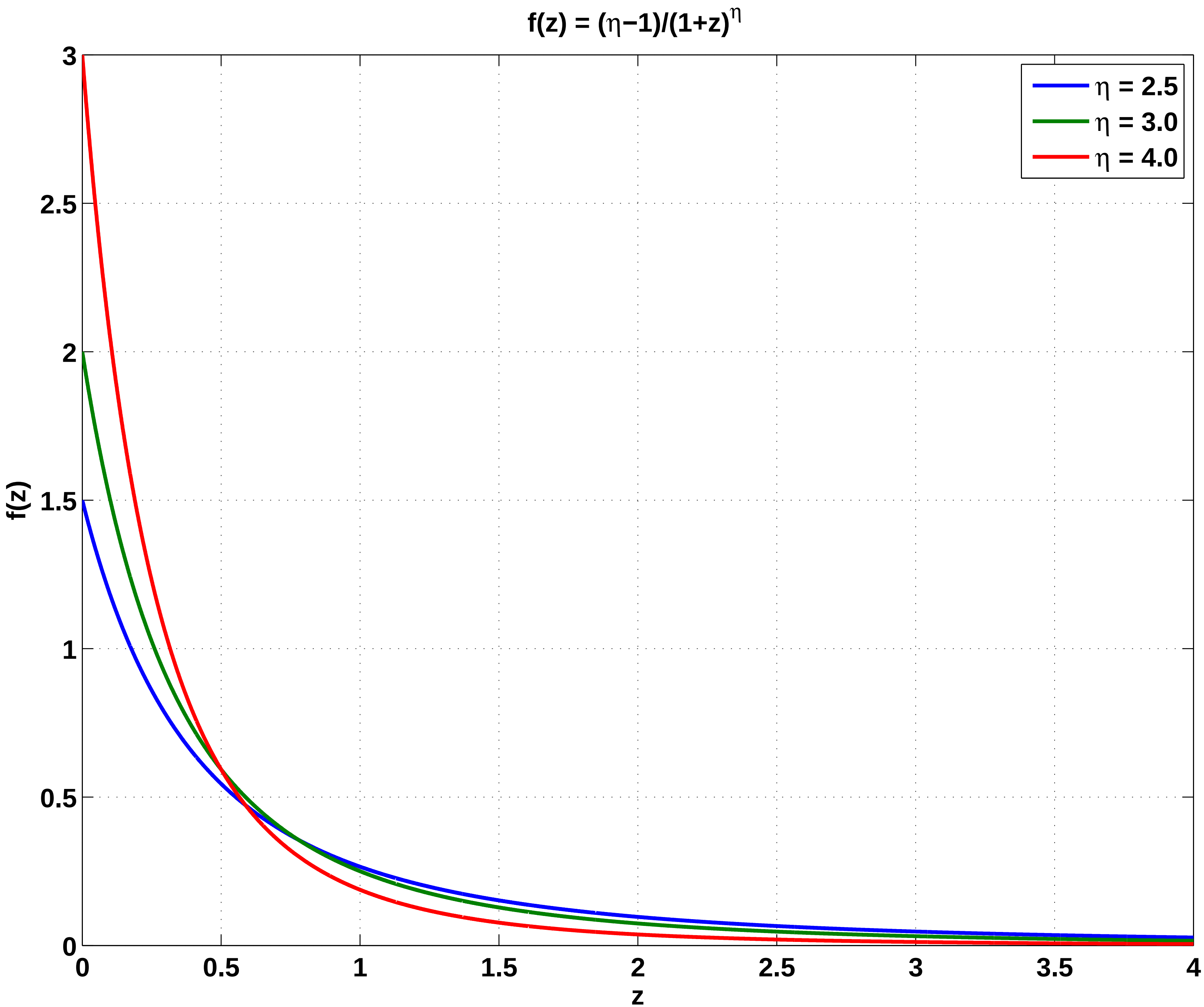
Numerical solutions

- To be precise, we get some numbers for the (few) parameters and solve the model, using data for the year 1984.

- We need to specify the form and parameters of the transaction size distribution F.

- We let $z \in [0, \infty)$ and

$$f(z) = \frac{\eta - 1}{(1 + z)^{\eta}}, \eta > 2$$

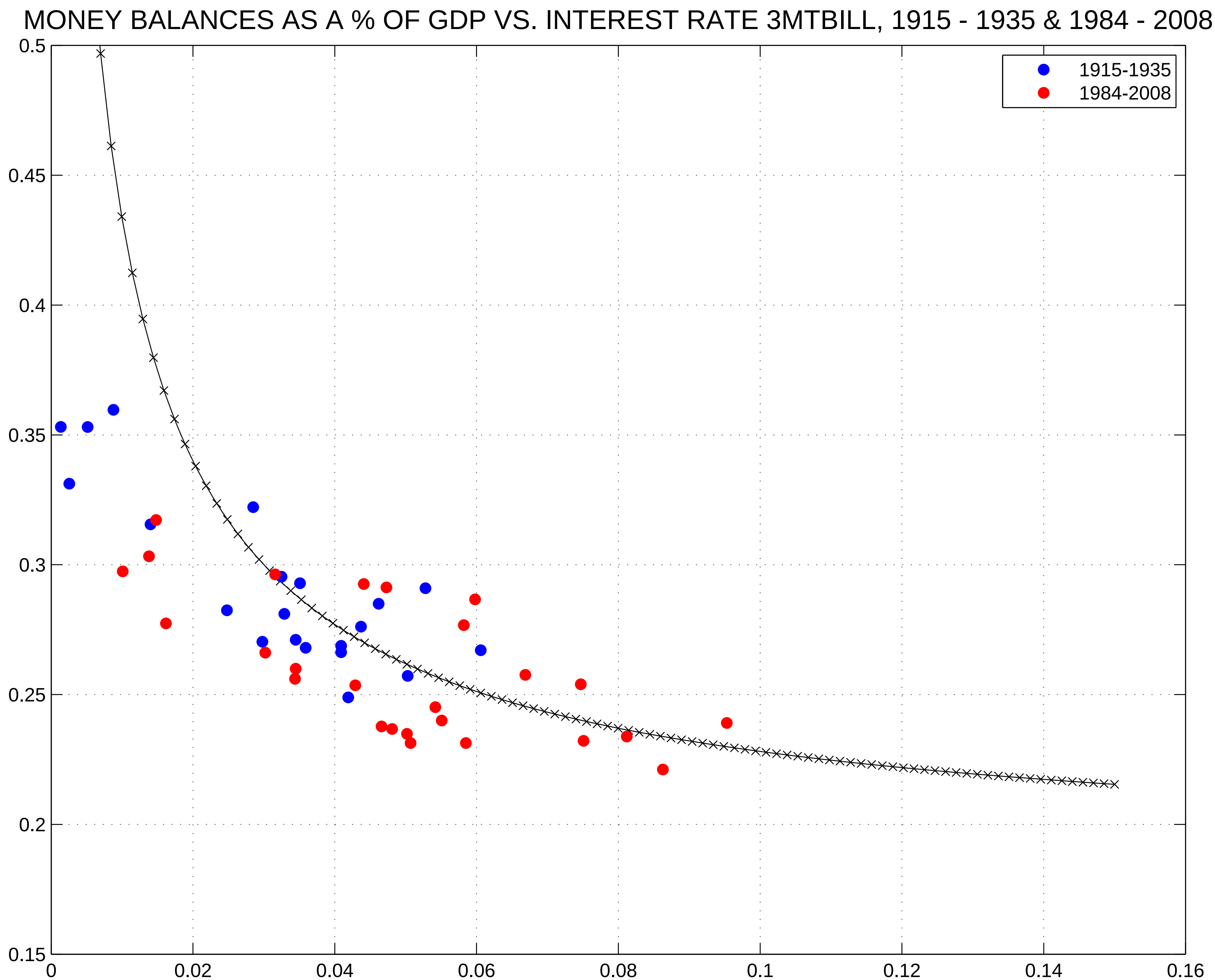


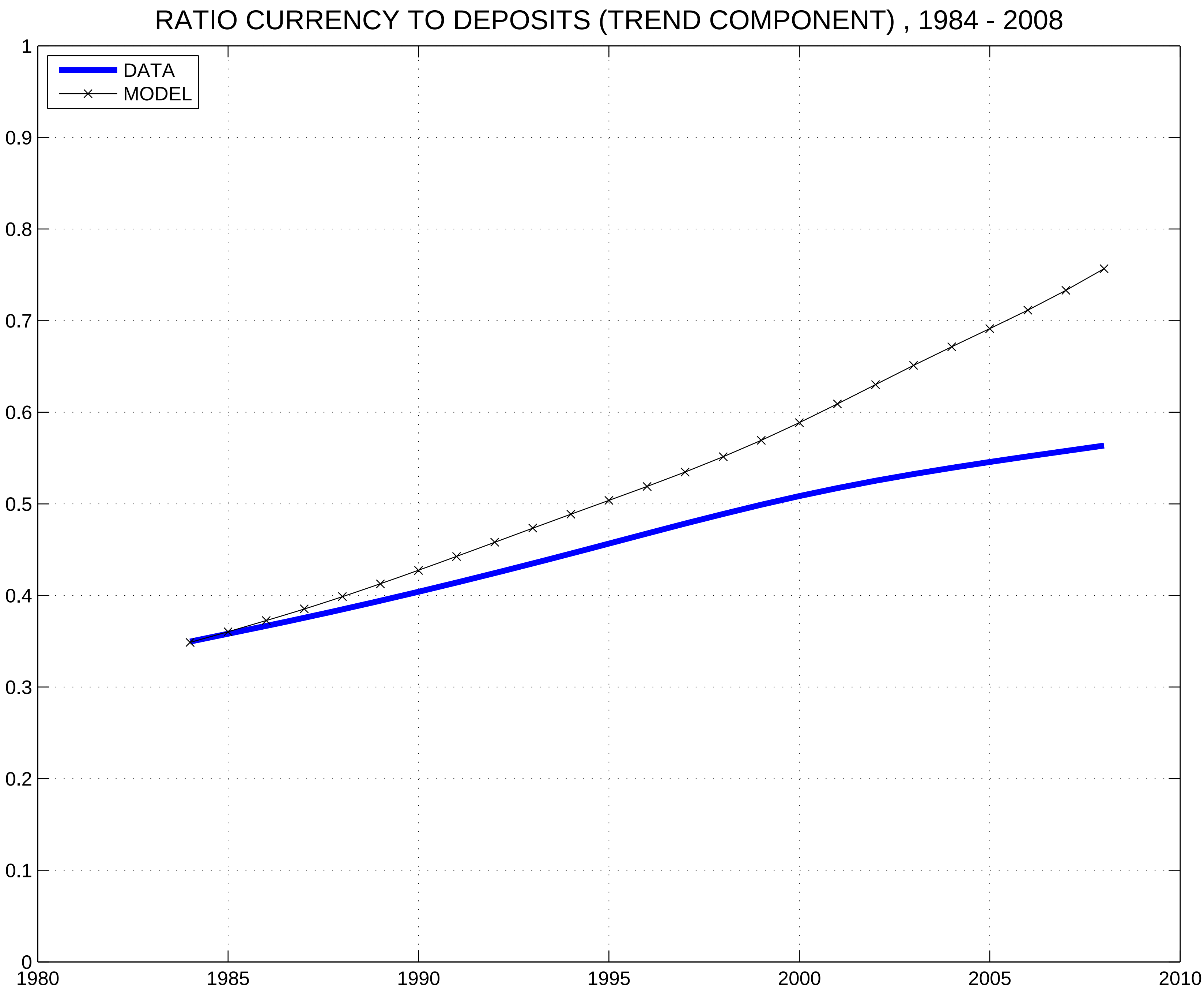
f(z) = (η−1)/(1+z)^η
η = 2.5
η = 3.0
η = 4.0
f(z)
z
0
0.5
1
1.5
2
2.5
3
3.5
4

- We can now solve for real money balances over GDP, and for the behavior of the ratios between the components C, D and A.

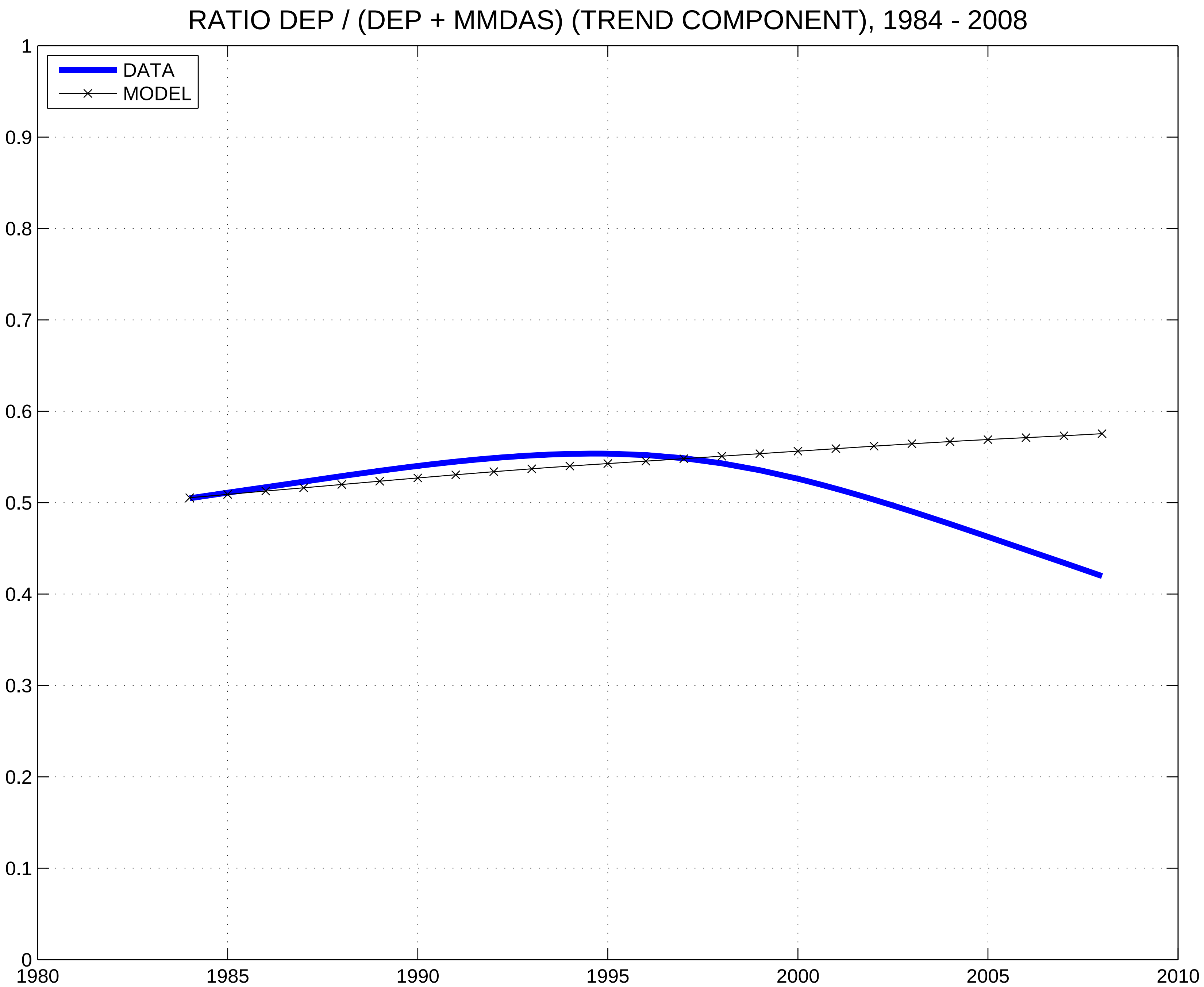
- We compare the predictions of the model with the data.

- Simple illustration to show the ability of the model to capture some essential features of the data.


MONEY BALANCES AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1915 - 1935 & 1984 - 2008
1915-1935
1984-2008
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16



RATIO CURRENCY TO DEPOSITS (TREND COMPONENT) , 1984 - 2008
DATA
MODEL
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1985
1990
1995
2000
2005
2010


RATIO DEP / (DEP + MMDAS) (TREND COMPONENT), 1984 - 2008
DATA
MODEL
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1980
1985
1990
1995
2000
2005
2010

Decentralization

- How about the Regulation Q period?

- Deposits could not pay interest, so changes in r do not necessarily affect the incentives to use deposits.

- Explains why focusing on each component of M1 did not matter much till 1980.

- How did Banks compete during Reg Q?

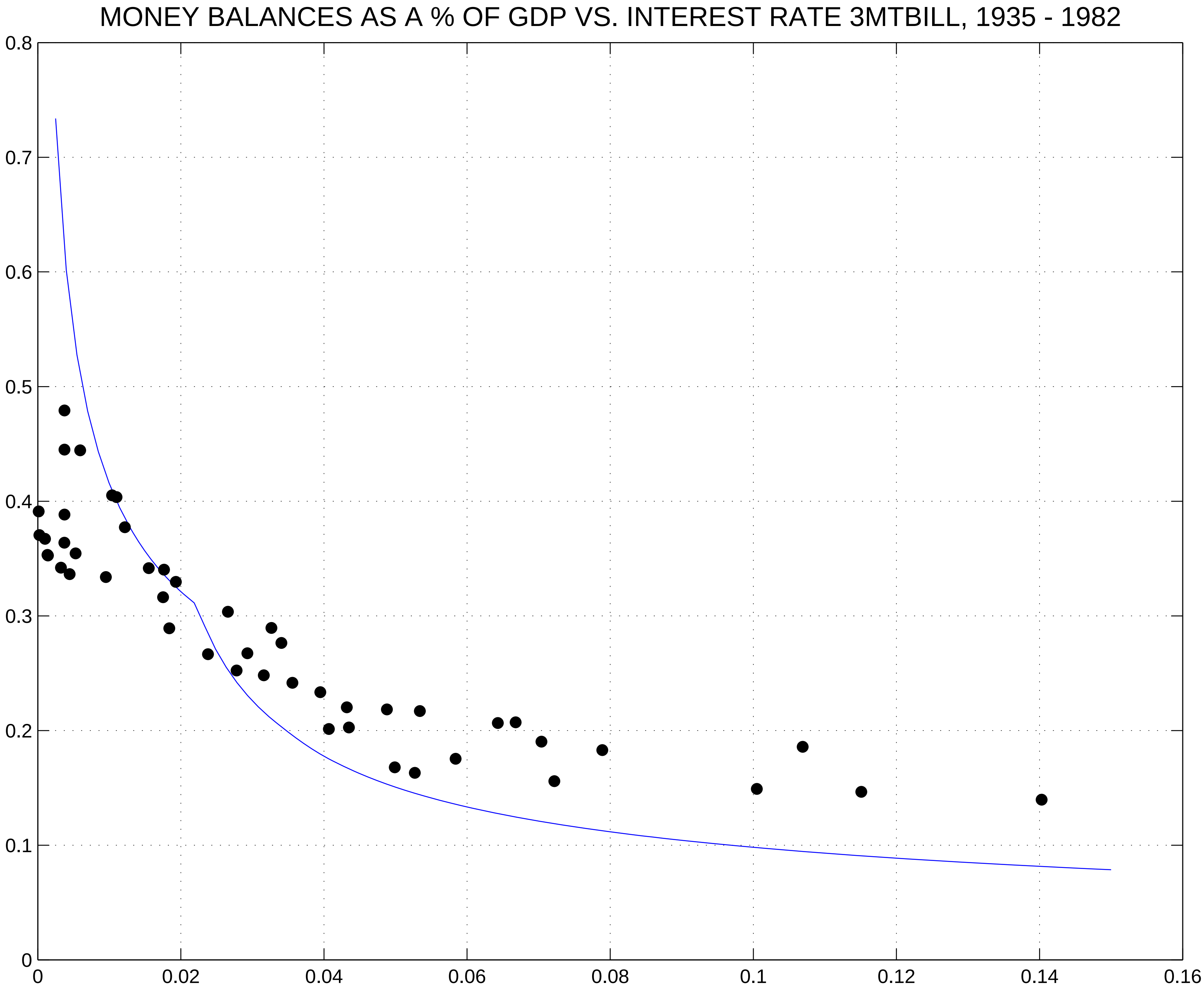
- We assume that for low interest rates, banks could offer reduced fees.

- This reduction in fees made deposits relatively more attractive than cash, so it acted as an increase in the interest on deposits.

- But this had some limits once fees became zero.

- Thus, Reg Q became binding, once the interest rate increased by the end of the 60's.

- We impose this restriction into the model and solve it, using the calibration of 1984.


MONEY BALANCES AS A % OF GDP VS. INTEREST RATE 3MTBILL, 1935 - 1982
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

Conclusions

- Money demand is remarkably stable.
- We overpredict money balances for low interest rates.
- After regulation Q, the model matches the trend of each deposit type reasonably well for over a decade, but misses the observed substitution between MMDA and DD that started in the late 90's.
- Is the assumption that operating costs are constant consistent with the Sweep technology?

- During Reg Q, the model can match the U-shape pattern of the cash to money balances ratio, but over-predicts its level. (Very sensitive to our assumptions regarding the "size" of transactions cost in calibration).

- The model of banking is very stark (misses by far the behavior of interest rates on deposits after 1983).

- A better theory of banking is needed.

- On the good side, in the model - and in the data - the behavior of the aggregate is not very sensitive to the behavior of each component: large substitutions within, without affecting the aggregate.

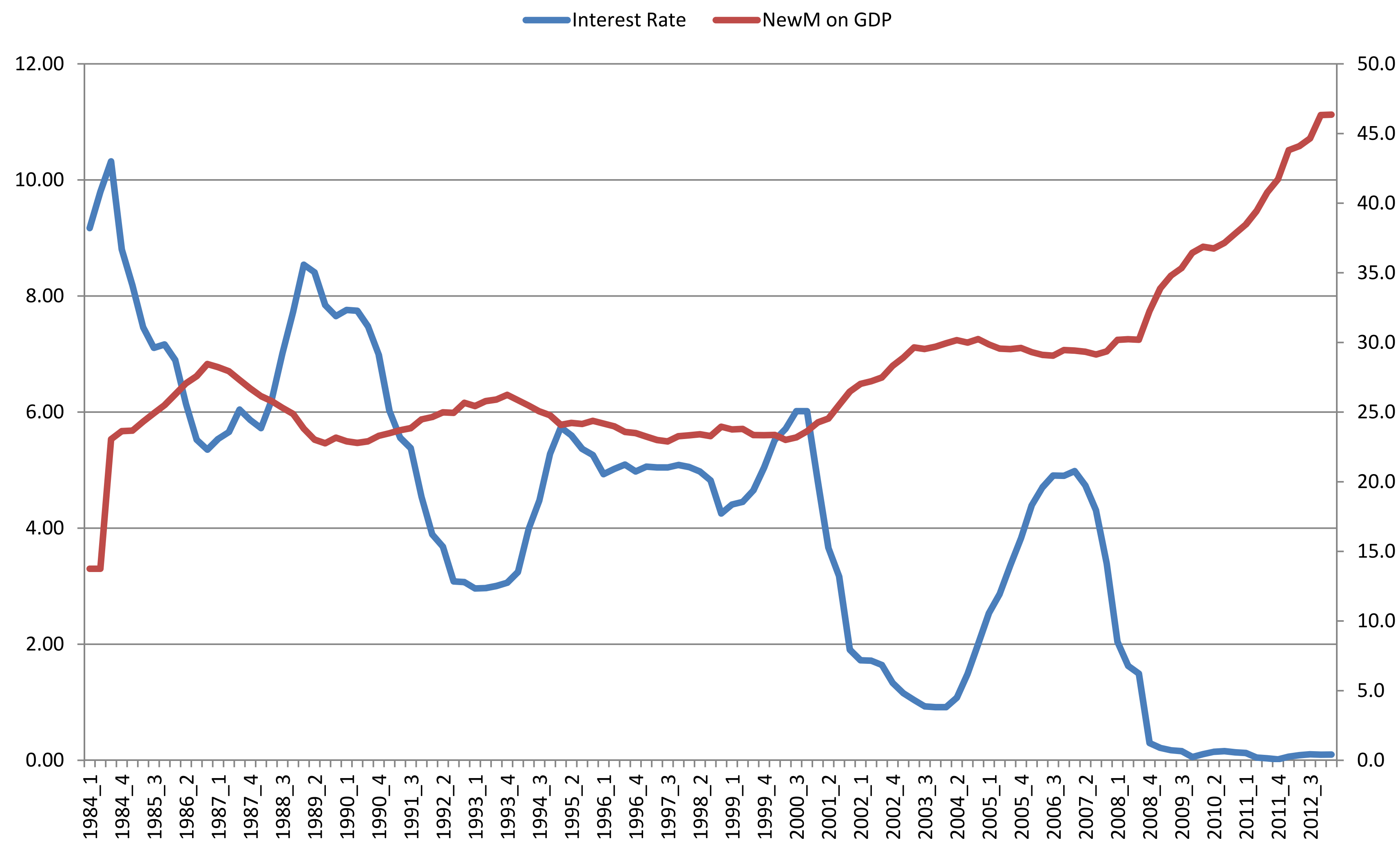
- We started the discussion mentioning the recent financial crisis, but the evidence we used is all pre-crisis data and the analysis is all based on theoretical steady states.

- We are trying to get the quantity theory of money back to where it seemed to be in 1980, but after all the older theories were as silent on financial crises as is this one is.

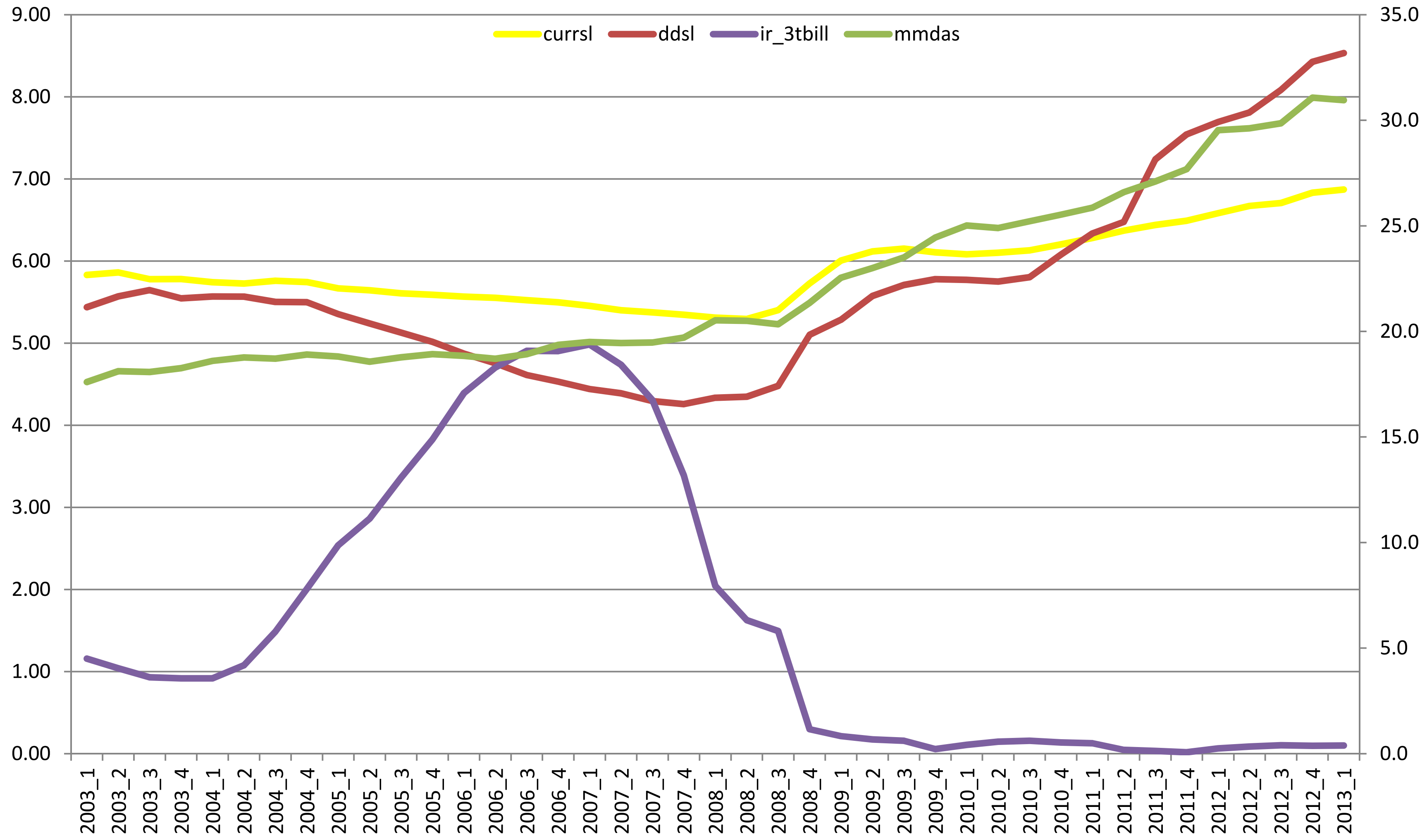
The recent behavior of NewM

- What happened since 2008?
- At the zero lower bound, the components of NewM are perfect substitutes of short term government bonds.
- Inflation is given by the negative real interest rate.
- We expect a large increase in NewM. We expect a large increase in all components.

Time Series NewM and TBRate, Quarterly



Recent behavior of components NewM



- Once interest rates become positive, say at 4%, I argue that NewM should be around 25% of GDP.

- The monetary base should be

- Cash should be around 5% of GDP.

- Now, NewM is around 48% of GDP.

- How will the reduction in NewM be achieved?

- The nominal value of NewM goes down, or the price level goes up.

- Assume that all reduction in deposits comes about private agents buying short term government bonds (nominal value of deposits coming down).

- Assume also that bank reserves go down accordingly, due to open market operations of the Fed.

- Cash may be 7,5% of GDP at the time of the "exit".

- But cash was 90% of the base.

- If all this cash stays in the system, the monetary base will increase by

$$\frac{7.5}{5} \times 0.9 = 0.45$$

- It is a 45% increase in the monetary base which would imply, **in a ss**, a 45% in prices.

- High standard deviation on this forecast!

- Changes in the multiplier?