On the Stability of Money Demand

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- Failure of Lehman Brothers in September, 2008 led to severe banking panic.

- Fed responded to by increasing bank reserves from some $40 billion on September 1 to $800 b. by New Years Day.

- Remarkable feature of these events that none of the leading macro-econometric models—including the model in use by the Fed itself—had anything to contribute to the analysis of this liquidity crisis or of the Fed's response to it.

- Bankers, as always, used short interest rates as the only monetary tool, only indicator of the stance of monetary policy

- Sometime in the 1990s they were joined by most influential monetary economists

- Broad consensus was reached that no measure of "liquidity"—of the quantity of money—was of any value in conducting monetary policy

- Entire generation emerged viewing increases in the quantity of money as "quantitative easing," "unconventional policies"

- There were understandable reasons for this

- "Money demand functions"—empirical relations connecting monetary aggregates like M1, M2 and M0 to movements in prices and interest rates—began to deteriorate in the 1980s, not restored since

- Document this in next section.

- Offer diagnosis of this breakdown: Regulation Q and inflation.

- Propose a fix: a new monetary aggregate: Money market deposit accounts (MMDAs)

$$\text{New-M1} = \text{M1} + \text{MMDAs}$$

- Builds on earlier fixes by Broaddus and Goodfriend (1984), Motley (1988), Poole (1991), Reynard (2004), Teles and Zhou (2005), Ireland (2009)

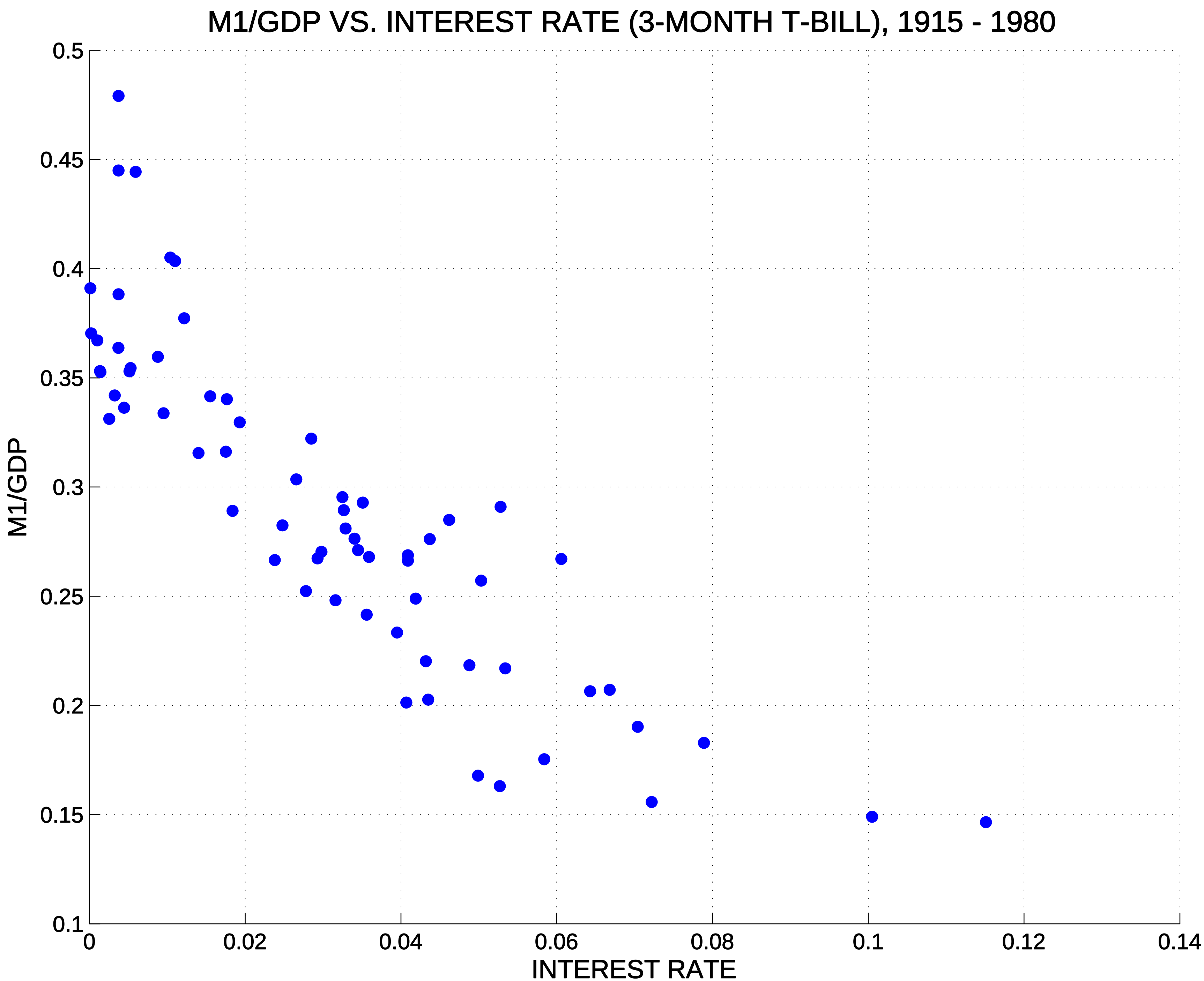
1 U.S. monetary history since 1915

- What exactly was this “breakdown” ?

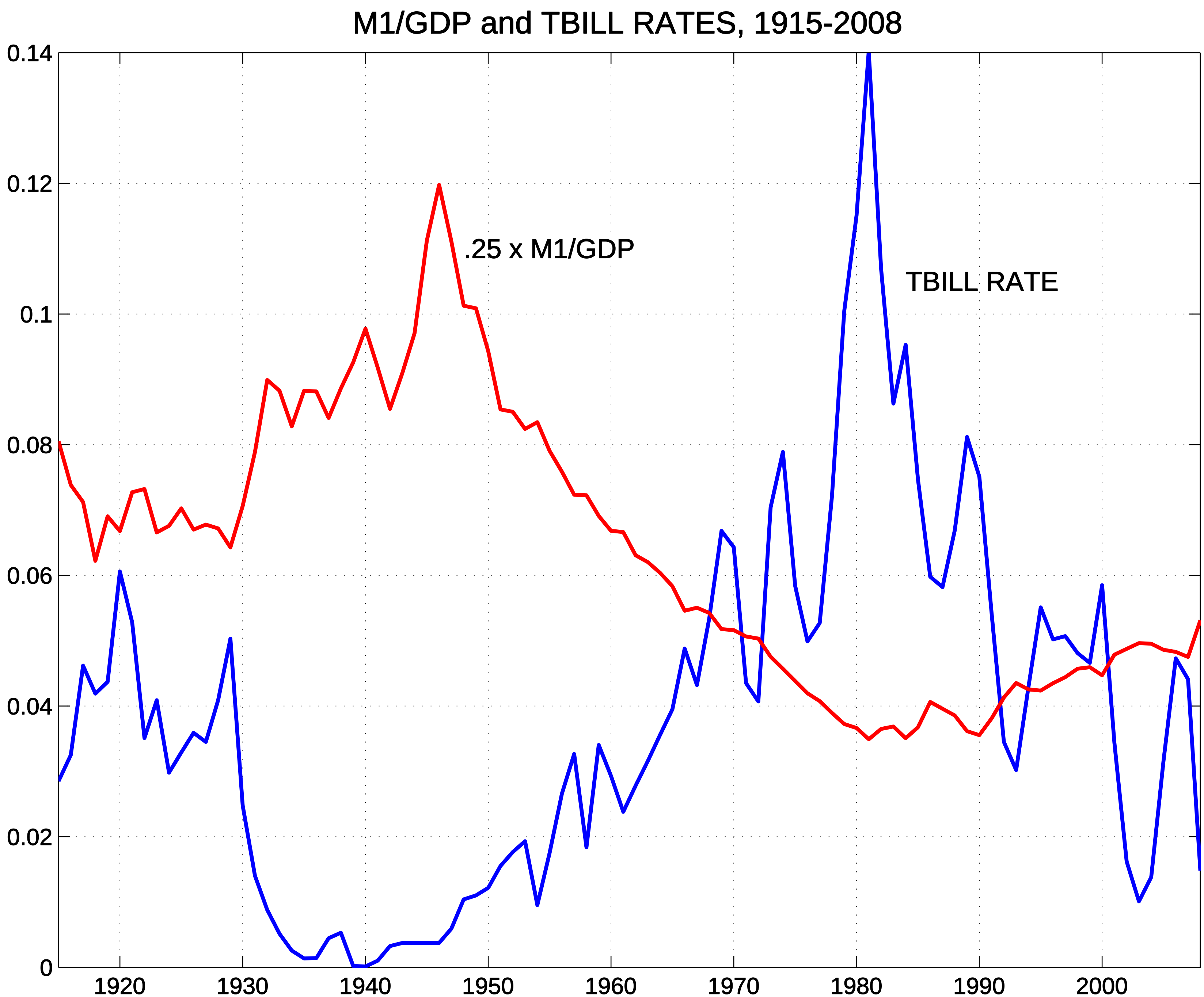
- What did we think we knew in 1980 and what went wrong?

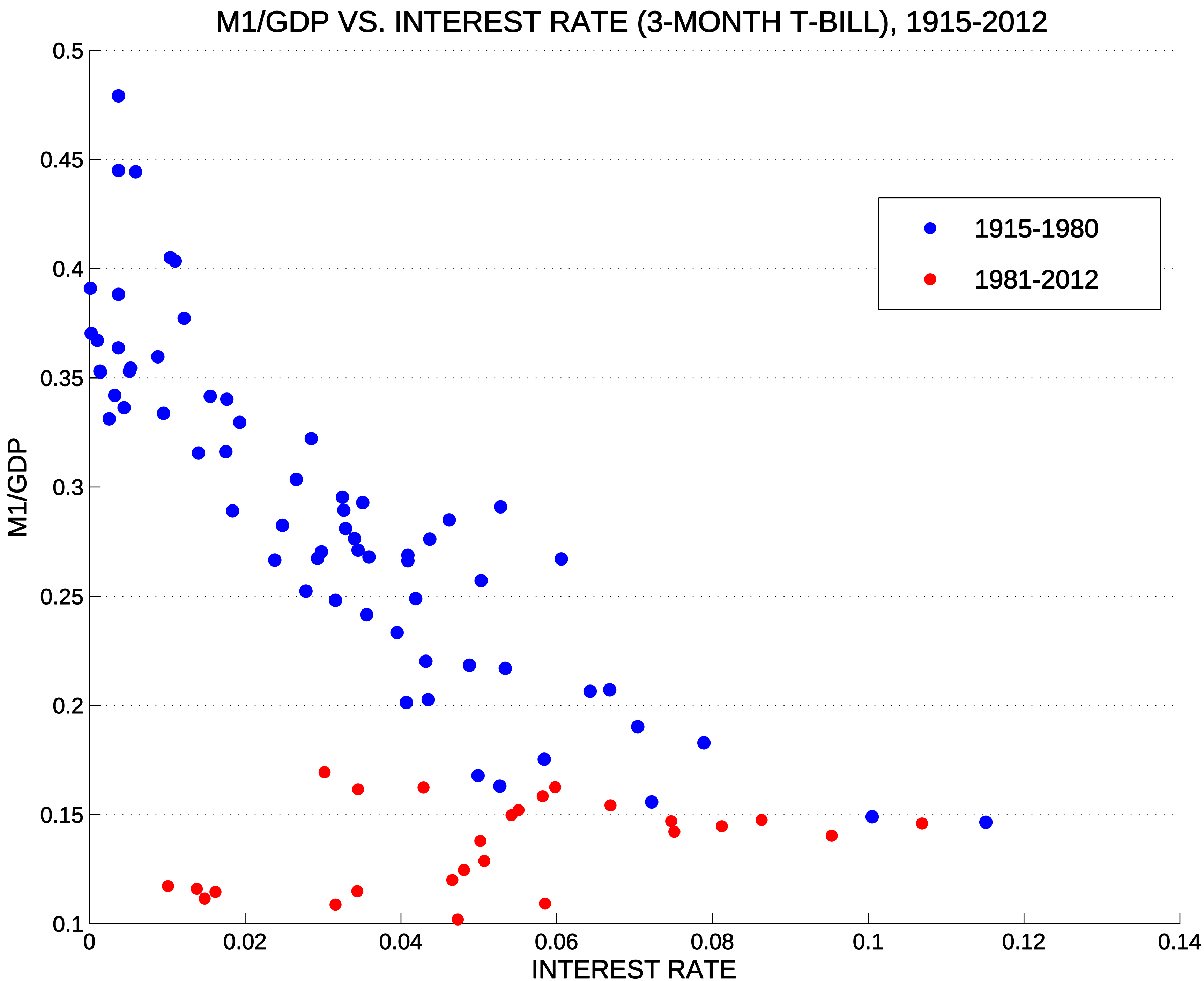
- Begin with annual time series of currency, demand deposits, M1, all divided by GDP, plotted against 3 month T-bill rate

- Loosely interpreted: a “demand function” for money relative to spending, with the short interest rate as the opportunity cost

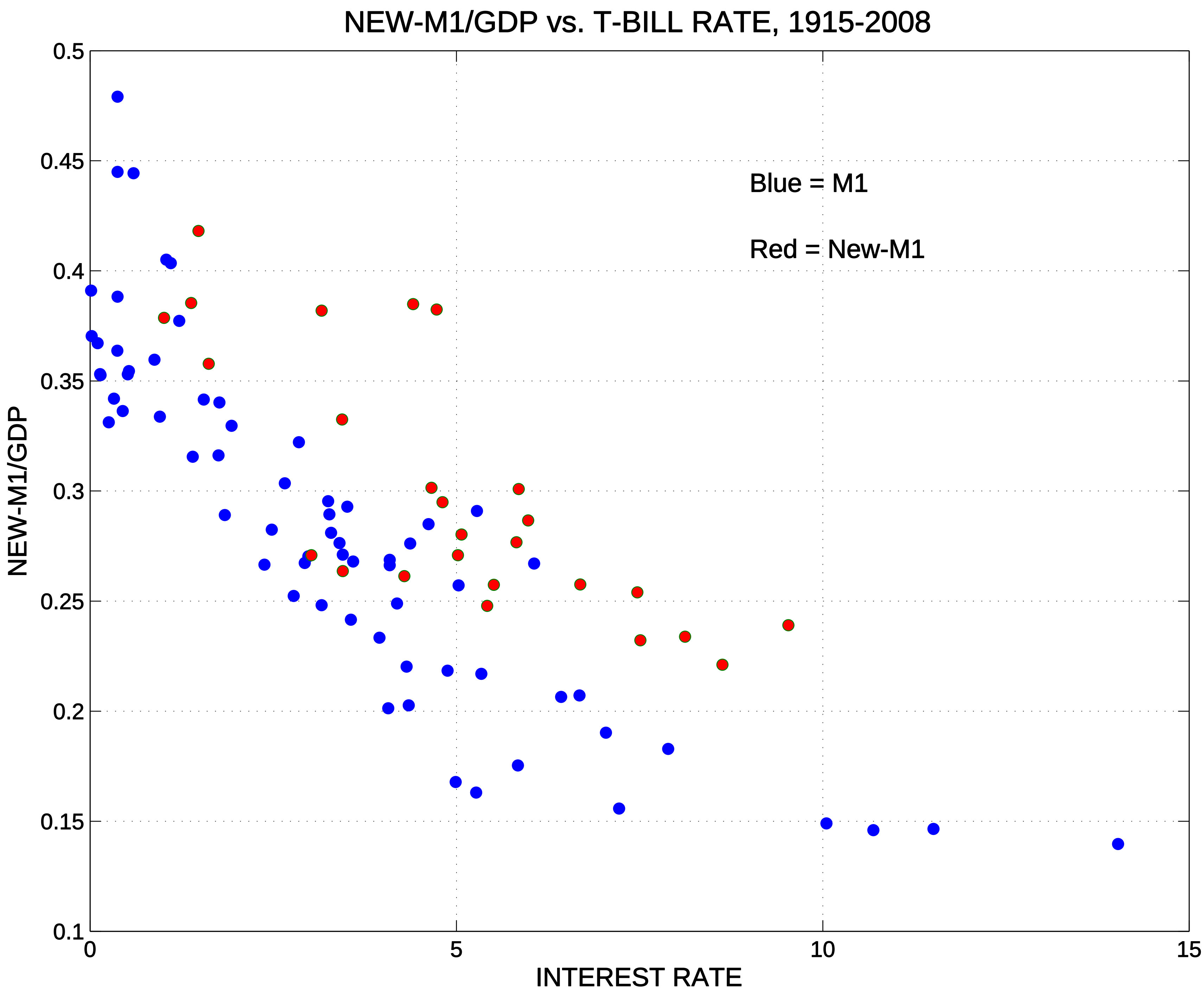


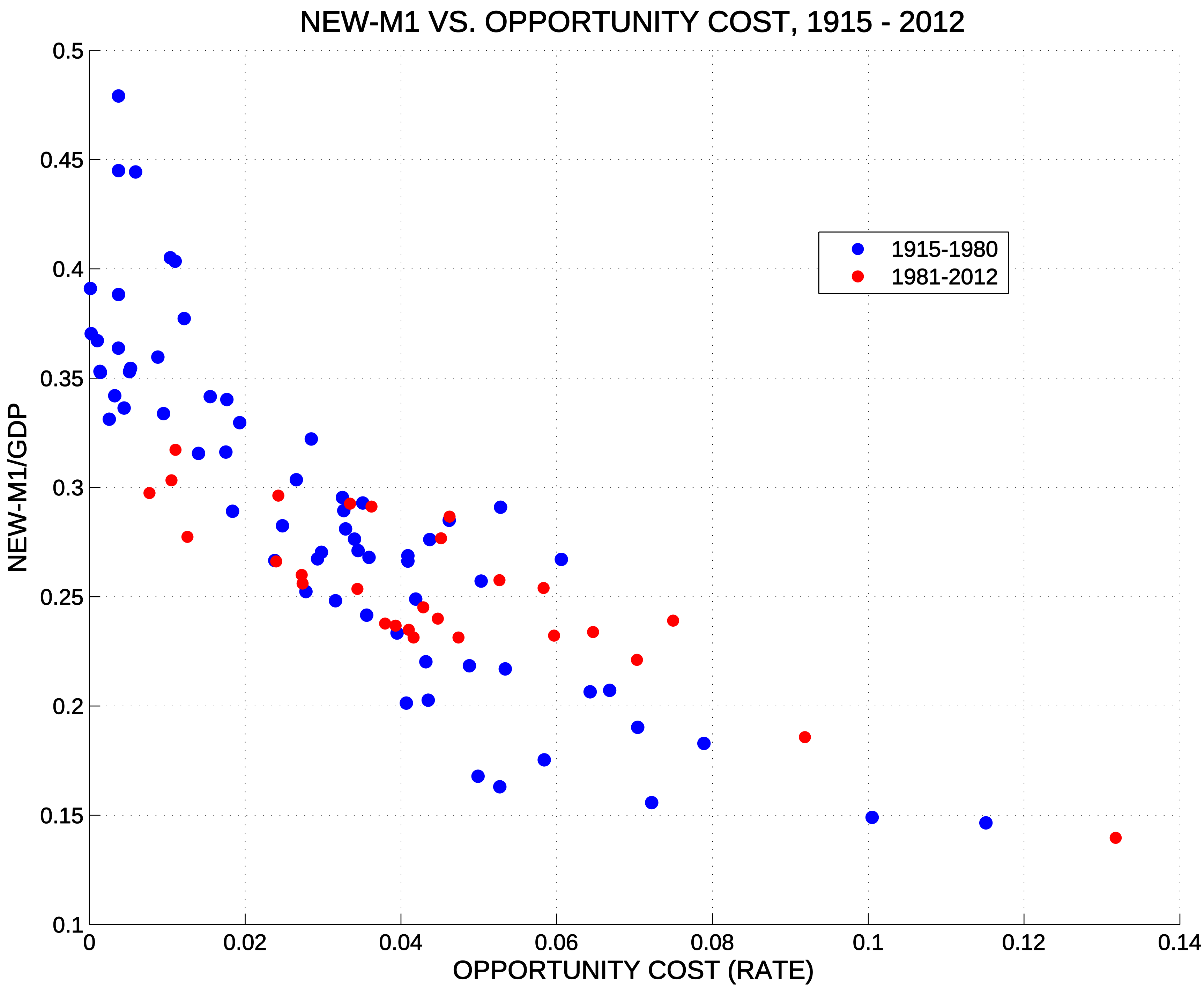
M1/GDP VS. INTEREST RATE (3-MONTH T-BILL), 1915 - 1980
M1/GDP
INTEREST RATE
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14


M1/GDP and TBILL RATES, 1915-2008
.25 x M1/GDP
TBILL RATE
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1920
1930
1940
1950
1960
1970
1980
1990
2000



M1/GDP VS. INTEREST RATE (3-MONTH T-BILL), 1915-2012
M1/GDP
INTEREST RATE
1915-1980
1981-2012
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


NEW-M1/GDP vs. T-BILL RATE, 1915-2008
Blue = M1
Red = New-M1
NEW-M1/GDP
INTEREST RATE
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0
5
10
15


NEW-M1 VS. OPPORTUNITY COST, 1915 - 2012
NEW-M1/GDP
OPPORTUNITY COST (RATE)
1915-1980
1981-2012
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

2 Basic Theoretical Model

- Last slide is our bottom line: won't get much better

- But how is this figure related to equilibrium behavior of economy?

- What are the distinct roles of M1 and MMDA's in the payments system?

- Build on McCallum and Goodriend (1987), Prescott (1987), Freeman and Kydland (2000)

- Basic model: a single payment instrument

- General equilibrium where M_t, P_t grow at constant, common rate π, GDP y constant, and nominal interest rate $r = \rho + \pi$.

- Identical households have preferences over perishable good x_t

$$\sum_{t=0}^{\infty} \beta^t U(x_t), \qquad \beta = \frac{1}{1+\rho}.$$

- Each household has one unit of labor each period, y, to be divided between production and cash management. Only factor of production

- Household must buy goods with cash, time: trips to the bank n_t at time cost ϕ each

- Payments technology, require labors input and cash reserve

- Special case of McCallum and Goodfriend (1987):

$$x_t \leq k \frac{M_t}{P_t} n_t$$

- Each household begins period with M_t dollars

$$M_{t+1} = M_t + T_t + P_t y(1 - \phi n_t) - p x_t$$

- Normalize $M_t = 1$; renormalize every period; $p_t = P_t / M_t$

$$m_{t+1}(1 + \pi) = m_t + \pi + p_t y(1 - \phi n_t) - p_t x_t$$

- Seek a constant solution to the problem

$$v(m) = \max_{x,n}\{U(x) + \beta v\left(\frac{m + \pi + py(1 - \phi n) - px}{1 + \pi}\right)\}$$

$$\text{subject to} \qquad px \leq kmn$$

- FOCs and envelope give

$$py\phi n = r$$

- Equilibrium implies

$$px = py(1 - \phi n) = kn$$

- Conclude that

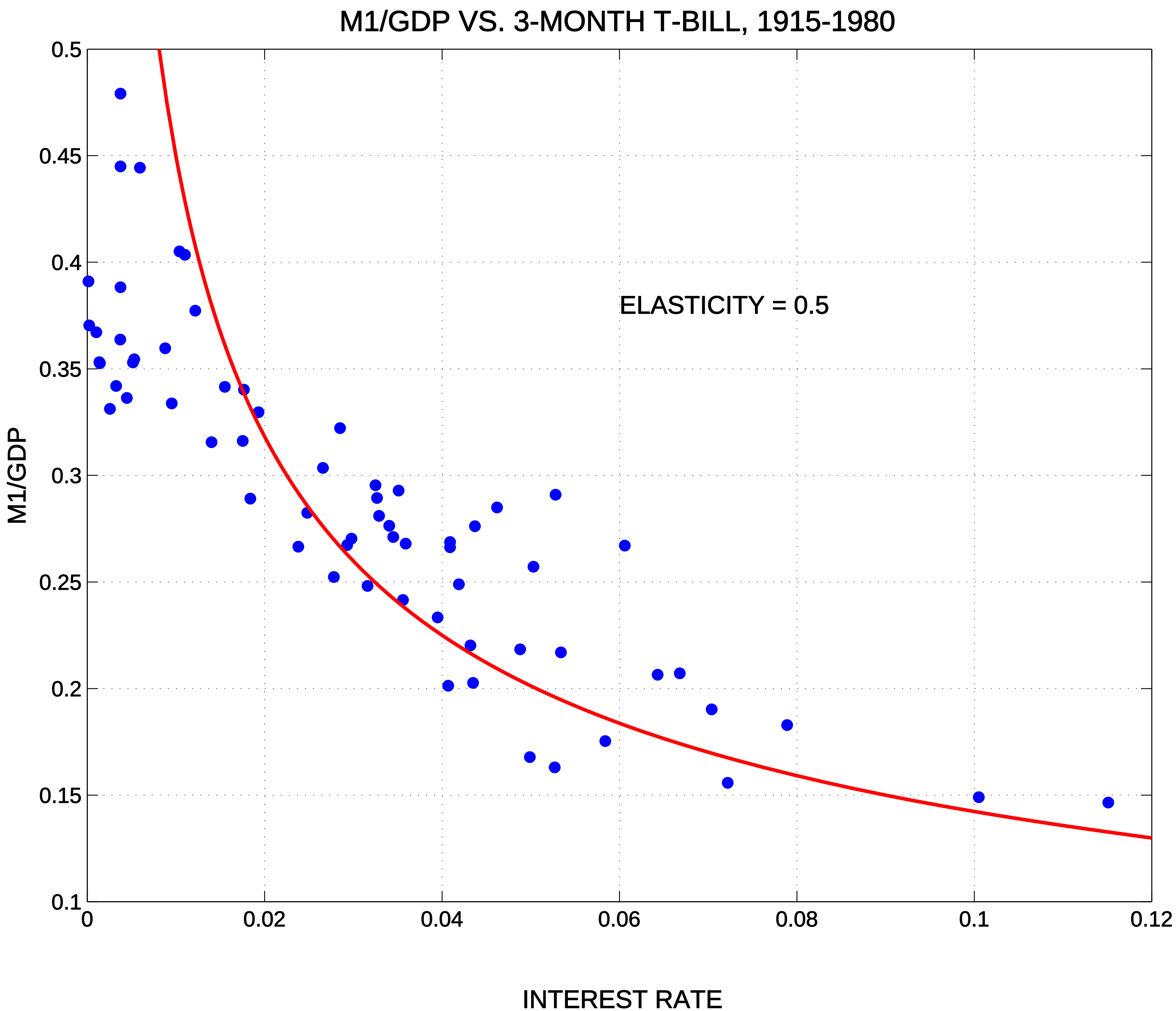
$$(py)^2 - rpy = \frac{kr}{\phi}$$

- If k/ϕ is much larger than r, a pretty good approximation is Baumol-Tobin:

$$py = \left(\frac{kr}{\phi}\right)^{1/2}$$

- "Money demand function" is then

$$\frac{M}{Py} = \left(\frac{\phi}{kr}\right)^{1/2}$$



M1/GDP VS. 3-MONTH T-BILL, 1915-1980
ELASTICITY = 0.5
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

- In this economy, $r = \rho + \pi$ are given, constant numbers

- As π increases, interest rate r increases. Agents raise fraction of labor devoted to payments, economizing on cash at expense of goods consumption

- There are no shocks. Current and expected inflation rates coincide

- In practice, this limits us to predictions on long run time series

- What is GDP in this example?

- Consumption good is $x = y(1 - \phi n)$

- If running to and from the bank is done by consumers on their own, GDP is x

- If bankers are hired to do this, GDP includes banking services and GDP will be

$$y = x + \phi n y$$

- In this case, do bankers need to be paid in advance?

- Keep in mind

3 Multiple Monetary Instruments

- Our view of changes since 1980 is that combination of high inflation rates and Regulation Q which prohibited commercial banks from paying interest on deposits drove depositors out of regulated commercial banks.

- If so, where did depositors go?

- Shift to cashless society? Don't you wish! Your creditors want payment in cash: nothing else will do.

- Only question is: how do you get it to them?

- Prescott (1987), Freeman and Kydland (1900) offer models where multiple monetary instruments combine in payments technology

- Central idea is that items purchased come in different sizes z ($\#$ of \$ per check)

- Size distribution defined by cdf $F(z)$, density $f(z)$, $\nu = \int_0^\infty z f(z)\, dz$.

- Consuming x_t means purchasing $(z/\nu)\, x_t$ units of each size z : fixed proportions

- Creditor wants $ and gets them. But there are different ways of delivering cash to creditor

- As in Goodfriend, McCallum, tradeoff is between labor and cash reserve,

- Continue with Baumol-Tobin n trips to the bank, as in basic model

- For specificity consider three instruments: currency, demand deposits, MMDA's.

- Think of sizes $z \in (0, \gamma)$ paid in cash, (γ, δ) with demand deposits, (δ, ∞) with MMDAs

- Each instrument requires holding some base money **and** spending time to deliver payment

  - currency: no time cost, hold $\theta^c > 1$ in cash to deliver \$1 (theft is a problem)

  - demand deposits: time cost k^d per check (not per \$), hold $\theta^d < 1$ to deliver \$1

  - MMDAs: time cost k^a per check, hold $\theta^a < 1$ to deliver \$1

- Agents have to choose cutoffs δ and γ

- Assume constant returns to banking

- Agents act as own banker, divide time between banking and producing goods

- Total time devoted to check processing is

$$x\left[k^d(F(\delta) - F(\gamma)) + k^a\,(1 - F(\delta)\right]$$

where cdfs F measure numbers (not values) of payments:

$$F(\delta) - F(\gamma) = \int_{\gamma}^{\delta} f(z)dz$$

- Consumption is then

$$x = y\,(1 - \phi n) - x\left[k^d(F(\delta) - F(\gamma)) + k^a\,(1 - F(\delta)\right]$$

- These are time costs. Turn next to cost of holding cash for

- Define fraction of purchases smaller than size γ :

$$\Omega(\gamma) = \frac{1}{\nu} \int_0^{\gamma} z f(z) dz$$

- Agent begins period with m in (normalized) base money. To meet payments

$$m \geq \theta^c c + \theta^d d + \theta^a a$$

$$nc \geq px\Omega(\gamma)$$

$$nd \geq px\left[\Omega(\delta) - \Omega(\gamma)\right]$$

$$na \geq px\left[1 - \Omega(\delta)\right]$$

- With these added constraints in place, we solve

$$v(m) = \max_{x,n,c,d,a,\gamma,\delta} \{U(x) + \beta v\left(m'\right)\}$$

where m' is renormalized cash holdings and law of motion for money balances is

$$(1+\pi)\, m' = m + T + py(1 - \phi n)$$

$$-px\left[k^d\left(F(\delta) - F(\gamma)\right) + k^a\left(1 - F(\delta)\right)\right]$$

$$-(\theta^c - 1)c$$

- Here $(\theta^c - 1)c$ is lost currency (cf. Alvarez and Lippi)

- Solve for $x, n, c, d, a, \gamma, \delta$

- Can show δ proportional to γ (dependent on r if $\theta^c > 1$),

$$\delta = \frac{k^a - k^d}{k^d} \frac{\left[\frac{(\theta^c - 1)}{r} + \theta^c - \theta^d\right]}{\theta^d - \theta^a} \gamma = \xi(r)\gamma$$

- Better have $\gamma < \delta$

- Reduce rest to two variables n and γ

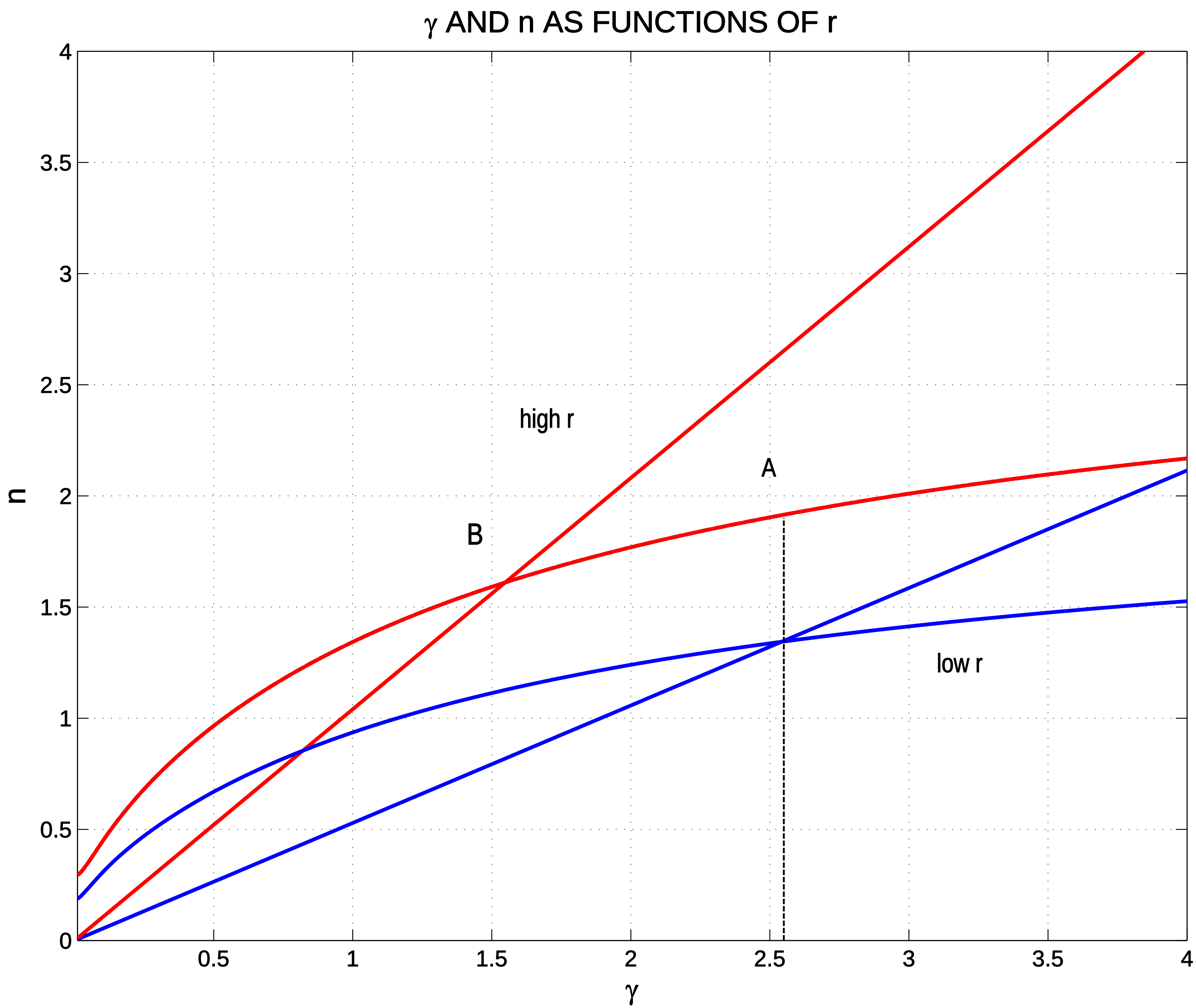
- In case of $\theta^c = 1$ simplifies to

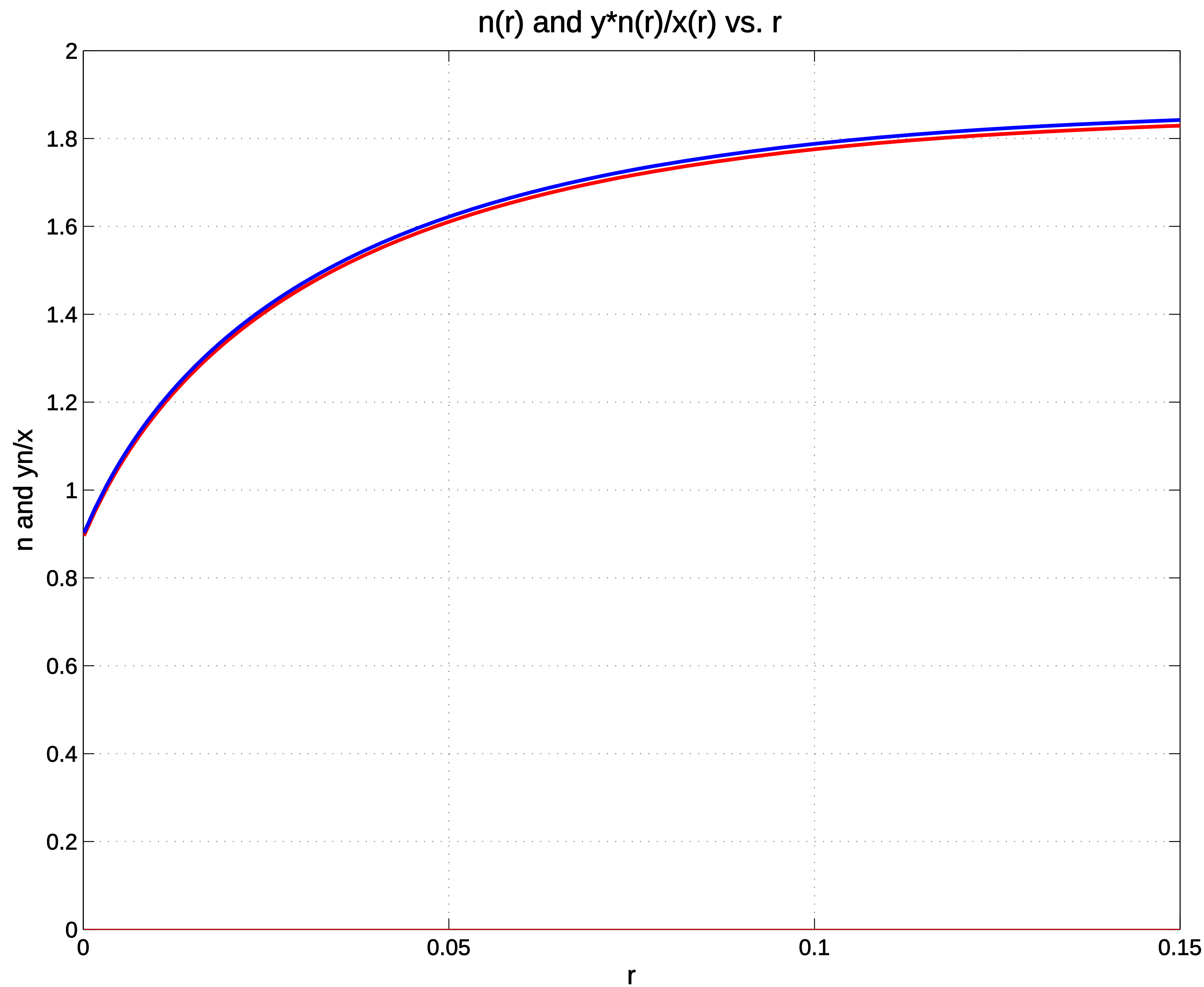
$$\frac{n^2\phi}{1-\phi n} = \frac{r\left[\Omega(\gamma) + \theta^d\left[\Omega(\xi\gamma) - \Omega(\gamma)\right] + \theta^a\left[1 - \Omega(\xi\gamma)\right]\right]}{1 + k^d\left(F(\xi\gamma) - F(\gamma)\right) + k^a\left(1 - F(\xi\gamma)\right)}$$

and

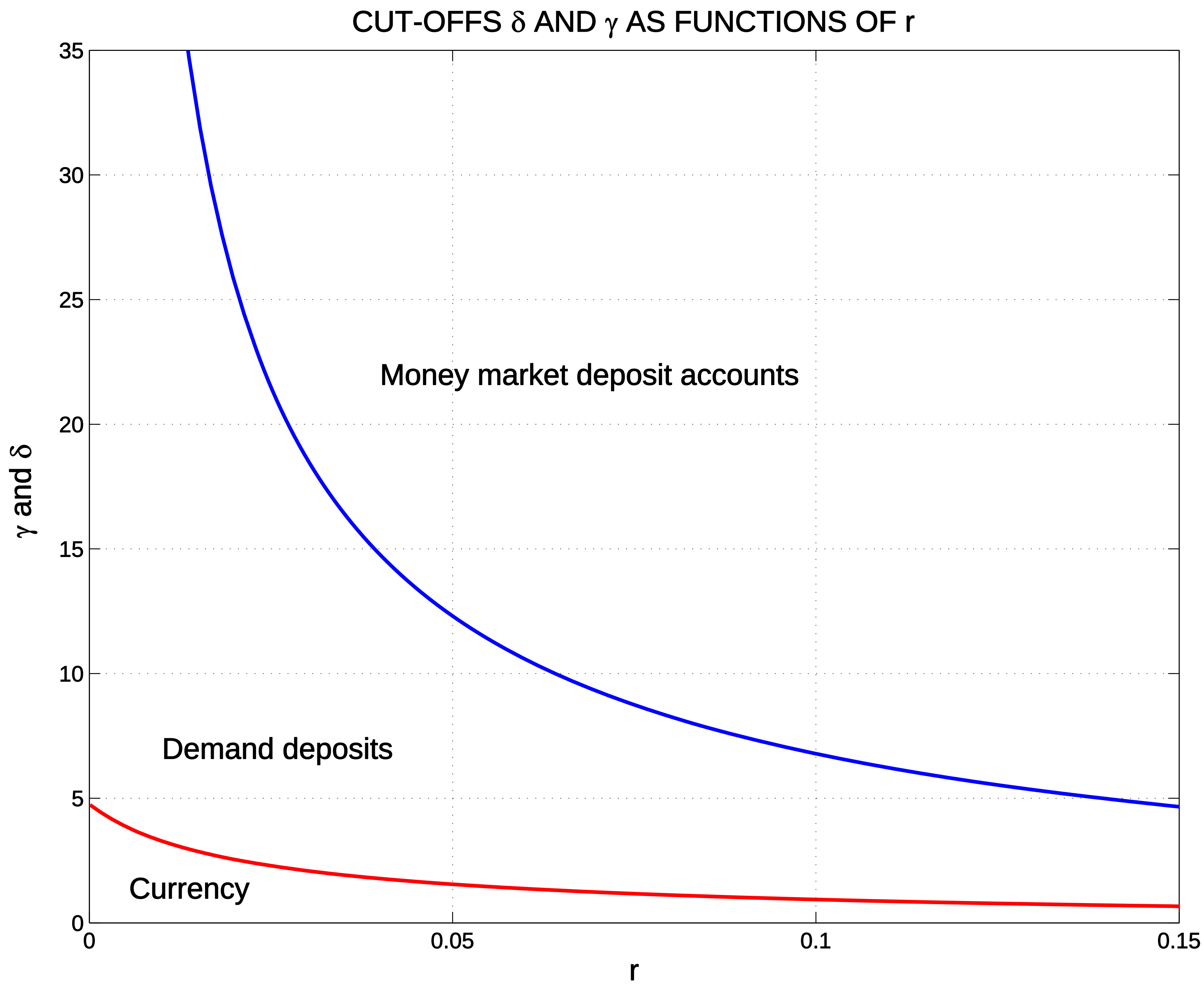
$$n = \frac{r}{\nu}\left(\frac{1-\theta^d}{k^d}\right)\gamma$$

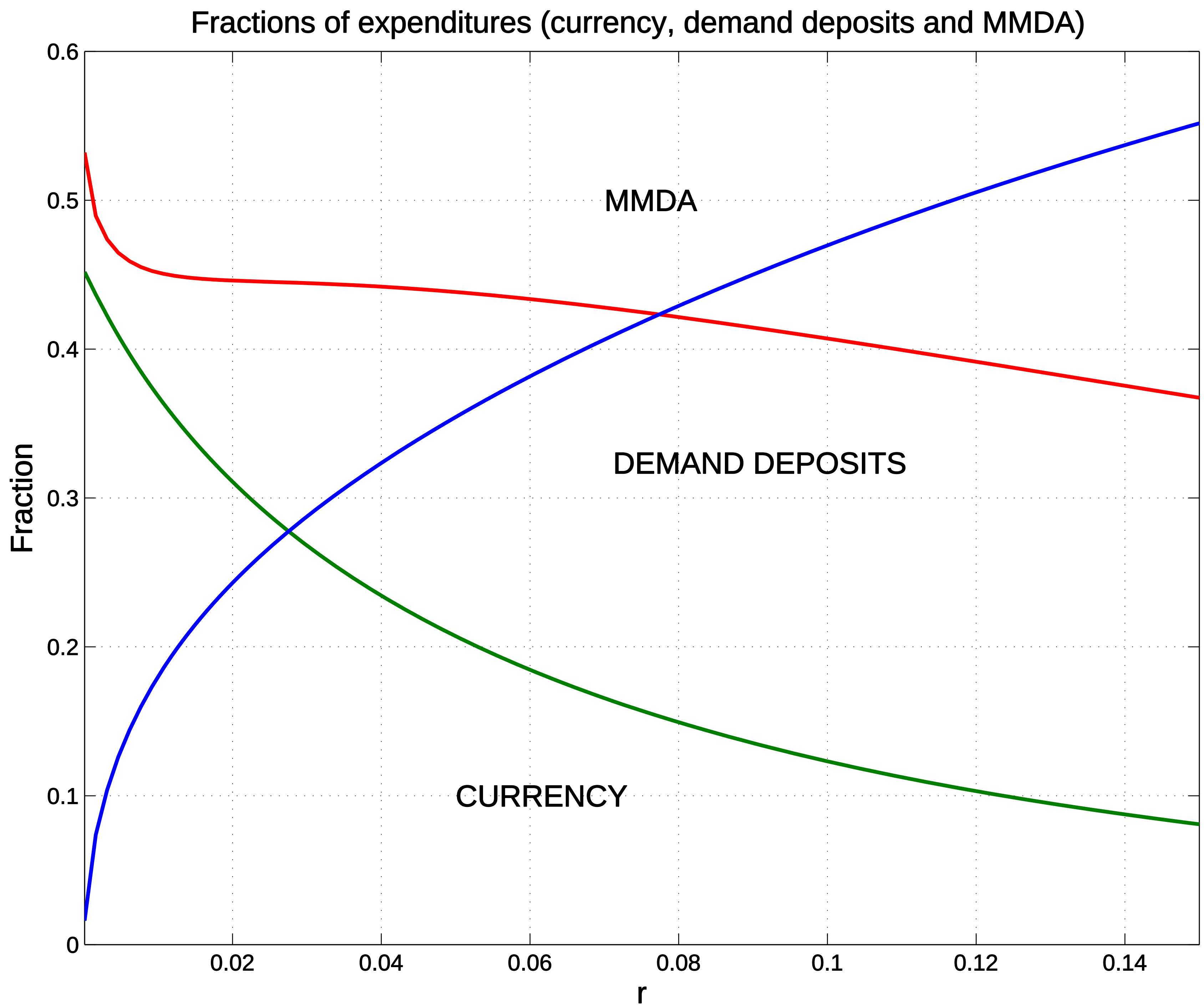
- Figure for general case has same general shape


γ AND n AS FUNCTIONS OF r
n
γ
4
3.5
3
2.5
2
1.5
1
0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
high r
A
B
low r

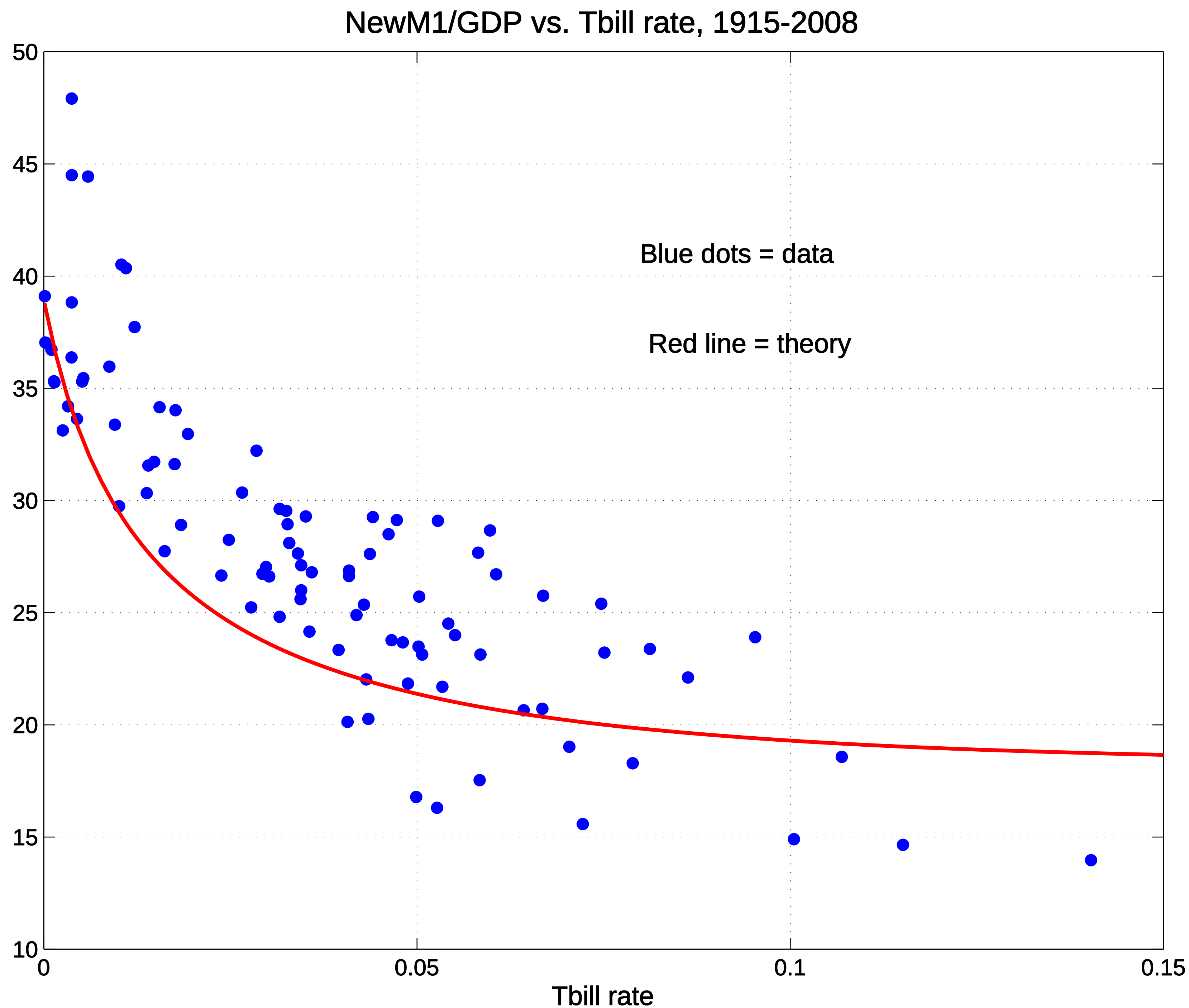


n(r) and y*n(r)/x(r) vs. r
n and yn/x
r
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
0
0.05
0.1
0.15


CUT-OFFS δ AND γ AS FUNCTIONS OF r
Money market deposit accounts
Demand deposits
Currency
γ and δ
r
0
5
10
15
20
25
30
35
0
0.05
0.1
0.15



Fractions of expenditures (currency, demand deposits and MMDA)
0.6
0.5
0.4
0.3
0.2
0.1
0
Fraction
0.02
0.04
0.06
0.08
0.1
0.12
0.14
r
MMDA
DEMAND DEPOSITS
CURRENCY


NewM1/GDP vs. Tbill rate, 1915-2008
50
45
40
35
30
25
20
15
10
0
0.05
0.1
0.15
Tbill rate
Blue dots = data
Red line = theory

4 - Calibration and Simulation

- Figures just shown based on specific calibration

- In McCallum-Goodfriend example, we estimated

$$\frac{M}{py} = \left(\frac{\phi}{kr}\right)^{1/2} = Ar^{-1/2}$$

  where A is free parameter chosen to get good fit

- Why not calibrate A from micro-evidence ?

- Because M/Py in model is ratio of stock to annual flow of GDP, about 0.3 in figure, but in fact actual transaction flows are about 60 times GDP

- Implicit assumption is that M/Py is stable, given r, but that theory tells us nothing about A

- Remains to seek numbers for $\theta^c, \theta^d, \theta^a, k^d, k^a, \phi$ and functions F and Ω.

- For cash reserves we estimate $\theta^c = 1.01$, $\theta^d = 0.1$, $\theta^a = 0.01$

- Small size checks are more common than larger ones.

- We assume the distribution

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

- Implies that

$$F(z) = 1 - \frac{1}{(1+z)^\eta} \quad \text{and} \quad \Omega(z) = 1 - \frac{1+\gamma\eta}{(1+\gamma)^\eta}$$

- No direct evidence on η was used

- For labor costs, $\phi = 0.0057$, $k^d = 0.03$, $k^a = 0.049$

- Ratio of money to consumption in equilibrium (with $\theta^c = 1$) is

$$\frac{c + d + a}{px(r)} = \frac{1}{n(r)}$$

where $n(r)$ can be solved for

- Ratio of money to gdp is then

$$\frac{m}{py} = \frac{x(r)}{y}\frac{1}{n(r)}$$

- Multiply by A to get

$$\frac{m}{py} = \frac{x(r)}{y}\frac{A}{n(r)}$$

5 - Decentralization

- Awkward to discuss banking without having banking firms

- In paper (Section 4) we decentralize by introducing zero-profit banks that use labor to do the work summarized in ϕ, k^d, k^a and maintain the cash reserves θ^d and θ^a

- Need to decide how to allocate labor and cash reserves between households and banks

- We assigned cash reserves θ^d and θ^a and labor costs k^d and k^a to banks

- Currency and labor ϕn to households

- Bank costs are part of GDP; household costs are not

- Banks set fees k^d, k^a

$$\frac{q^d}{p} = k^d \quad \text{and} \quad \frac{q^a}{p} = k^a$$

  ...and pay interest

$$r_d = \left(1 - \theta^d\right) r \quad \text{and} \quad r_a = (1 - \theta^a)\, r$$

- Familiar model for free competitive banking system, limited only by cash requirements θ^d and θ^a, possibly government imposed

6 - Glass-Steagall

- Banking Act of 1933 separated commercial banks from investment banks, demand deposits from time deposits

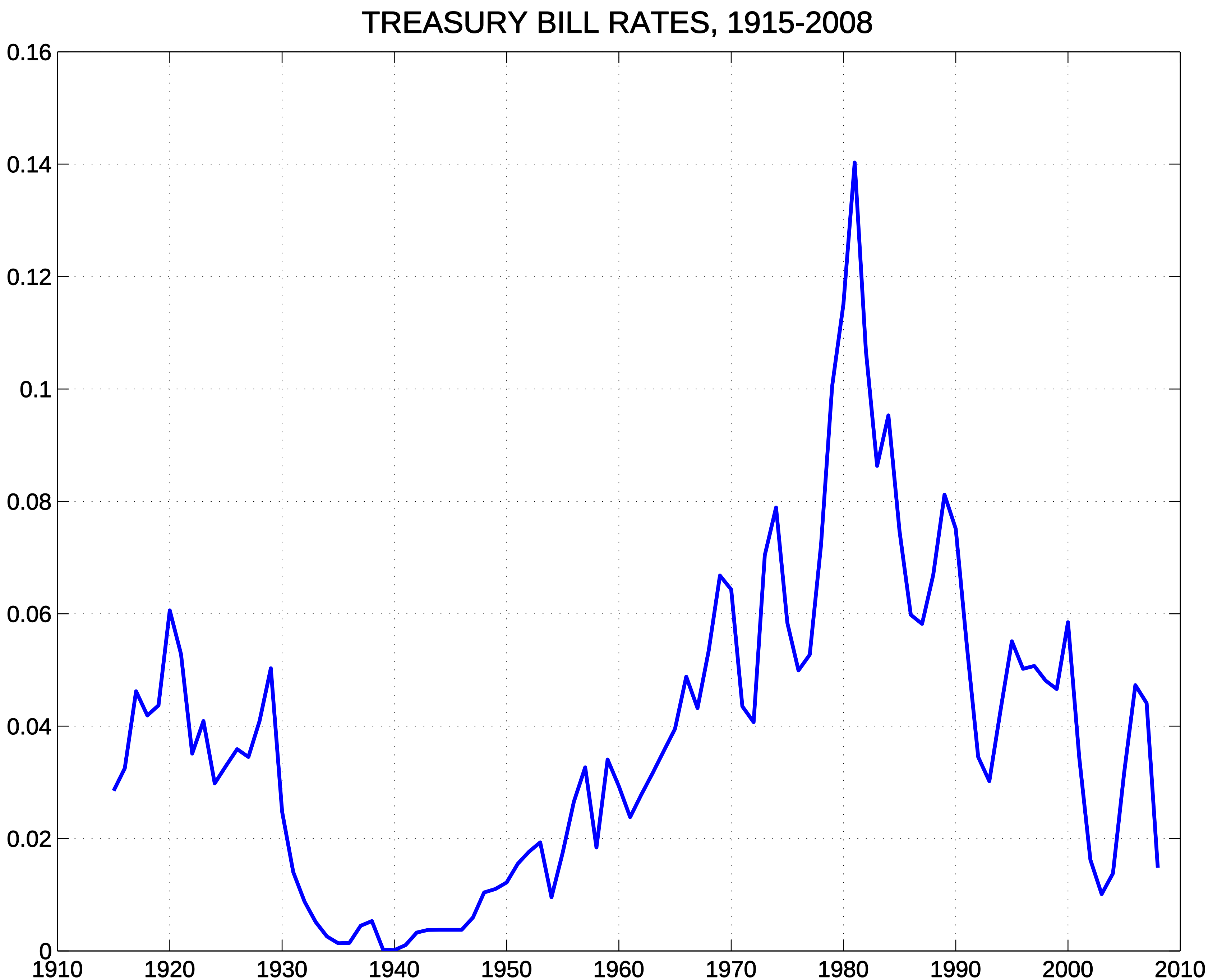
- Also imposed Regulation Q: no interest paid on demand deposits

- Clearly not a free competitive banking system

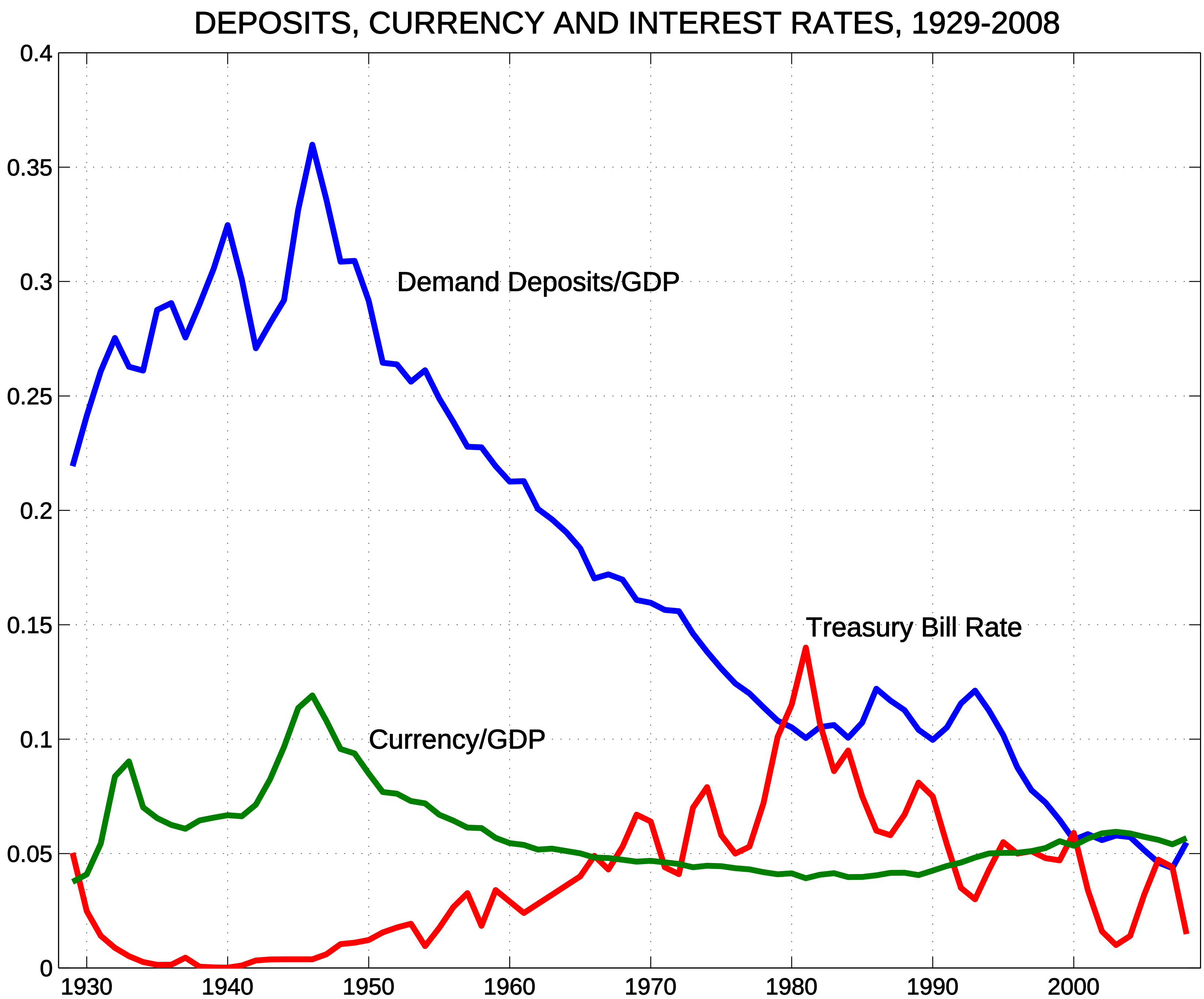
- Nice cartel for banks, but won't individual banks and other institutions find ways to work around this regulation?

- What effects did this have on monetary behavior, payments system? How model?

- Section 6 of paper addresses this
- Idea is that banks will offset zero interest by providing free services: free checking, record keeping, etc.
- Let's look at time series of Tbill rates


TREASURY BILL RATES, 1915-2008
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
1910
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010

- From 1933 until through 1951 Tbill rates held < 0.01
- Likely that depositors had to pay for services; no need for interest payments
- From 1952 on until peak of 0.14 in1981 pretty steady increase in rates
- Savings and loans, Euro-dollars, Now accounts, sweeps
- As inflation rose, incentives increased, demand deposits shrunk


DEPOSITS, CURRENCY AND INTEREST RATES, 1929-2008
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
1930
1940
1950
1960
1970
1980
1990
2000
Demand Deposits/GDP
Treasury Bill Rate
Currency/GDP

7 - Conclusions

- Good news is that money demand today behaves very much like it did from 1915 to 1980
- Bad news is that the monetary models we had in 1980 were somewhat limited
- Much to do—and is being done!
- Idea of a heirarchy of liquid assets, with different mixes of yields and convertibility is familiar to cash managers everywhere
- Our models need to accomodate this