Lecture 11: The Demand for Money and the Price Level
See Barro Ch. 10

Trevor Gallen

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Where are we? Taking stock

1. We’ve spent the last 7 of 9 chapters building up an equilibrium model of growth and the business cycle.

2. Persistent-but-not-permanent TFP/productivity/$A_t$, shocks look like a good candidate, because they help explain why: consumption (a little), investment (a lot), wages, interest rates, labor, and labor productivity all go down simultaneously, and why we have a slow recovery.

3. So far we’ve largely been money and price free! We have prices floating in the background, but because all people care about is real prices, real wages, real interest rates, whatever the price level is doesn’t matter!

4. We’re going to change that here, and talk about money as a medium of exchange, and some potential problems with it.

5. It will eventually give us an alternative candidate for business cycles (chapters 15 and 16).
So far we’ve analyzed two types of assets a household can have:

- Physical capital ($K$)
- Financial capital ($B$)

We’ve left out money ($M$) so far because it’s really hard to understand why people hold money...why?

Now we’ll try to justify why people hold money and analyze the consequences.
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- Physical capital ($K$)
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We’ve left out money ($M$) so far because it’s really hard to understand why people hold money...why? (recall $i_K$ and $i_B$...what is $i_M$?)

Now we’ll try to justify why people hold money and analyze the consequences
We’ll be talking about fiat money, not commodity money (which is basically what we had before)

Why don’t people just use commodity money?
  - Potential legal restrictions on private money
  - Legally required to accept it
  - Potentially a public good

It wasn’t always this way...1837-1862...
Sometimes we think about the quantity of currency in circulation (physical dollars and cents).

An expanded version of this also includes deposits held by banks at the Federal Reserve (promises that could be turned into currency on demand).

- This is called “high-powered money” or “the monetary base.”

But the things we use for money are bigger than that: there is more money in bank accounts (things that should be able to be turned into currency on demand) than there is physical currency.

- For instance, checking accounts.

- This broader definition is M1.
But we really use even more things to trade: we can include savings accounts, CD’s, money market mutual fund money.

For our intents and purposes in this chapter, currency is what we’ll be thinking about.

Currency as a fraction of nominal GDP has been fairly constant in the U.S., at about 6%.

In other countries it’s changed.

Leads to a question...why do people hold currency?
Demand for Money-I

- There are two countervailing effects on the demand for money (think currency and checking accounts)
  1. When you hold currency, you aren’t earning interest, so you don’t want to hold money
  2. When you hold currency, you’re able to purchase things

- When thinking about the demand for money, think of things like this:
  1. Each morning, you look at prices $P$ and interest rates $i$
  2. You decide how many times to run to the ATM
     - More trips to the ATM is costly
     - But it allows you to earn more interest

- Let’s think of the demand for money as $\frac{M^d}{P}$, the “real” amount of money needed.
What happens when interest rates are high?

\[ M, the \] nominal demand for money, falls.

\( M, the \) price level, \( P \), is lower, the real demand for money falls.
What happens when interest rates are high?

You lose more if you have money out of the ATM
Demand for Money—Interest Rates

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- You lose more if you have money out of the ATM
- Consequently, you’re more willing to take many trips to ATM

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Given a price level \( P \), \( M_d \) is lower, the real demand for money falls.
Demand for Money - Interest Rates

- What happens when interest rates are high?
- You lose more if you have money out of the ATM
- Consequently, you’re more willing to take many trips to ATM
- Need to hold less money at any given point in time. \( M^d \), the nominal demand for money, falls.
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- Given a price level $P$, $\frac{M^d}{P}$ is lower, the real demand for money falls
Demand for Money-Price Level

- What happens when the price level doubles (including the two prices for labor and capital, the wage rate $w$, nominal rental price $i$)
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Now you have twice as much money! Recall that nominal income is $\Pi + wL + i(B + PK)$. $\Pi$ doubles (and is zero) because it’s in nominal terms. $w$ and $i$ double by assumption. Then dividing by $P$ to get the real, $\frac{\Pi}{P} + \frac{w}{P}L + \frac{i}{P}(B + PK)$ has both numerator and denominator all doubling. So real income doesn’t change.
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- So nothing real has changed: you still have same real income, so want same real consumption, which requires $\frac{M^d}{P}$ to stay the same. If $P$ doubles, $M^d$ doubles, too.
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So nothing real has changed: you still have same real income, so want same real consumption, which requires \( \frac{M^d}{P} \) to stay the same. If \( P \) doubles, \( M^d \) doubles, too.

In this case, nominal demand for money doubles, and real demand stays the same. Behavior stays the same.
If this doesn’t make sense, consider the idea that the government comes in and declares all dollar amounts in the U.S. are now worth twice as much: then nothing changes, except now you have “twice” as much nominal money you need to pay for the same consumption, etc.
Now imagine real income doubles (nominal income doubles while prices stay constant). Start with households holding half of all weekly income ($50/$100) when they withdraw (two trips to ATM per week).
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But this doesn’t make sense! If you went from $100 to $200 in income, and you found it worth taking $50 out twice a week so you could get interest on it, then you should be willing to visit the bank many times, taking $50 or $75 out each time.
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In other words, a doubling of real income should increase real money demand, but by less than doubling it.
Demand for Money-Real GDP

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In other words, a doubling of real income should increase real money demand, but by less than doubling it.
There are other things that impact the demand and real demand for money.

As the cost of going to the bank (think of ATM’s) falls, the number of trips rises, and the demand for money falls (you need to hold less money at any given point).

- You also may hold more money because money is now more convenient.

As you’re able to use credit cards and checking accounts, you need less use of currency.
All of this leads us to posit a formula for nominal money demand:

\[ M^d = P \cdot L(Y, i) \]

Where \( M^d \) is nominal money demand, \( P \) is the price level, \( L \) is a function which takes in real income \( Y \) and nominal interest rates \( i \).

You can also write the real demand for money as:

\[ \frac{M^d}{P} = L(Y, i) \]

So think of \( L(y, i) \) as the real demand for money.
Money Demand Function: Empirical Evidence

There’s good evidence for the money demand function

1. Goldman: \( i \uparrow 10\%, \ M^d \downarrow 3\% \)

2. Mulligan and Sala-i-Martin: \( i \uparrow 10\% \) from 2\% to 2.2\%, \( M^d \downarrow 2\% \).

3. Mulligan and Sala-i-Martin: \( i \uparrow 10\% \) from 6\% to 6.6\%, \( M^d \downarrow 5\% \).

4. Goldfeld: \( Y \uparrow 10\%, \ M^d \uparrow 7\% \)

5. Goldfeld: \( P \uparrow 10\%, \ M^d \uparrow 10\% \)

In other words, this empirically seems like a good function
Money Demand Function: So what?

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- Why have we been doing this?

- The money demand function, when combined with a money supply function, determines the price level $P$. 

   \[ M_s = M_d \]

   \[ P = M_s L(Y, i) \]

   Given interest rates, real GDP, and the total quantity of money, we can solve for what the price level must be.
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- Or, $P = \frac{M^s}{L(Y, i)}$. Given interest rates, real GDP, and the total quantity of money, we can solve for what the price level must be.
Money Supply and Demand-I

Figure 10.1  The Nominal Quantity of Money Supplied Equals the Nominal Quantity Demanded
Dane’s Question

1. Does appreciation of gold in Fort Knox offset operating expenditures?

2. Operating expenditures on civilian & military payroll, contractors in 2012 was about $651 million

3. Fort Knox holds about $175 billion in gold

4. Average rate of return on gold has averaged 0.32%/year since 1990 (Ken French)

5. This yields, on $175 billion in gold, about $560 million

6. About 86% of Fort Knox’s operating expenditures are paid for by gold appreciation
Money Supply and Demand-II

- The demand for money depends on the price level
- The quantity of money is set
- Therefore, in order for everyone to be willing to hold all the currency that exists, money demand must equal money supply
- The price level adjusts until supply equals demand
Money Supply and Demand—III

- This may be a little confusing at first! Note that as the price level rises, you demand more money!

- Why?

- Imagine the following: the government declares every dollar is worth $2! New Dollars

- In order for supply to equal demand, $M^s = M^d$.

- If it didn’t, if $M^d$ remained the same while $M^s$ shifted out, then people would (for instance) spend their money on goods

- If, for instance, there weren’t enough goods (demand has shifted out) then the price level will rise

- This will keep happening until the price makes it so that $M^s = M^d$. 


Money Supply and Demand—VI

Figure 10.2  An Increase in the Nominal Quantity of Money

\[ M^s = PL(Y, i) \]
Note that because a high price level means that money isn’t worth much, the demand curve slopes up.

A decrease in the demand for money is therefore a counterclockwise rotation.

Basically the $y$-axis is flipped from what you might be used to.
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Money Supply and Demand - V

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Money Supply and Demand-V

- Great: so the price level of consumption goods doubles because money supply doubles

- What about our other prices? Wages and interest rates?

- When deciding how much to work, an hour of work buys me \( \frac{w}{P} \) goods.

- If wages stayed the same while prices doubled, firms would want more labor even as workers want less: wages would increase
Money Supply and Demand-V

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- In order for people to work the same amount as before you have to pay them the same real wage: \( \frac{w}{P} \) is unchanged, so \( w \) must have doubled.
Money Supply and Demand - V

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▶ When deciding how much to work, an hour of work buys me \( \frac{w}{P} \) goods.

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▶ In order for people to work the same amount as before you have to pay them the same real wage: \( \frac{w}{P} \) is unchanged, so \( w \) must have doubled.

▶ Similarly for people choosing to save.
Money Supply and Demand—VI

- Double money supply $M^s$
  - This doubles the price level $P$
  - In order for markets to clear, real wage $\frac{w}{P}$ and real interest rates $\frac{R}{P}$ must stay unchanged, so they double as well.
  - People face all the same tradeoffs on real wages and real interest rates, so $\kappa$, and $L$ stay the same.
  - So real GDP $Y = A(\kappa K)^\alpha L^{1-\alpha}$ doesn’t change either
- In real terms, nothing changed.
- This should make sense to you: if we declared every dollar was actually !$2! New Dollars, and prices could adjust easily, then nothing would change.
Neutrality of money

What we’ve just discussed is the neutrality of money.

We’re saying that in an economy where prices can adjust, changes in the money supply don’t change anything.

It’s nearly universally accepted that the neutrality of money holds in the long run: we’ll see evidence on this in the next chapter.

There is significant disagreement about whether or not (and to what degree) it’s neutral in the short run.

Most of this disagreement revolves around the degree to which prices can change.

This will set us up for chapters 15 and 16.

For now we’ll look a little more at the supply and demand for money.
We have the equation relating the price level $P$, money supply $M^s$, and money demand $L(Y, i)$:

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We can therefore look at our graph and talk about shifts in $Y$ and $i$. 
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▶ It will stack up with our empirical discussion
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▶ Let’s go through some examples.
Question 1

When $i$ decreases, what happens to real demand for money $L(Y, i)$?
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- Let’s draw this!
Answer 1a

Price level (P)  \( M^s \)

Currency (M)  \( M^d \)
**Answer 1b**

The diagram illustrates the relationship between the price level (P) and currency (M) with a supply of money (M^s) and demand of money (M^d).

- **Price level (P)**: The vertical axis represents the price level, with P* indicating the current price level.
- **Currency (M)**: The horizontal axis represents the currency, with (P*)' indicating a new price level.
- **Money supply (M^s)**: The vertical line represents the supply of money, with the intersection at P*.
- **Money demand (M^d)**: The diagonal line represents the demand for money, with the intersection at (P*)'.

Key points:
- Interest rates decrease:
  - From M^d to (M^d)'
  - This indicates a decrease in interest rates.
- Price level falls:
  - From P* to (P*)'
  - This indicates a decrease in the price level.

The diagram shows how changes in the money supply and demand affect the price level and interest rates.
Question 2

- When $Y$ decreases, what happens to real demand for money $L(Y, i)$?
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- Let’s draw this!
Answer 1b

Is this confusing? What happens to the price in recessions?
Cyclical Behavior of the Price Level

With \( P = \frac{M_s}{L(Y, i)} \) we can think about how the price level changes over the business cycle.
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- When a recession happens, \( Y \) falls.
Cyclical Behavior of the Price Level

- With $P = \frac{M_s}{L(Y, i)}$ we can think about how the price level changes over the business cycle

- When a recession happens, $Y$ falls.
  - So $L(Y, i)$ falls, and the price level falls
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- When a recession happens, $i$ also falls.
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- The two effects conflict, result depends on how strong two effects are.

- Empirically, we see \( i \) falling only a little and \( L(Y, i) \) is less responsive to changes in \( i \).
Cyclical Behavior of the Price Level

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- The two effects conflict, result depends on how strong two effects are.

- Empirically, we see $i$ falling only a little and $L(Y, i)$ is less responsive to changes in $i$.

- Consequently, in a recession we think the $Y$ effect dominates and $L(Y, i)$.
Cyclical Behavior of the Price Level

- We’re left with what might be an initially confusing prediction!

- During Recessions, the price level should rise?! 

- Let’s look at the data
The price level is countercyclical!

Figure 10.4 Cyclical Behavior of U.S. Real GDP and the Price Level
The price level is countercyclical!

- This doesn’t make sense if you were thinking a recession is when demand shifts down and supply stays the same.

- But that isn’t our model: ours is not that demand shifted down, it’s that supply shifted down.

- People are less productive, so fewer things are being made: it makes sense prices would be higher in recessions!

- Note that all this assumes that $M^s$ is constant. We’ll discuss it not being constant shortly.
Price-level targeting

▶ Up until now we’ve been taking $M^s$ and $(M^s)'$ as exogenous, as given

▶ In reality, it responds to shocks: governments and central bankers move it around when things happen

▶ Start with our equation:

$$P = \frac{M^s}{L(Y, i)}$$

▶ Now assume that bankers want to fix $P = \bar{P}$, keep prices constant

▶ In that case, they have to shift around $M^s$ so that this holds:

$$\bar{P} = \frac{M^s}{L(Y, i)} \implies M^s = \bar{P}L(Y, i)$$

▶ So if bankers want to set the price level, they must set the money supply to be something specific.

▶ With this assumption we can analyze what happens to $M$...
Trend growth of money

- Think about growth: $Y$ is going up while $i$ is staying relatively constant.

$$M^s = \bar{P}L(Y, i)$$

- Consequently, $L(Y, i)$ is constantly increasing (shifting clockwise)

- In order for $\bar{P}$ to stay the same, $M^s$ must also be increasing

- Empirical estimates of $L(Y, i)$ suggest $Y$ and $M$ should increase by roughly the same amount

- We see this, but will discuss it more
Cyclical Behavior of Money

- Think about business cycles: $Y$ is going up (ignore $i$)

\[ M^s = \bar{P}L(Y, i) \]

- In booms, $L(Y, i)$ is increasing (shifting clockwise)

- In order for $\bar{P}$ to stay the same, $M^s$ must also be increasing in booms and falling during busts

- Empirically, it is true that $M$ and $Y$ are positively correlated (M is weakly procyclical)

- As we’ve seen, it isn’t procyclical enough to make prices not be countercyclical! (I.e. “$\bar{P}$” is an exaggeration).
Seasonal Variation in Money

- This was actually, in part, the reason for the Federal Reserve

- Seasonal variations in the need for money used to be a huge deal in agrarian days

- We wanted an “elastic currency” to mute price fluctuations

- This is the case: in December, when demand for money is high, the Federal Reserve also engineers more money to keep prices less volatile than they otherwise would be

- Everyone largely ignores this facet of the Federal Reserve, but it’s historically phenomenally important.

- We’ll return to this when we talk about the Federal Reserve and financial crises later in the semester