(5)

Velocity + Quantity Eqn M+I 3,4

Quantity Theory of Money (Review)

$P \to P^* = \frac{M^s}{m^D}$ in L.R. eq.

"M^s": M — set by gov't, banks.

m^D —

- increases with volume of real transactions/yr (proportional to real income y)

- increases with avg time each \$ held betw. transactions

  or, decreases w/ # times/yr each \$ changes hands, aka "Velocity of Money".

Income Velocity of M

Y = Nominal Income [\$/yr]
$\propto$ total transactions/yr.

M = Nominal M-Stock [\$]

$\frac{M}{Y}$ [yrs] $\propto$ avg time each \$ is held

$V = \frac{Y}{M}$ [yrs^{-1}] = Income Velocity of M

$\propto$ # times each \$ changes hands/yr.

= "Velocity" for short.

(Transaction Velocity

T = total transactions/yr

$V_T = \frac{T}{M}$ = actual # times avg \$ changes hands/yr.

but T harder to measure, so rarely used.

$T \gg Y$, so $V \ll V_T$)

Quantity Equation (M+I 3)

$$V = \frac{Y}{M} = \frac{Py}{M}, \quad y = Y/P$$

$$\Rightarrow \boxed{MV = Py} \quad \text{Q-Eq'n (Levels Form)}$$

$$\Rightarrow P = \frac{MV}{y}$$

- $M \uparrow \rightarrow P \uparrow$
- $V \uparrow \rightarrow P \uparrow$
- $y \uparrow \rightarrow P \downarrow$

- Identically true since $V := \frac{Y}{M}$
- Reflects QTOM if $V \rightarrow V^* = \frac{y}{m^D}$ since then $P \rightarrow P^* = \frac{M}{m^D}$

Dynamic Form of Q-Eq'n.

Time 0:

$$\underline{MV = PY}$$

$(a+b)(c+d)$
$= ac + ad + bc + bd$

Time 1:

$$(M+\Delta M)(V+\Delta V) = (P+\Delta P)(Y+\Delta Y)$$

$$\Rightarrow \cancel{MV} + \frac{M\Delta V + V\Delta M + \Delta M \Delta V}{MV}$$

$$= \cancel{PY} + \frac{P\Delta Y + Y\Delta P + \Delta P \Delta Y}{PY}$$

$$\Rightarrow \frac{\Delta M}{M} + \frac{\Delta V}{V} + \cancel{\frac{\Delta M}{M}\frac{\Delta V}{V}} \to 0$$

$$\approx \frac{\Delta P}{P} + \frac{\Delta Y}{Y} + \cancel{\frac{\Delta P}{P}\frac{\Delta Y}{Y}} \to 0$$

$$\Rightarrow \boxed{\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}}$$

Q-Eq'n
(Dynamic Form)

Q-Eq'n: $\frac{\Delta M}{M} + \frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y}$

Implications of Dynamic Q Eq'n.

$$\frac{\Delta P}{P} = \frac{\Delta M}{M} + \frac{\Delta V}{V} - \frac{\Delta Y}{Y}$$

Inflation =
Money growth
+ Velocity growth
− Real income growth.

Eg

$$\frac{\Delta M}{M} = 5\%$$

$$\frac{\Delta Y}{Y} = 3\%$$

$$\frac{\Delta V}{V} = 0 \quad (V = \text{const.})$$

$$\Rightarrow \frac{\Delta P}{P} = (+5\%) + (0) - (+3\%)$$

$$= \underline{\underline{+2\%}}$$

But if $\frac{\Delta V}{V} = -4\%$, same $\frac{\Delta M}{M}$, $\frac{\Delta Y}{Y}$

$$\Rightarrow \frac{\Delta P}{P} = (+5\%) + (-4\%) - (+3\%)$$

$$= \underline{\underline{-2\%}}$$

Similarly,

$$\frac{\Delta V}{V} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y} - \frac{\Delta M}{M}$$

$$\frac{\Delta M}{M} = \frac{\Delta P}{P} + \frac{\Delta Y}{Y} - \frac{\Delta V}{V}$$

Q. Eq'n $\Rightarrow$

If $V = \text{const.}$ $\left(\frac{\Delta V}{V} = 0\right)$,

need $\frac{\Delta M}{M} = \frac{\Delta Y}{Y}$ for $\frac{\Delta P}{P} = 0$

— Milton Friedman "Monetarist" prescription for P-stability.

Inflationary Dynamics

Actual inflation driven by

1. Excess S or D for M
   Leads to Q.T. in Long Run.

2. Public's inflationary expectations
   Gives π inertia

3. Microeconomic S+D shocks
   Makes month-to-month π
   very noisy.

2 and or 3 can lead P away from
Q.T. equilibrium, but eventually
1 will pull it back.

Price Controls M+I 3.5, 3.6

- Why not fix prices by law?

Price Ceilings

- World War II
- Vietnam
  1971-74
- Gas Prices
  binding 1971-74, 1979

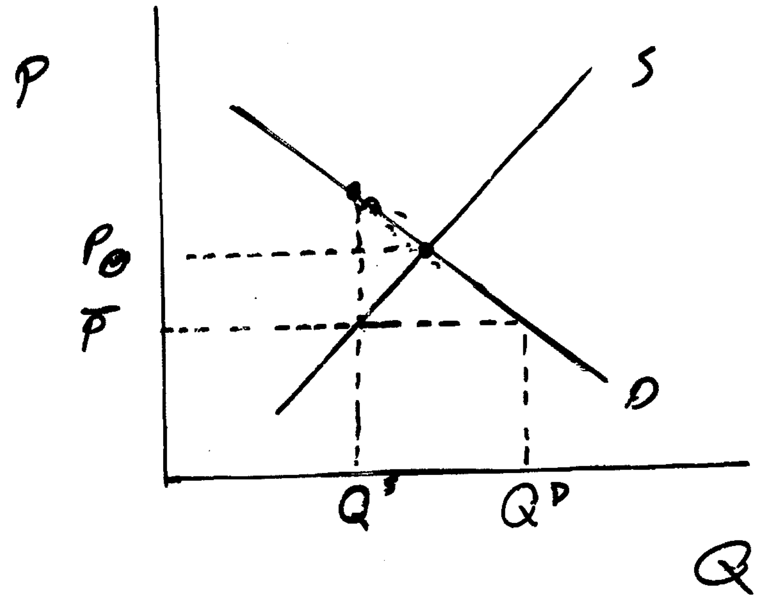
Price Floors

- New Deal 1930's

Price Ceiling

$\bar{P} < P_0$

$\Rightarrow Q^D > Q^S \;@\; \bar{P}$



$\Rightarrow$ Suppressed Inflation

- Shortages $Q^D - Q^S$
- Quality Deterioration
- Rationing (WW II)
- Black Markets

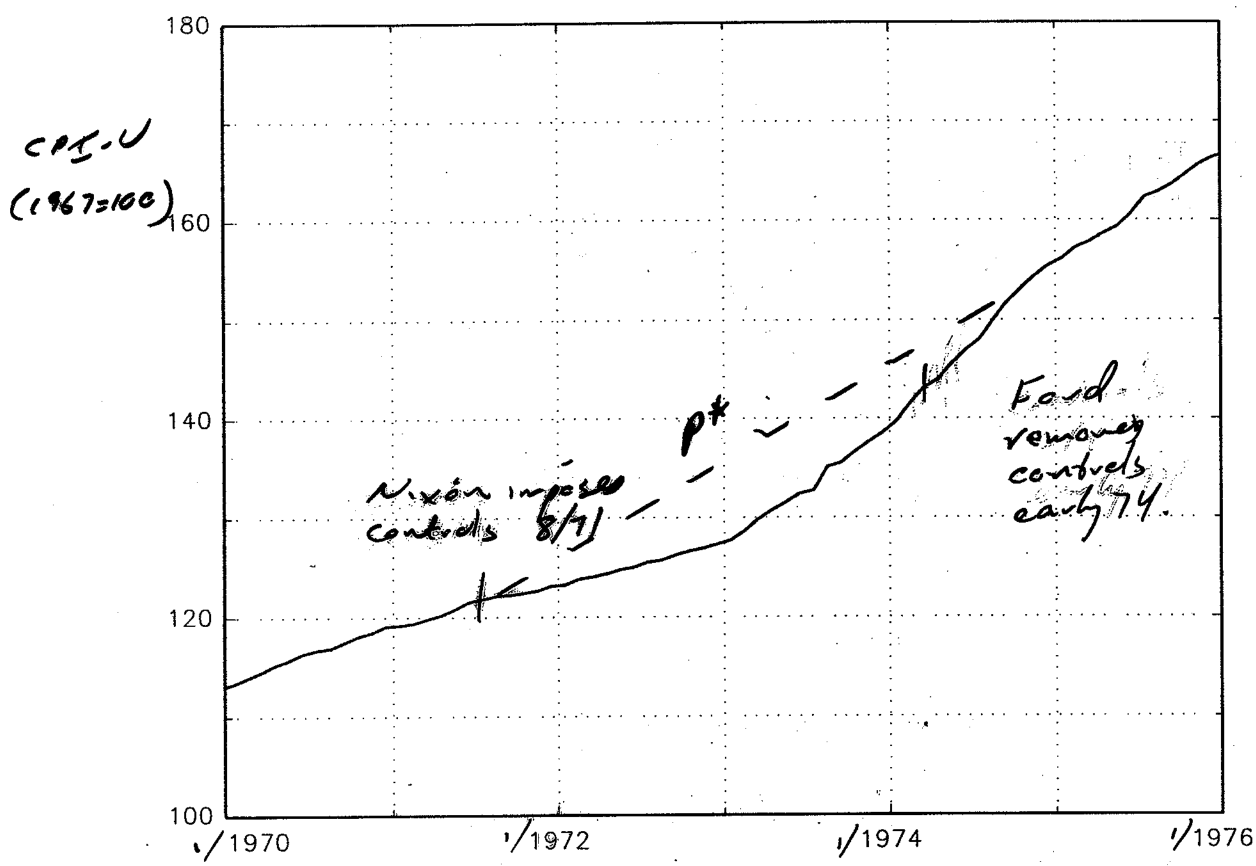
Some consumers willing to pay $> P_0$

WW II – Office of Price Admin. (OPA)

Vietnam / Nixon 1971–74

- gas shortages acute 1973.
- gas controls binding again 1979.

Nixon Price Control Period
1971–74



1972 —
Measured π held low, shortages build.

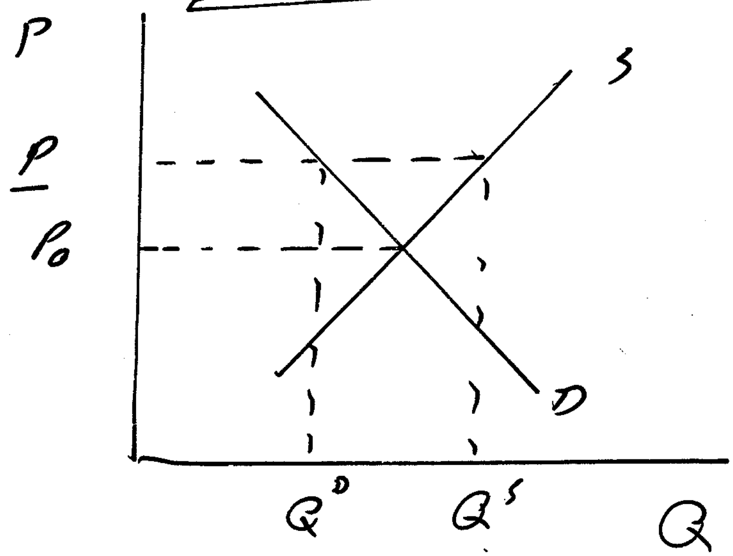
1973 —
$p < p^*$, shortages acute, esp. gas in fall.

1974 —
p catches up to p^*. Measured π > 10%,
then falls abruptly after p catches up.

Price Floors

$\underline{P} > P_e$

$\Rightarrow Q^S > Q^D$



$\Rightarrow$ Suppressed Deflation

- Unsold Output
- Unemployment

New Deal, 1930's.

Price Floors in Great Depression (1929-WWII)

Herbert Hoover (29-33)

- Successfully urged industry not to cut wages
  - → Real wages ↑ as P↓, Unemploymt ↑
- Encouraged Trade Assns.
  - Maintained Prices, Cut Output.

(Lee Ohanian working paper,

"Who or What caused the Great Depression?")

FDR New Deal (33-WWII)

- Nat'l Recovery Admin. (NRA) 1933-35.
  - imposed industrial cartels
  - set min prices, cut output
- Ag. Adjustment Act 1933-36, 1938 –
  - created "Market Orders" (farm cartels)
  - set min prices, cut output
- Wagner Act (1935)
  - majority of workers can force union,
  - union wages on all existing, new workers.
- Minimum Wage (1938)

Result – U remained high, Output depressed throughout decade of 30's.

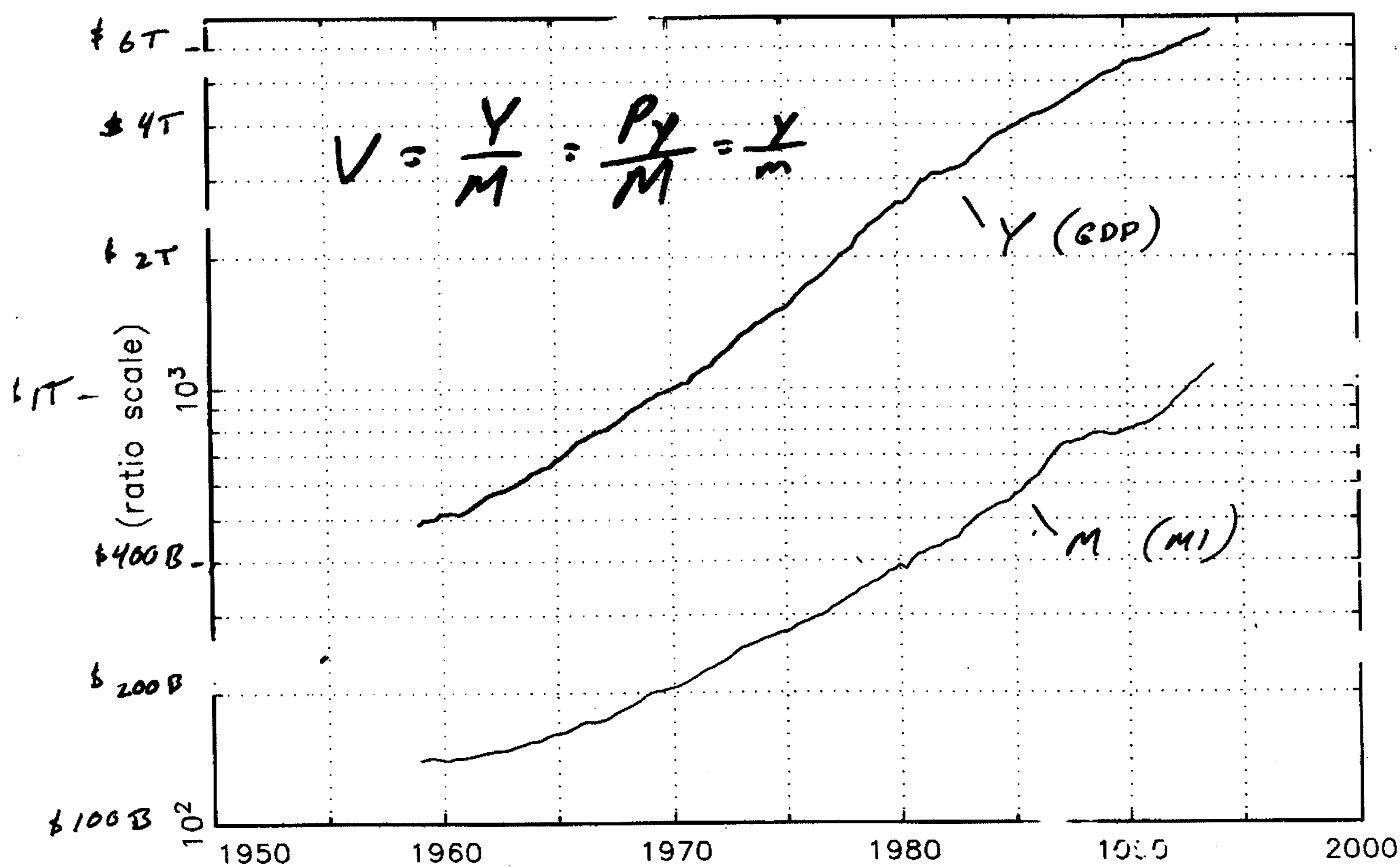
Apart from transitory deviations

from Q.T. equilibrium $P = M/m^D$,

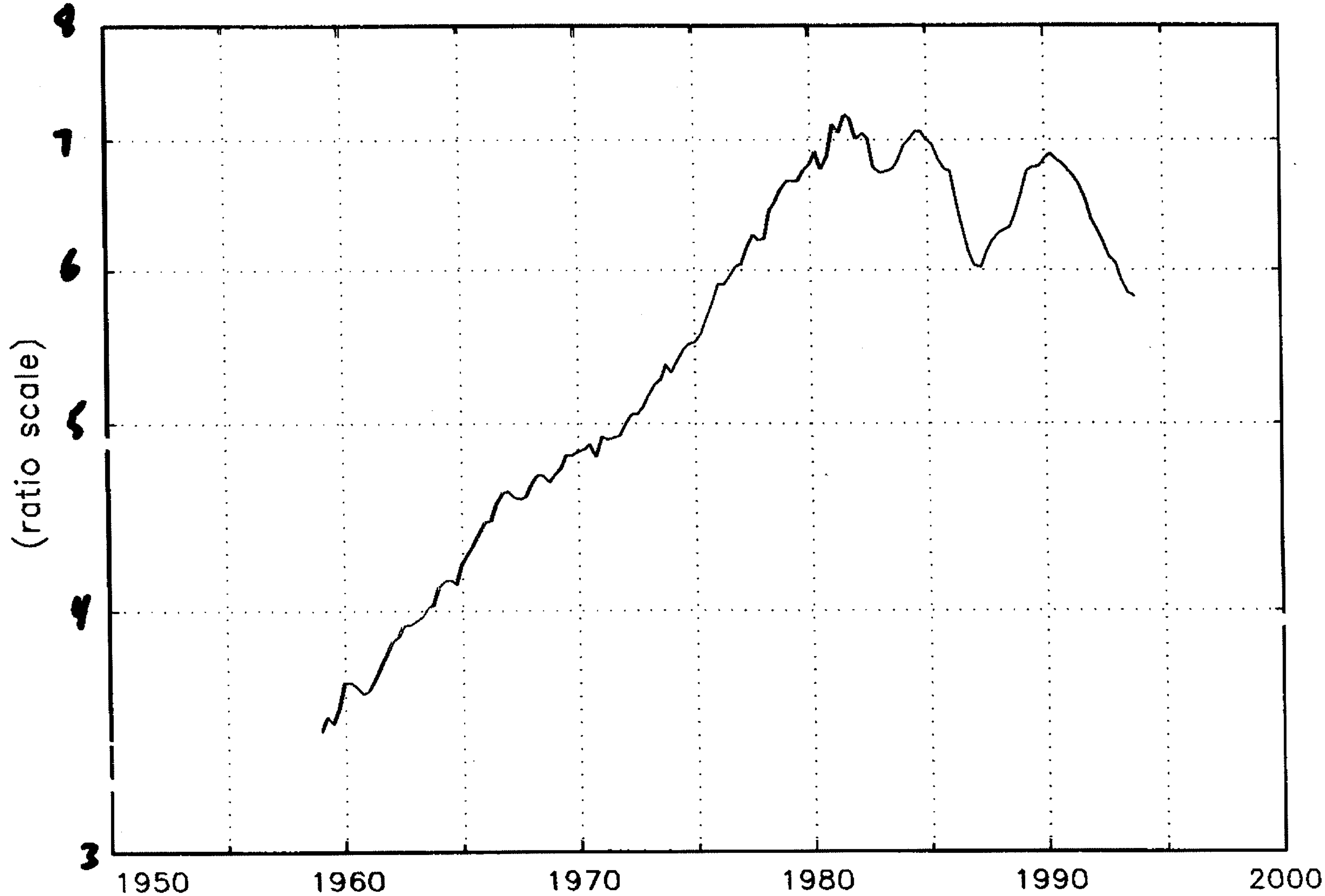
does V change?

If so, why?

M1, Nominal GDP



M1 velocity = $\frac{Y}{M}$



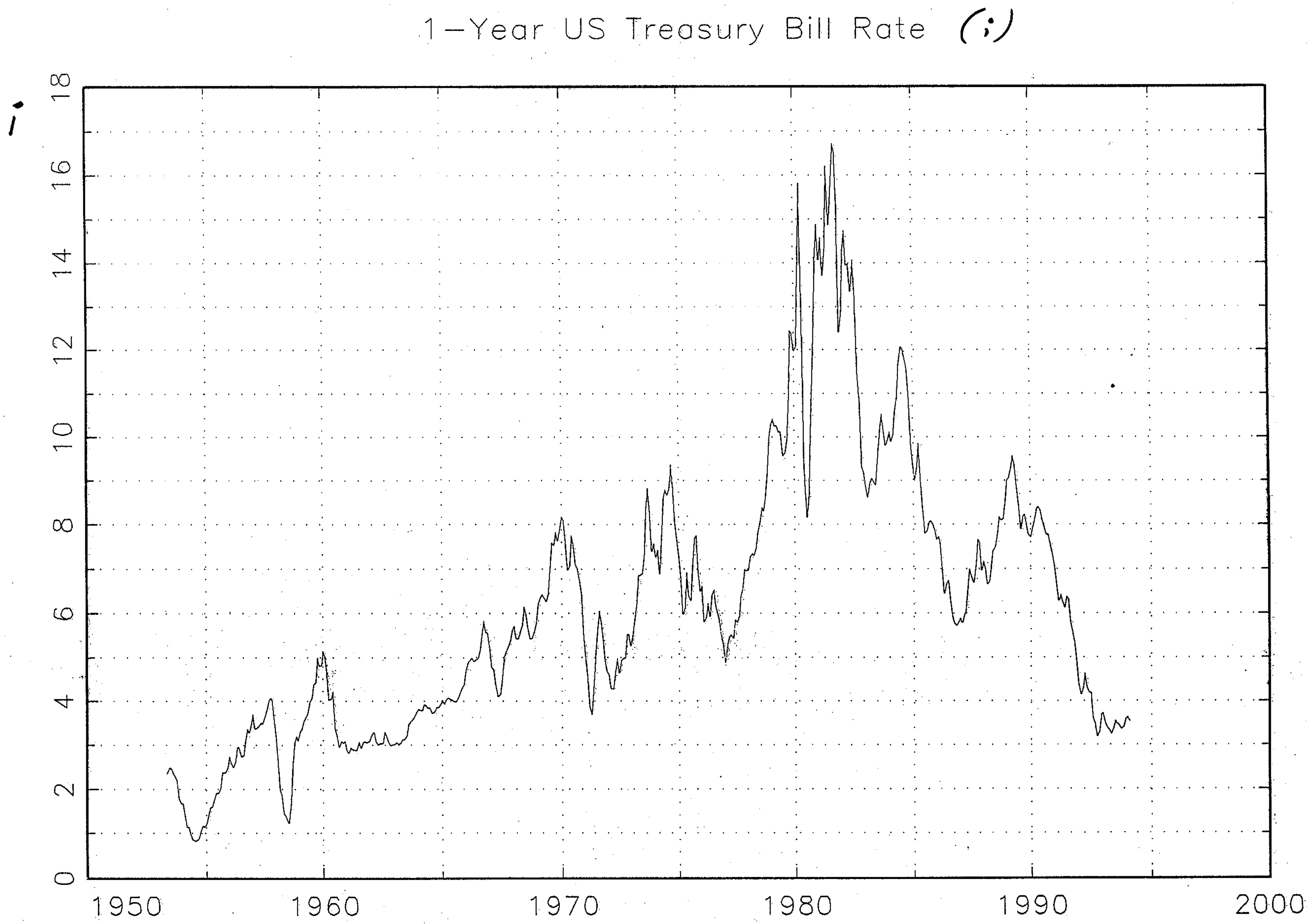
Why does V change?

1. Nominal interest rate i
   = opportunity cost of holding M.

   $i \uparrow \rightarrow V \uparrow, \ m^D \downarrow$

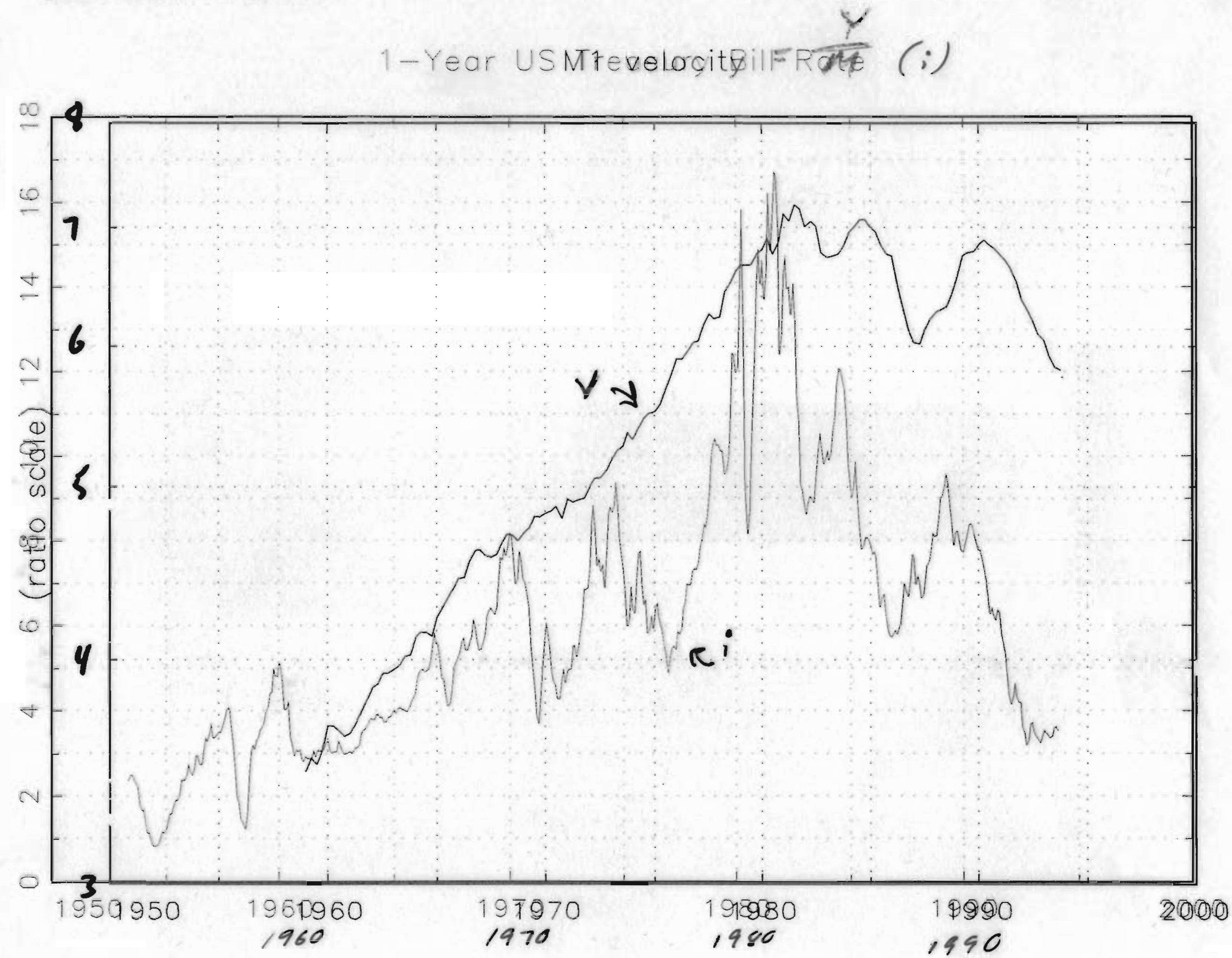
2. Economies of Scale?

   $Y \uparrow \rightarrow \frac{m^D}{Y} \downarrow \rightarrow V \uparrow$?



1-Year US Treasury Bill Rate (i)
i
0
2
4
6
8
10
12
14
16
18
1950
1960
1970
1980
1990
2000

V and i together



Overlay of V, i shows—

- Uptrend in i accounts for uptrend in V, 1950s – 1980
- Short moves in i often not reflected in V.
- Down trend in i, 1980–95 reverses uptrend in V
- V responds to swings in i, 1980–95.
- But V does not return to 1950's levels as i does.

$\Rightarrow$

1. V rises with i
2. economies of scale make V rise with Y over time as well.

Why does i change?

The Fisher Equation   Irving Fisher 1930

$$\boxed{i = r + \pi^e}$$

i = Nominal interest rate

r = real interest rate

π^e = expected inflation

- r determined in L.R. by savings, investment, independently of π, π^e. (Loanable Funds Model)
- π^e determined by past π by Adaptive Learning

$\Rightarrow$ feedback from π to i, V.

Money Demand $m^D(y, i)$

(for real money balances)

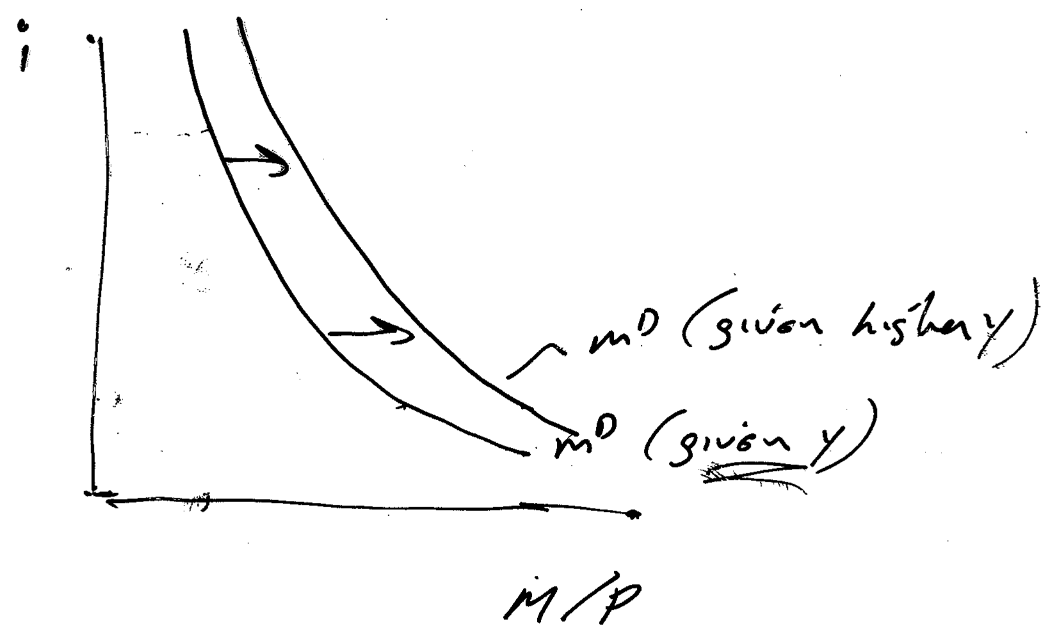
i = **nominal** interest Rate on loans

= opportunity cost of holding M

if M pays no interest.

$m^D \uparrow$ with y,

$m^D \downarrow$ with i



McCulloch (1997) m^D estimates (M1)

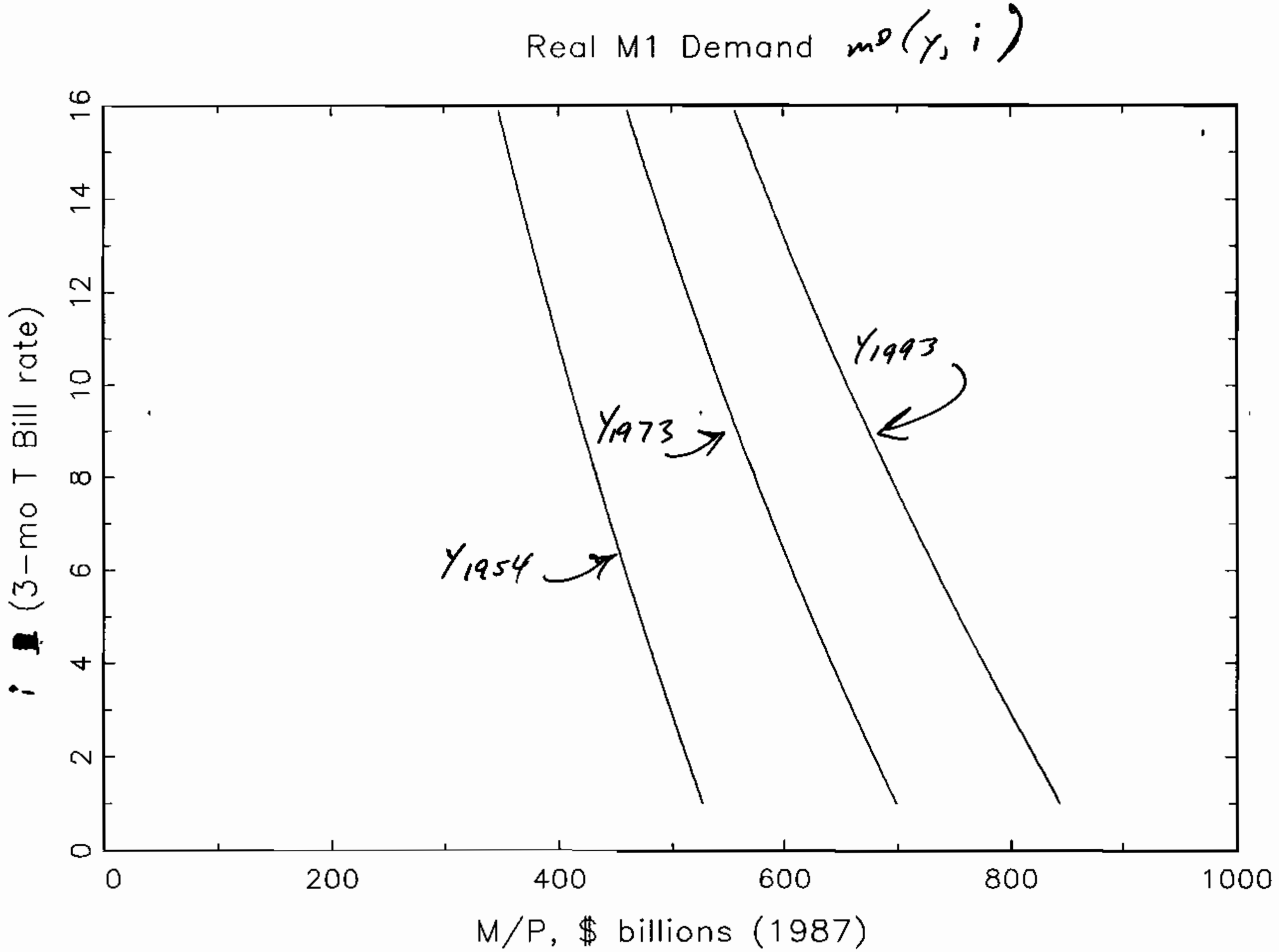
$$m^D = (\text{const})\ \underline{y^{.42}}\ \underline{\exp(-.028\,i)}$$

$(i$ in %/yr$)$

$$\Rightarrow \underline{V = \frac{Y}{M} = \frac{y}{m} = (\text{const})\ y^{.58}}\ \underline{\exp(.028\,i)}$$

so $V \uparrow$ as $y \uparrow$ or $i \uparrow$,

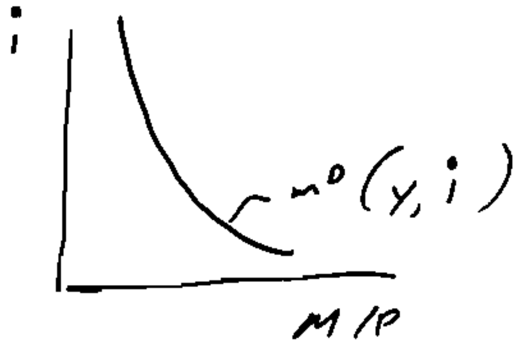
uptrend in $y \Rightarrow$ uptrend in V



Real M1 Demand $m^D(Y, i)$
i (3-mo T Bill rate)
0
2
4
6
8
10
12
14
16
0
200
400
600
800
1000
M/P, $ billions (1987)
Y_{1954}
Y_{1973}
Y_{1993}

Velocity Boost Inflation

$$\pi = \frac{\Delta M}{M} + \frac{\Delta V}{V} - \frac{\Delta Y}{Y} \quad - Q\ \text{Eq'n}$$



$\frac{\Delta M}{M} \uparrow$

$\rightarrow \pi \uparrow \quad \rightarrow \pi^e \uparrow$ (by Adaptive Learning)

$\rightarrow i \uparrow$ (by Fisher eq'n)

$\rightarrow m^D \downarrow$

$\rightarrow V \uparrow$ (since $V = \frac{Y}{m}$)

$\rightarrow \frac{\Delta V}{V} > 0$ as $V \uparrow$

$\rightarrow$ extra inflation during transition

$$\pi > \frac{\Delta M}{M} - \frac{\Delta Y}{Y} \text{ as } V \uparrow.$$

Velocity Drag Deflation

$\frac{\Delta M}{M} \downarrow \to \pi \downarrow \to \pi^e \downarrow$ (by AE)

$\to i \downarrow$ by Fisher Eq'n

$\to m^D \uparrow$

$\to V \downarrow$

$\to \frac{\Delta V}{V} < 0$ as $V \downarrow$

$\Rightarrow \underline{\pi < \frac{\Delta M}{M} - \frac{\Delta Y}{Y} \text{ as } V \downarrow.}$

<u>May result in unintended deflation.</u>

Self-Generating Inflation

Possible in theory with Fiat M.

Suppose $\frac{\Delta M}{M} = \frac{\Delta Y}{Y}$, so $\pi = 0$ if V = const,
but supply shock pushes $P\uparrow$.

$$
\begin{tikzcd}
 & P\uparrow\uparrow \arrow[dr, bend left] & \\
m^D\downarrow, V\uparrow \arrow[ur, bend left] & & \pi^e\uparrow \arrow[dl, bend left] \\
 & i\uparrow \arrow[ul, bend left] &
\end{tikzcd}
$$

Vicious Circle of
Self-Generating π:

when

- π^e responds quickly to π

and

- M^D responds strongly to π^e, i

Self - Generating Inflation

Possible in theory with Fiat M.

Suppose $\frac{\Delta M}{M} = \frac{\Delta Y}{Y}$, so $\pi = 0$ if $V = \text{const}$,
but supply shock pushes $P\uparrow$.

$$
\begin{tikzcd}
 & P\uparrow \arrow[dr] & \\
m^D\downarrow, V\uparrow \arrow[ur] & & \pi^e\uparrow \arrow[dl] \\
 & i\uparrow \arrow[ul] &
\end{tikzcd}
$$

P stable when

- π^e responds slowly to π
- m^D responds weakly to i

In practice, runaway π always associated with runaway $\Delta M/M$.

Why do gov'ts often allow $\frac{\Delta M}{M} > \frac{\Delta Y}{Y}$, $\pi > 0$?

3 Motives for $\frac{\Delta M}{M}$, π:

1. Inflationary Finance

M + I 5

2. Stimulate y, reduce Unemployment

M + I 6

3. Reduce r and/or i.

— M + B 19, 21