Money Demand

Money Demand - \( L(Y,i) \); \( L_Y > 0 \) & \( L_i < 0 \); at equilibrium = \( M/P \)

What is Money? - has multiple meanings:
- "How much money do you make?"... income (flow)
- "How much money are you worth?"... wealth (stock)
- **Economic Definition** - liquid portion of wealth (cash, checking balances, etc.)
  - Liquid - can be used for transactions

Example - person A has most income, B has most wealth, C has most money

\[
\begin{array}{c|c|c|c}
   & A & B & C \\
\hline
M & 1,000 & 2,000 & 3,000 \\
Home & 90,000 & -- & 50,000 \\
Securities & 5,000 & 220,000 & -- \\
Wealth & 96,000 & 222,000 & 53,000 \\
Income & 60,000 & 40,000 & 20,000 \\
\end{array}
\]

\( M1 \) - purely transaction-based definition; currency plus checking account balances (demand deposits) & traveler's checks; ~ $650B in cash & $650B in others; total ~ $1.3 Trillion

\( M2 \) - purely transaction-based (\( M1 \)) plus easily transferable savings accounts (e.g., overnight repurchase agreements, US dollar accounts in Europe, money-market mutual funds, savings deposits, small time deposits); ~ $6 Trillion

\( M3 \) - everything in \( M2 \) plus large time deposits & other accounts used less frequently for transactions purposes; ~ $9 Trillion

**Credit Cards** - affect how much money people want to hold, but are excluded from definition of money because they're not assets

**Real Income** - \( Y \) = nominal income \( \div \) price level (\( P \))

**Nominal Income** - \( PY \)

**Velocity of Money** - number of times a dollar gets spent in a year; \( V = PY/M \); depends on:
1. Frequency of paychecks (# paychecks ↑ ⇒ \( M \downarrow \) & \( V \uparrow \))
2. Regularity of paychecks (more regular (i.e., less seasonal) ⇒ \( M \downarrow \) & \( V \uparrow \))
3. Predictability of paychecks (more predictable ⇒ \( M \downarrow \) & \( V \uparrow \))
4. Ease of credit (more credit ⇒ \( M \downarrow \) & \( V \uparrow \))

**Historic Trends** - \( V \) for \( M2 \) < \( V \) for \( M1 \) (because \( M2 \) has more money); \( V \) for \( M2 \) hasn't changed much over time (people still save roughly same % of income; \( V \) for \( M1 \) has been increasing (more credit, less seasonal, & more frequent pay periods)

\[
\begin{array}{c|c|c|c|c|c|c}
\hline
M1 & -- & 2.4 & 2.0 & 3.0 & 6.9 & 8.8 \\
M2 & 2.5 & 1.5 & 1.4 & 1.7 & 1.8 & 1.8 \\
\end{array}
\]

(can't distinguish)

**Intuition Behind Transaction Demand** - look at amount of money people hold over time; fluctuates based on \( Y \) and \( i \); transaction models try to explain how based on how the money is used

**Single Pay Period** - assume person gets paid \( PY \) at start of year and spends it all continuously over the course of the year; on average, person holds \( PY/2 \); expand concept to entire economy (i.e., \( PY = \text{nominal GDP} \)) and the amount of money needed is \( M = PY/2 \) : \( V = PY/PY/2 = 2 \)
Two Pay Periods - assume person gets paid twice a year \((PY/2)\) each time at start of year and again in 6 months; spends it all continuously over the six months; on average person holds \(PY/4\); expand concept to entire economy and the amount of money needed is \(M = PY/4\) \(\therefore V = PY/PY/4 = 4\)

All Credit - Assuming person gets paid twice a month; each pay period, uses all income to pay off credit card; all purchases during rest of month are on the credit card; amount of money needed is very low and velocity is very high

Baumol Model

Inventory Model - based on transaction demand for money; looks at keeping money like stocking inventory; short on intuition, but empirically testable

Receipts \((T)\) - assume receipts (income) = expenditures; \(T\) in real dollars \(\therefore PT\) is nominal
Withdrawal \((C)\) - amount of usual withdrawal (from M2 to cash); depends \(b\) & \(i\); determines amount of money needed \(M = C/2\)

Cost of Withdrawal \((b)\) - real cost of making a withdrawal
Interest \((i)\) - cost of holding cash (instead of letting it earn interest)

Number of Withdrawals - \(PT/C\)
Average Cash on Hand - \(C/2\)

Total Nominal Cost - \(\frac{PT}{C} Pb + i \frac{C}{2}\); cost of making withdrawals plus cost of interest foregone

Trade-off - to lower cost of withdrawals you should make fewer of them (i.e., \(C\uparrow\)), but that increases the interest foregone

Minimize Cost - decision variable is \(C\) so take first derivative wrt \(C\) and set it equal to zero:

\[-\frac{PT}{C^2} Pb + i \frac{1}{2} = 0 \Rightarrow C^* = P \sqrt[2]{\frac{2bT}{i}}\]

Money Supply - \(M = \frac{C^*}{2} = \sqrt[2]{\frac{bT}{2i}}\); we can substitute GDP \((Y)\) for \(T\) to get money supply

Results - money supply changes in proportion to price level \((P\uparrow\) by 10% \(\Rightarrow M\uparrow\) by 10%); \(M\) increases by less than in proportion to income and decreases by less than in proportion (specifically by \(Y^{1/2}\) and \(i^{1/2}\))

Problem - can't really substitute GDP because some transactions require money but aren't captured in GDP (used cars, illegal activities, etc.)

Tobin Model

Scenario - assume \(T = \$144K/\)year; can put money in interest bearing asset that earns \(i = 10\%\); each transaction costs \(b = \$700\)

No Bank Trips - demand for money \(L = \$144K/2 = \$72K\); no interest earned and no costs incurred

1 Trip - save 1/2 money at start of year and go back to back to get it in 6 months;
\(L = (T/2)/2 = \$36K\); 2 transactions so cost is 2*\$700 = \$1400; earn interest on half the money for half the year: \(T/2\cdot i/2 = \$3600\)

2 Trips - save 2/3 money at start of year; go back to get 1/2 of savings \((T/3)\) in 4 months \((1/3\) of year); go back again to get rest at 2/3 year; \(L = (T/3)/2 = \$24K\); transactions cost 3*\$700 = \$2100; 1/3 of money earns interest for 2/3 year and 1/3 of money earns interest for 1/3 of year: \(T/3\cdot i\cdot (1/3+2/3) = \$4800\)
\[ n \text{ Trips} - \]
\[ L = \frac{(T/n)}{2} \]
\[ \text{Cost} = bn \]
\[ \text{Interest Earned} = \frac{T}{n} \cdot i \cdot \frac{(n-1)}{2} \quad (\text{Note: sum of } r \text{ consecutive integers is } \frac{r(r+1)}{2}) \]

**Decreasing Returns** - each additional trip yields less additional interest income

**Goal** - maximize net benefit (interest earned minus transactions cost); in this scenario, best to make 3 trips so \( L = \$18K \)

<table>
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<tr>
<th>Trips</th>
<th>TX</th>
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<th>Net</th>
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</table>

**Results** -

\( i \uparrow \Rightarrow \text{earnings increase so number of transactions increase... } L \downarrow \)

\( T \uparrow \Rightarrow LT \) (regardless of # of transactions); earnings increase so number of transactions increase; manage cash more intensively; hold more money but less than in proportion to \( \Delta T \) (similar to Baumol model)

Economies of Scale - same cost per transaction so it pays more (on net) to make more transactions when you have more money

**Problem** - why don't we do this? Get paid twice per month so \( T \) very low; doesn't pay to cover transaction cost

**Second Problem** - getting paid twice per month implies we would hold a week's income in cash which implies \( V = 52, \) but it's only 8.8 (we hold 5 weeks income in cash); why?

1. Households vs. firms (firms hold more cash)
2. Most cash is $100 bills... probably held for illegal transactions or overseas
3. Portfolio

**Quantity Theory of Money** by Milton Friedman; large amounts of cash are held for portfolio reasons, not just transactions

**Empirical Work**

Allan Meltzer, "The Demand for Money: Evidence From the Time Series." JPE 1963

**Data** - annual data from 1900-1950

**Logs** - use \( \ln(M/P), \ln(i), \ln(Y), \) etc. because coefficients can be interpreted as elasticities

**Baumol Model** - suggests \( \ln(M/P) = [\text{const}] - 0.5\ln(i) + 0.5\ln(Y) \)

**Results** -

\[ \ln(M1/P) = [\text{const}] - 0.99\ln(i) + 1.11\ln(W/P) \quad R^2 = 0.992 \quad (W = \text{wealth}) \]

\[ (0.04) \quad (0.03) \]

\[ \ln(M2/P) = [\text{const}] - 0.5\ln(i) + 1.32\ln(W/P) \quad R^2 = 0.994 \]

\[ (0.05) \quad (0.02) \]

\[ \ln(M1/P) = [\text{const}] - 0.79\ln(i) + 1.05\ln(Y) \quad R^2 = 0.981 \]

\[ (0.04) \quad (0.04) \]

\[ \ln(M1/P) = [\text{const}] - 0.92\ln(i) + 0.97\ln(W/P) + 0.13\ln(Y) \quad R^2 = 0.995 \]

\[ (0.05) \quad (0.10) \quad (0.09) \quad Y \text{ not significant} \]

**Notes** -

1. Makes sense to use M2 with wealth (portfolio) and M1 with income (transactions)
2. \( W \) more important than \( Y \) for determining money demand
3. Multicollinearity problem; $Y$ & $M$ correlated, but so are $W$ & $Y$; can't interpret coefficients
4. $M/P$ always gets good fits, but not always good forecasts
5. Coefficient for $i$ is always < 0 and significant; coefficient for scale ($W$ or $Y$) is always > 0 & significant

**Baby Sitting Example**

Sweeney & Sweeney, "Monetary Theory and the Great Capitol Hill Baby Sitting Co-op Crisis."

**Background** - cooperative of 150 families taking advantage of economies of scale in babysitting; true cost of sitting there watching "Clifford" so adding another kid doesn't cost much on the margin

**Barter** - economists usually think of barter as being inefficient because it requires **double coincidence of wants** (have to find someone who wants what you're supplying and has what you want; usually takes along time to find someone to trade with)

**Potential Problems** - aside from inefficiency of barter, people could abuse the system (use baby sitter 20 times and only sit 5 times)

**Solutions** -
1. **bookkeeping** - credit and debit hours of babysitting; problems with accuracy and unpleasant phone calls
2. **scrip** - explain rules and give 40 scrip ("money") good for 1/2 hour of babysitting; people use/earn scrip with no bookkeeping required; problems include counterfeiting and people moving (decrease money supply)

$L > M/P \Rightarrow$ people baby sit to earn more scrip

$L < M/P \Rightarrow$ people go out more to get rid of scrip

**Crisis** - CHBSC used scrip; co-op had administration (people to explain rules, interview new members, etc.); wouldn't work with volunteers so staff was paid with scrip through dues (4200 scrip/year ~ 2100 hours ~ 1 hr/mo/couple... call that $T$ = net taxes); problem was staff being too efficient; only used 3800 scrip ~ 1900 hours... call that $G$ = government purchases; money supply was shrinking; result - more people on the list to baby-sit, but fewer people asking for baby sitters ($S > D$; equivalent of unemployment)

**Economist Solution** - have administrators redistribute the "surplus" (monetary policy); not obvious to people that money supply is the problem

**CHBSC Solution** - rule requiring people to go out at least once every six months; most of the members were lawyers and used to "Stalinist, central planning" (Bomberger)

**IS-LM** - what's needed is either increasing the money supply ($M \uparrow$) or have prices drop ($P \downarrow$); problem is prices are fixed (scrip says "1/2 hour")

**Black Market** - could have baby sitters offering to work for less ("I'll work for 1 scrip per hour"); could have people going outside the co-op spending real money rather than scrip

**Keynesian Idea** - monetary is great compared to barter, but has problems when money market is out of balance; need a central bank to maintain $L = M/P$ or need flexible pricing so $P$ can change to maintain balance (problem with sticky prices... especially wages)

**Eventual Solution** - CHBSC redistributed the "surplus" and gave new members 60 units of scrip (rather than 40); also, members leaving the co-op only have to return 40 units; now have increasing money supply... could cause problems in future
History of Economic Thought on Money

John Maynard Keynes - not first to use money demand or first to talk about recessions; first to use monetary policy to explain recession

"Common Knowledge" - "downturns are a necessary evil in capitalist economy"; capitalist system is best because it's increases standard of living fastest, but downturns are "necessary" because doesn't seem to be anything to do about it; Keynes was unique because he was the only one not saying recessions would get worse

Minority Opinions -
Marx - downturns are good; capitalist system produces too much then cuts back to get rid of inventories; owners take advantage of workers; said downturns would get worse and worse, but increased dependence of technology would result in educated work force that would eventually overthrow the owners; "Centralization of the means of production and socialization of labor at last reach a point where they become incompatible with their capitalist integument." "Thus integument is burst asunder. The knell of capitalist private property sounds. The expropriators are expropriated."

S????? - government help doesn't let firms eliminate "dead wood" so downturns would get worse over time; "[A recovery] is sound only if it [comes] of itself. For any revival which is merely due to the artificial stimulus leaves part of the work of depressions undone and adds, to an undigested maladjustment, new maladjustment of its own which has to be liquidated in turn, thus threatening business with another [worse] crisis ahead."

Britain - looking at money since 1700s shows not much change until last 50 years, and since then there's been no deflation

1776-1900 - price fairly stable because on gold standard; (1) government can't just print money (doesn't have enough gold to back it up); (2) fixes exchange rate between pound and any other currency on gold standard (1 pound = 5 U.S. dollars); designed to prevent persistent inflation

WW I - went off gold standard; tripled money supply which tripled prices

Economic Consequences of the Peace - published by Keynes in 1919; said reparations on Germans were shortsighted; just making German democracy unpopular (people would view it as collecting money for the Allies); led to hyperinflation like Keynes predicted

After War - went back to gold standard; had two options: (1) change exchange ratio (i.e., don't reverse the inflation), (2) cut money supply to get back to old exchange ratio; arguments for latter case were to gain credibility for future and to keep financial markets from moving to New York
**Economic Consequences of Mr. Churchill** - published by Keynes in 1925; tried to gain credibility by using similar title to previous paper where he was correct about Germany; argued that going to gold standard at current level would be better

**Depression** - Britain chose latter policy and had rapid deflation; unemployment was very high; Britain had long depression before the world-wide Great Depression hit in the 30s; people started to argue that Marx was right; Keynes argued it was a monetary problem in his book

**A General Theory of Employment, Interest and Money** - published by Keynes in 1936; didn't write it as an "I told you so" book because he still wasn't entirely convinced; prices adjusted quickly after Napoleonic (1812) War; Keynes thought deflation would take much longer after WW I because of unions (sticky prices); it happened faster than Keynes thought, but still didn't have unemployment problem solved

**General Idea of Monetary Policy** - \( P \downarrow \Rightarrow M/P \uparrow \Rightarrow LM \uparrow \Rightarrow i \downarrow \Rightarrow I \uparrow \Rightarrow Y \uparrow \); key is lower interest rates increasing output via investment

**Liquidity Trap** - if potential GDP is out too far, monetary policy alone can't solve the problem; eventually get to \( i = 0 \) from decreasing price level (or increased money supply), but will never get to full employment; once interest rates go to zero, investment is no longer encouraged and money gets "trapped" in portfolios (people hold money rather than invest it)

**Pigou Effect** - Pigou argued for \( C(Y - T, i, Wealth) \); deflation increases wealth which increases consumption; problem is effect of wealth on consumption (and hence output) is weak compared to effect of interest rate on investment (and hence output)

**Getting Trapped** - \( I(i - \pi^e) \); suppose \( i = 4\% \) and \( \pi^e = 2\% \). real rate = 2\%; cut money supply to get to previous exchange rate (move to \( LM_1 \)); wait for deflation to get LM back to full employment, but if it takes too long, people expect deflation so \( \pi^e \) drops (i.e. move to IS\(_1\)); people expect to pay back loans with money that is worth more so they don't want to borrow); by the time prices fall to original LM curve (\( i = 4\% \)), still haven't reach potential GDP because real rates are too high

**Solution** - Keynes argued in this case monetary policy is no good so we need fiscal policy (\( G \uparrow \)) to bring economy back; when in a liquidity trap, fiscal policy is fine to use because there is not much crowding out

**Keynesian Policy** - used as pejorative term for any fiscal policy (usually deficit spending) used to stimulate the economy; **Note**: Keyes argued for monetary policy; only talked about fiscal policy when interest rates were too low for monetary policy to work

**Why Study This?** - Japan; 1990s look the same; interest rates near zero and high unemployment

US? - target federal funds rate at 1\%; lowest in 40 years; been there for a while; if it stays too long, we could have \( \pi^e \downarrow \) and end up in liquidity trap

**Bomberger** - looks like some inflation is good for a monetary policy cushion... maybe 4\%
Lesson

Goldfield, "The Case of the Missing Money."

**Demand for Money (L)** - can't really predict it, but we assume it's function of Y and i and that \( L_L > 0 \) and \( L, < 0 \); assume it's: \( \ln(L) = a_0 + a_1 \ln(Y), + a_2 \ln(i), + ... \)

**Predict L** - usually use \( L = M/P \) (implicitly assumes market is at equilibrium); Goldfield argued that money demand may adjust slowly because there are two components to the cost of reaching equilibrium:

- **Partial Adjustment** - cost of changing \( L \) is \( a(\ln(M/P); - \ln(L))^2 + b(\ln(M/P); - \ln(M/P), -1)^2 \)

  - Cost of holding non-optimal Adjustment cost; cost to amount of money change portfolio

- **Holding Cost** - squared because (1) holding too much is just as bad as holding too little, (2) cost grows the farther you are from optimal amount

- **Adjustment Cost** - squared because (1) adjusting cost in both directions, (2) cost of adjustment grows the faster you change

- **Min Cost** - take derivative wrt \( \ln(M/P)_n \), set it equal to zero and solve for \( \ln(M/P) \),

  \[
  d(\text{cost})/d(\ln(M/P)_n) = 2a(\ln(M/P)_n - \ln(L)) + 2b(\ln(M/P)_n - \ln(M/P), -1) = 0
  \]

  \[
  \ln(M/P)_n = \frac{a}{a + b} \ln(L) + \frac{b}{a + b} \ln(M/P), -1 = \lambda \ln(L) + (1 - \lambda) \ln(M/P), -1
  \]

- **Zero Adjustment Cost** - note if \( b = 0 \), \( \ln(M/P)_n - \ln(L) \), (i.e., adjust immediately)

**Model** - substitute in formula for \( \ln(L) \), and get:

\[
\ln(M/P)_n = \lambda a_0 + \lambda a_1 \ln(Y), + \lambda a_2 \ln(i), + ... + (1 - \lambda) \ln(M/P), -1
\]

Rewrite with single parameters (that's what we'll estimate in a regression):

\[
\ln(M/P)_n = b_0 + b_1 \ln(Y), + b_2 \ln(i), + ... + cln(M/P), -1
\]

**Interpreting Coefficients** - note that 1 - \( \lambda = c \) (or \( \lambda = 1 - c \)); now \( b_1 = \lambda a_1 \Rightarrow a_1 = b_1/(1 - c) \); similarly \( a_2 = b_2/(1 - c) \)

"Short-Run" Elasticities - \( b_1, b_2, \) etc. (1 quarter)

"Long-Run" Elasticities - \( a_1, a_2, \) etc. (eventual)

**Goldfield's Results** - quarterly data 1952:2 to 1973:4

\[
\begin{align*}
\ln(M1/P)_n &= [\text{const}] + 0.179\ln(Y), - 0.042\ln(i_{ud}) - 0.181\ln(i_{cp}) + 0.676\ln(M1/P), -1 \\
R^2 &= 0.995 \\
&\quad (0.04) (0.011) (0.003) (0.068)
\end{align*}
\]

\[
\begin{align*}
\ln(M2/P)_n &= [\text{const}] + 0.206\ln(Y), - 0.021\ln(i_{ud}) - 0.071\ln(i_{ud}) - 0.029\ln(i_{ud}) + 0.884\ln(M2/P) \\
R^2 &= 0.999 \\
&\quad (0.054) (0.003) (0.028) (0.012) (0.045)
\end{align*}
\]

**Problem** - good fit doesn't imply good forecast; forecast error for 1976:2: -22% for M1 and -4.4% for M2

**Reason** - overestimated real money balances because he underestimated inflation; problem wasn't too little money, but too much inflation

**Example** - \( \mu = (aM_i/dT)/M_i = \) rate of growth of \( M_i \) (\( i = 1 \) or 2); \( \pi_i = \) inflation rate predicted implicitly by Goldfield's model; \( \pi = \) actual inflation rate

<table>
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<tr>
<th>Year</th>
<th>( \mu_1 )</th>
<th>( \mu_2 )</th>
<th>( \pi_1 )</th>
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<td>3.7%</td>
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**Lesson** - overestimating real money balances is equivalent to underestimating inflation; problem wasn't missing money, but too much inflation
The Federal Reserve

**Required Reserve Ratio** - amount of money banks are required to hold in cash at the end of each day as percentage of total deposits

**Federal Funds Rate** - interest rate banks charge each other to borrow money (usually lent daily to cover RRR requirement)

**Open Market Operations** - buy/sell government securities in order to achieve monetary policy objectives (manipulate M or FFR)

- **Expansionary** - buy bonds ⇒ M↑ ⇒ banks have more cash (excess reserves) ⇒ FFR↓
- **Contractionary** - sell bonds ⇒ M↓ ⇒ banks have less cash (harder to make RRR) ⇒ FFR↑

**Money Supply Target** - Fed focused on \(\frac{dM}{dt}/M\) (growth rate of money supply) and set targets for M1, M2, and M3 growth; usually only concerned about a range for FFR (used in 80s)

**Interest Rate Target** - Fed sets very narrow range for FFR and doesn’t worry about money supply (current policy)

**Potential Problems** - unforeseen problems cause problems with monetary policy; say Fed targets specific \(\Delta M\) or wants FFR = \(i_1\) to get to \(Y_1\) (and \(i_1\))

1. **IS↓** (for any reason, but usually \(\pi\)↓ or \(I\)↓)

   - **Money Supply Target**
   - **Interest Rate Target**

2. **LM↓** (from \(L↑\))

   - **Money Supply Target**
   - **Interest Rate Target**

**Summary** - if IS is more unpredictable, use money supply target because interest rate target exaggerates \(\Delta Y\) from \(\Delta IS\) (that’s bad... recessions worse); if \(L\) (LM) is more unpredictable, use interest rate target because money supply target is countered by \(\Delta Y\) from \(\Delta LM\) (policy is ineffective... not as bad as the exaggeration problem with IS)

**Real World** - usually (at least currently) \(L\) is more difficult to predict so Fed focuses on target FFR