Money, Banking, Prices, and Monetary Policy

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Macroeconomics 1 (Econ 112)
Term Two, 2023–2024, Week 6

Overview

- So far we have not explicitly introduced money into our model.
- Money is important for two reasons.
  1. Reduces transaction cost.
  2. Matters for nominal quantities.
- This week, we will introduce a monetary intertemporal model

Plan for this Class

1. **A Monetary Intertemporal Model**
2. The Effects of Monetary Policies

Model Setup

- Why do we use money in exchange? A useful analogy is that money is to economic exchange as oil is to an engine; money overcomes "frictions."
- First, in modern economies, barter exchange — the exchange of goods for goods — is difficult. For such transactions to happen, one must meet the "double coincidence of wants".
- Second, there are informational problem associated with the use of other exchange systems. For example, if we are using personal IOUs as means of transactions, people may need to evaluate the credit history before accepting the IOUs.
- Our model this week focuses on the second friction, and we will return to the first next week.

Model Setup (Cont'd)

- Two periods: the current and future.
  Two primary assets: money and nominal bonds.
- Money is assumed to be the numeraire. (All prices are denominated in terms of money).
- P denotes the current price level, or the current price of goods in terms of money. Similarly, P' denotes the price level in the future period.
- A nominal bond is an asset that sells for one unit of money in the current period, and pays off $1 + R$ units of money in the future period.
- R is the rate of return on a bond in units of money, or the nominal interest rate.
- Nominal bonds can be issued by the government, by consumers, or by firms, and all bonds bear the same nominal interest rate, as we are assuming that no one defaults on their debts

Real and Nominal Interest Rates and the Fisher Relation

- The real interest rate, r, is the rate of interest in terms of goods.
- The real interest rate is the real rate of return that someone receives when holding a nominal bond from the current period to the future period.
- Taking account of the inflation rate, i,

$$i = \frac{P' - P}{P}.$$

- Then, the real interest rate is determined by the Fisher relation, named after Irving Fisher, which is

$$1 + r = \frac{\frac{1+R}{P'}}{\frac{1}{P}} = \frac{1+R}{\frac{P'}{P}} = \frac{1+R}{1+i}.$$

Real and Nominal Interest Rates and the Fisher Relation (Cont'd)

- Given $R > 0$, we know that the rate of return on nominal bonds exceeds the rate of return on money, which is 0.

- The real rate of interest on money, r^m, is then

$$1 + r^m = \frac{1+0}{1+i} = \frac{1}{1+i} < r.$$

- Our task: explain why people are willing to hold money if they can receive a higher rate of return on the alternative asset, nominal bonds.

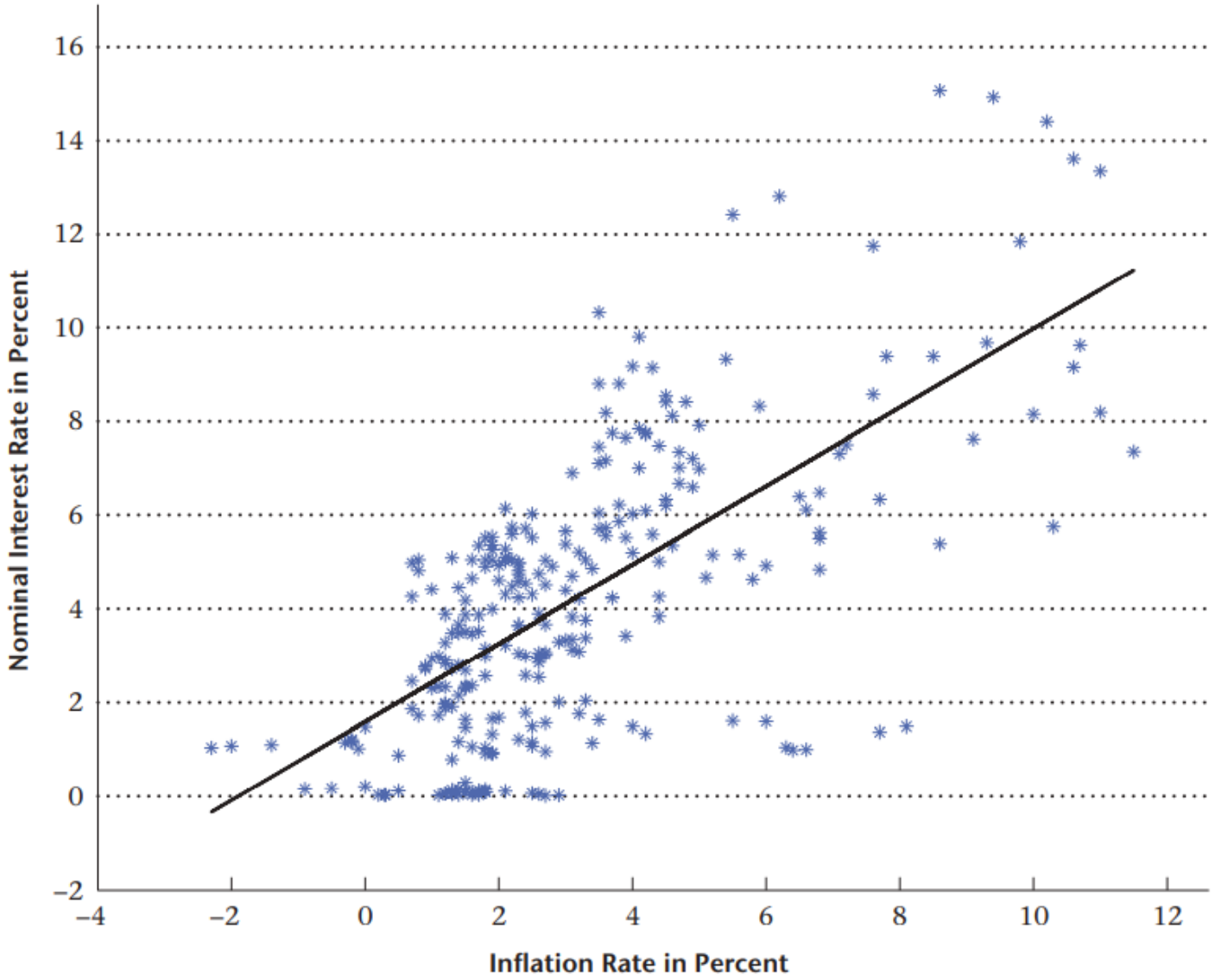
- The Fisher relation can be rewritten by multiplying each side of the equation in the previous slide by 1 + i and rearranging to get

$$r = R - i - ir.$$

- If both i and r are small, then ir is negligible. Hence, we can say that

$$r \approx R - i.$$

U.S. 3-Month Treasury Bill Rate vs. 12-Month Inflation Rate.



Banks and Alternative Means of Payment

- To understand the determinants of the demand for money, we need to be specific about how consumers and firms make choices between using currency issued by the central bank and the services of private banks in making transactions.
- Private banks have two roles:
  1. Facilitate transactions among consumers, firms, and the government. (Alternative means of payment).
  2. Serve as financial intermediaries that manage the savings of their depositors more efficiently than what could be accomplished by individual depositors.
- We will deal with the first role in this week.

Banks and Alternative Means of Payment (Cont'd)

- Private banks supply various alternative means of payment to government-supplied currency
  - Checks, debit cards, credit cards, prepaid cards...

- Important economic differences among them:

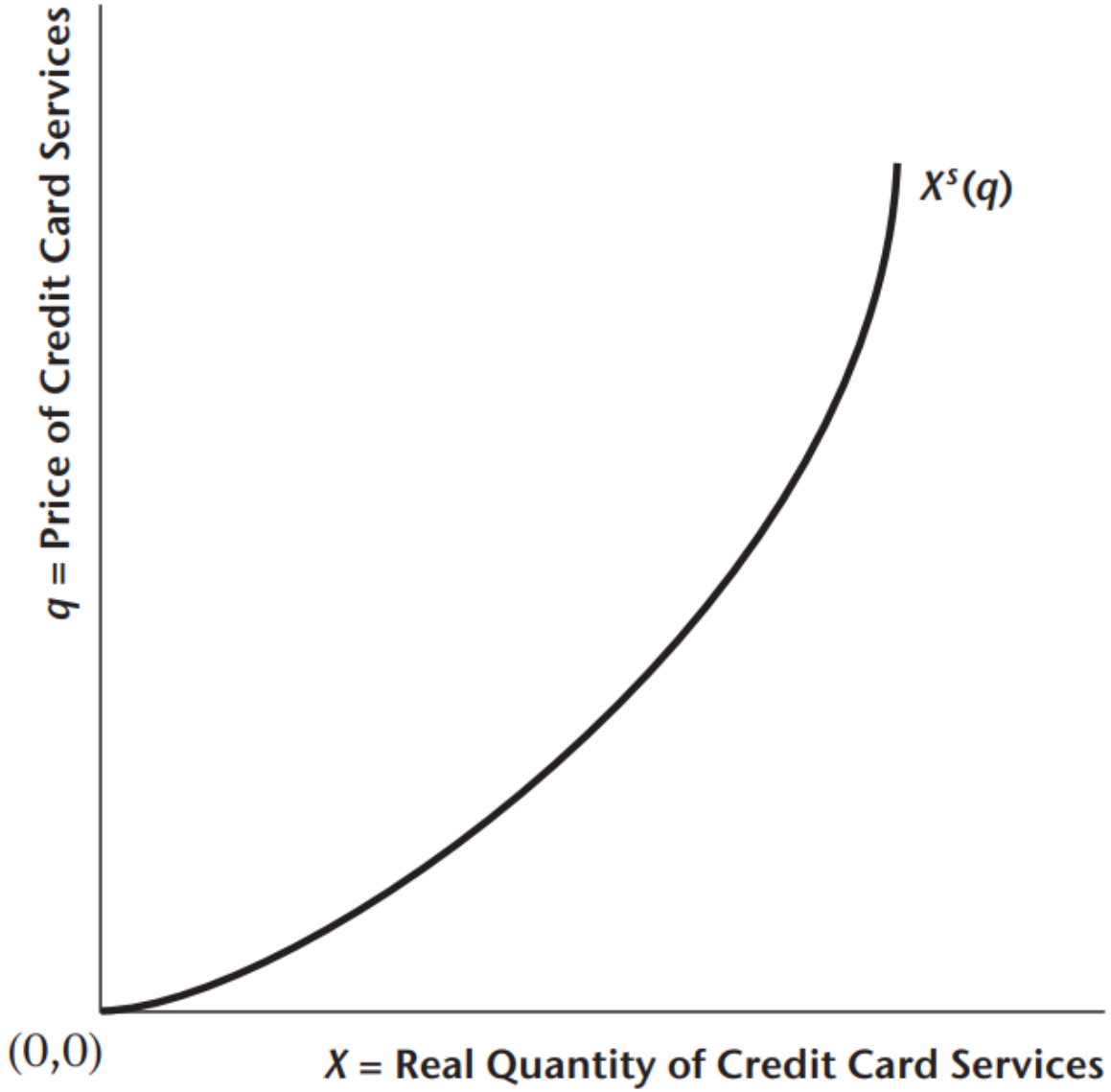
1. Whose liability the payments instrument represents.
   - Currency: Liability of the central bank.
   - Debit card/check: Liability of the private bank.
   - Credit card: Personal IOU issued by consumers. Retailer takes the IOU and exchanges it with a financial intermediary, say Visa. Visa has the IOU, and the consumers eventually pay Visa to extinguish the IOU.
   - Prepaid card: Consumers pay the card issuer for value on the card, effectively making a loan to the card issuer, and then the card issuer pays off the loan as the consumers spend the value on the card.

Banks and Alternative Means of Payment (Cont'd)

1. Whose liability the payments instrument represents.
2. Differences in the payment of interest on the liabilities in question. (Whether there are interests accrued).
3. Differences in transaction costs.

- For simplicity, we will merely consider credit card as the alternative means of payment operated by private banks.
- We will assume that when a consumer buys some goods with a credit card, the consumer acquires a debt with the bank that is paid off, at zero interest, at the end of the current period.
- However, banks would sell credit services for a price q, in units of goods, for each unit of real goods transacted using the credit card during the current period. Hence, the supply curve is represented by $X^s(q)$.
- Furthermore if consumers, firms, or the government want to borrow (or lend) from one period to the next, they do so on the credit market at the market nominal interest rate R.

The Supply Curve for Credit Card Services



The Demand for Credit Card Services

- To determine the demand for credit card services, we need to consider the behavior of consumers, firms, and government purchasing agents who are on the demand side of the goods market.
- Given that all of these economic agents want to collectively purchase Y units of goods, their decisions relates to the quantity of goods they wish to purchase with credit cards, denoted by $X^d(q)$.
- This is relative to the remainder $Y - X^d(q)$, which is the quantity of goods purchased with currency.
- How do we determine $X^d(q)$?
- What are the costs and benefits, for buying one more unit of goods with credit card, and one less unit of goods with currency, at the margin?

The Demand for Credit Card Services (Cont'd)

- The economic agent would then need to hold P fewer units of currency to make transactions during the current period.
- This quantity could then be lent on the credit market, yielding $P(1+R)$ units of money at the beginning of the future period. This is the marginal benefit.
- However, the consumer must give up $P(1+q)$ units of money at the end of the period in order to pay off the credit card debt and to pay the bank for its credit card services. This is the marginal cost.
- If it is the case that the marginal benefit outweighs the marginal cost, that is

$$P(1+R) > P(1+q) \quad \Leftrightarrow \quad R > q,$$

then the consumer will purchase all goods with a credit card.

The Demand for Credit Card Services (Cont'd)

- Alternatively, if it is the case that the marginal cost outweighs the marginal benefit, that is

$$P(1+R) < P(1+q) \quad \Leftrightarrow \quad R < q,$$

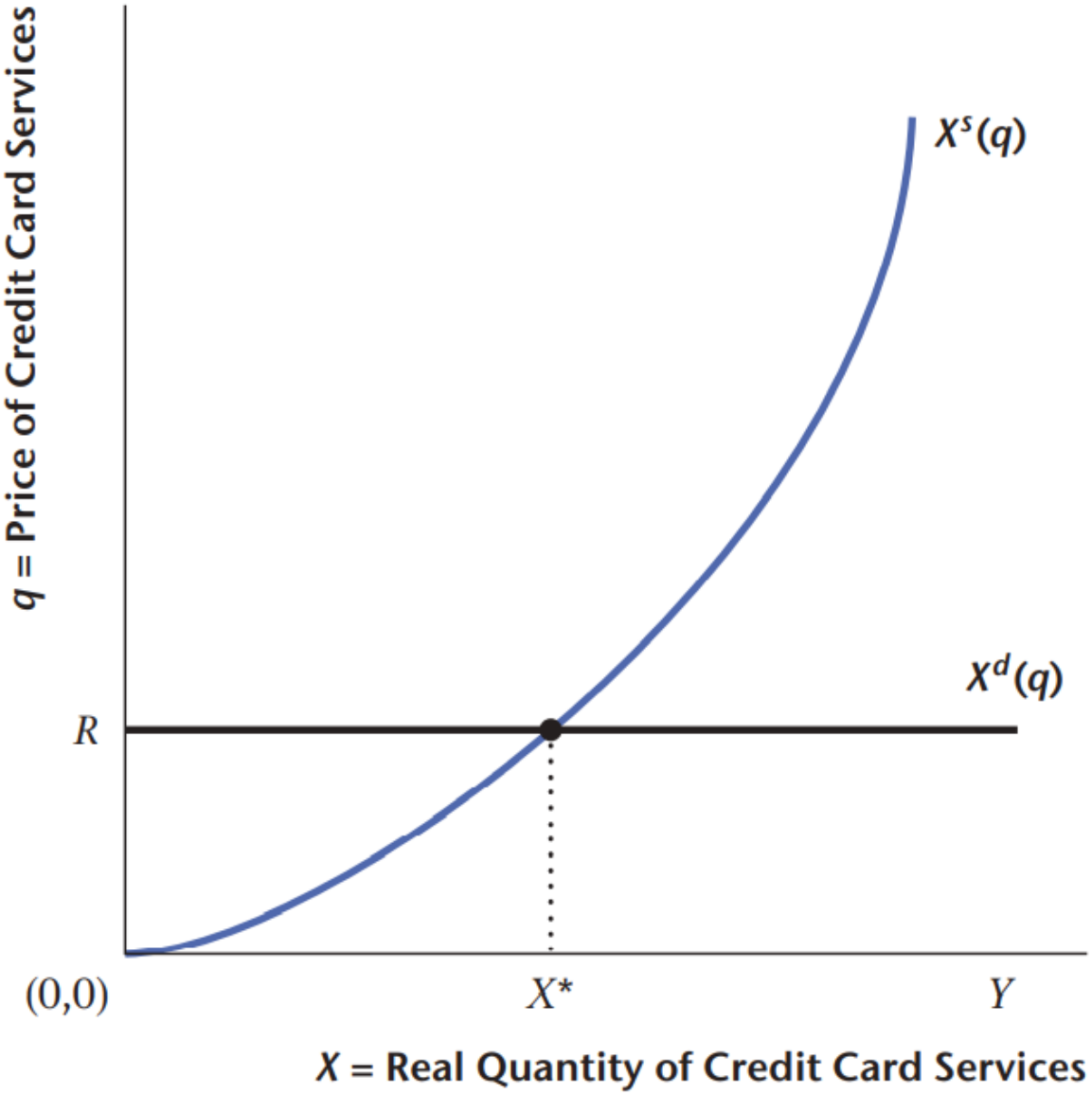
  then the consumer will purchase all goods with currency.

- If $R = q$, then the agent is indifferent between using currency and a credit card.

- This implies that the demand curve for credit card services is perfectly elastic at $q = R$.

- The equilibrium price for credit card services is therefore R, and the equilibrium quantity of credit card services is X^*.

Equilibrium in the Market for Credit Card Services

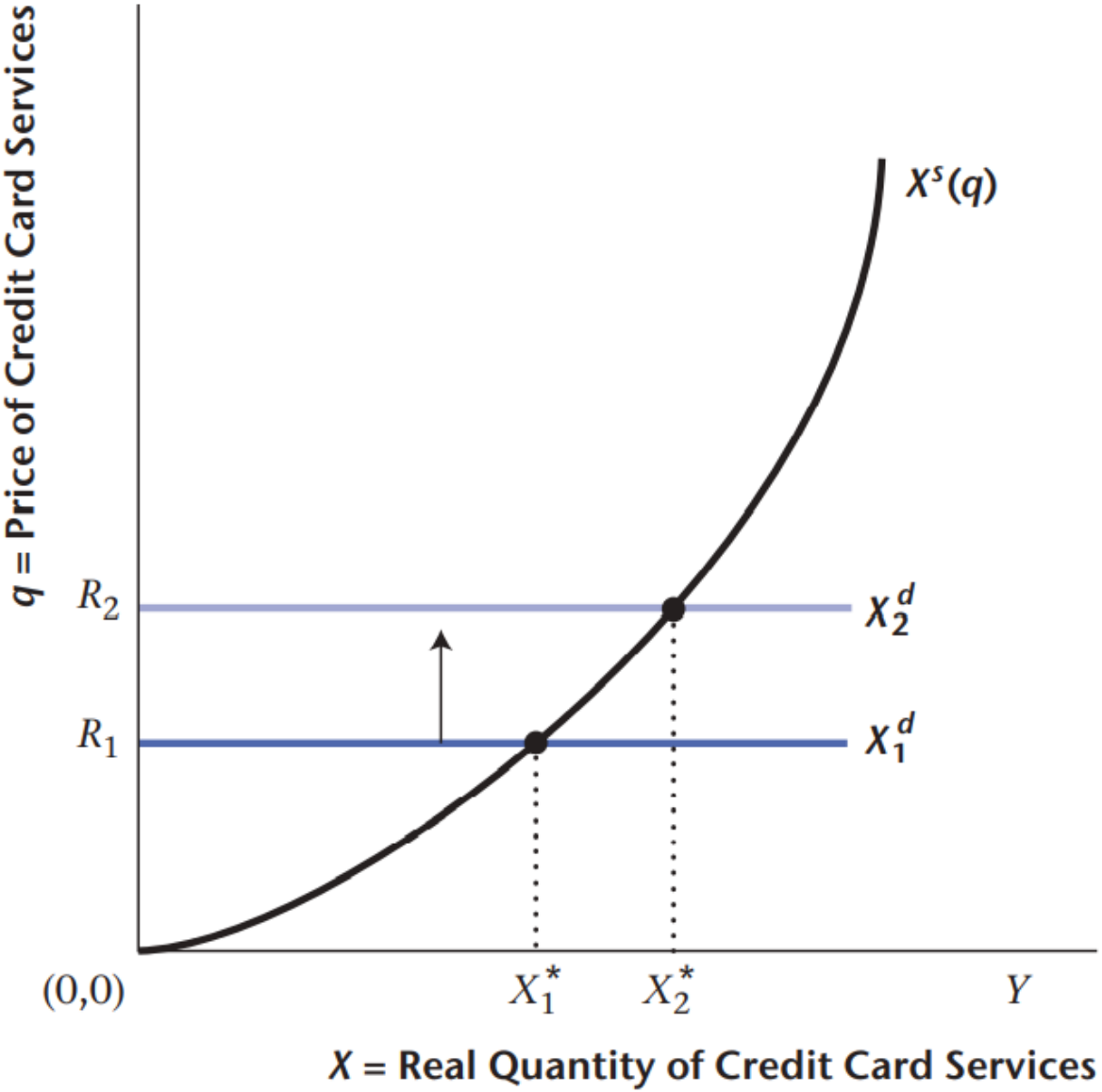


The Demand for Money

- Let's consider the effect of an increase in the nominal interest rate from R_1 to R_2.
- The equilibrium price of credit card services will rise, and the quantity of credit card services rises from X_1^* to X_2^*.
- We can then write the equilibrium quantity of credit card services as $X^*(R)$, which is an increasing function of the nominal interest rate R.
- This implies that the quantity of goods purchased with currency is $Y - X^*(R)$ when the market for credit card services is in equilibrium.
- The nominal quantity of currency that consumers, firms, and the government want to hold to make transactions is then

$$M^d = P\left[Y - X^*(R)\right] \equiv PL(Y, R)$$

The Effect of an Increase in the Nominal Interest Rate



The Demand for Money (Cont'd)

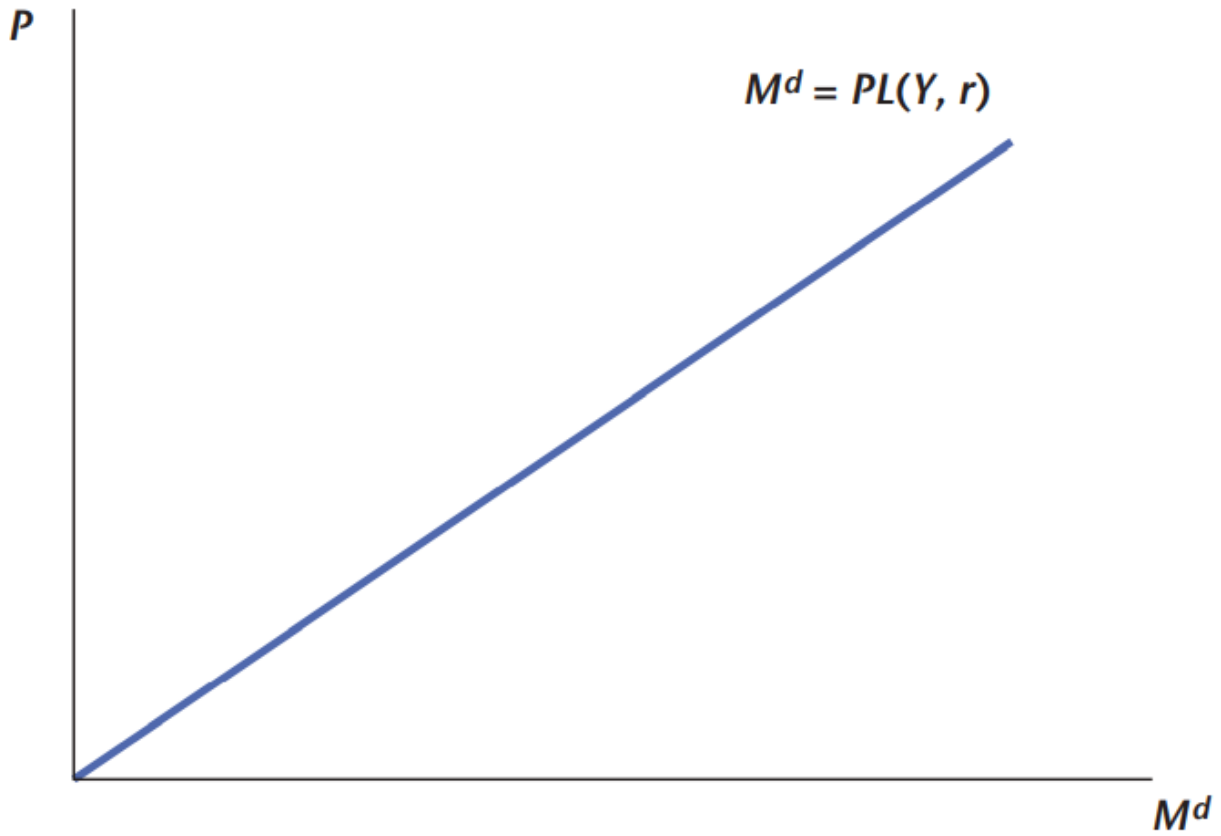
- The function L is increasing in real income, Y, and decreasing in the nominal interest rate, R. (Intuitions?)
- The function $M^d = PL(Y, R)$ is a nominal money demand function and proportional to the price level.
- The real quantity of money demanded is therefore M^d/P.
- Taking the approximate Fisher relation as an equality ($R = r + i$) implies that we can write the nominal demand for money as

$$M^d = PL(Y, r + i).$$

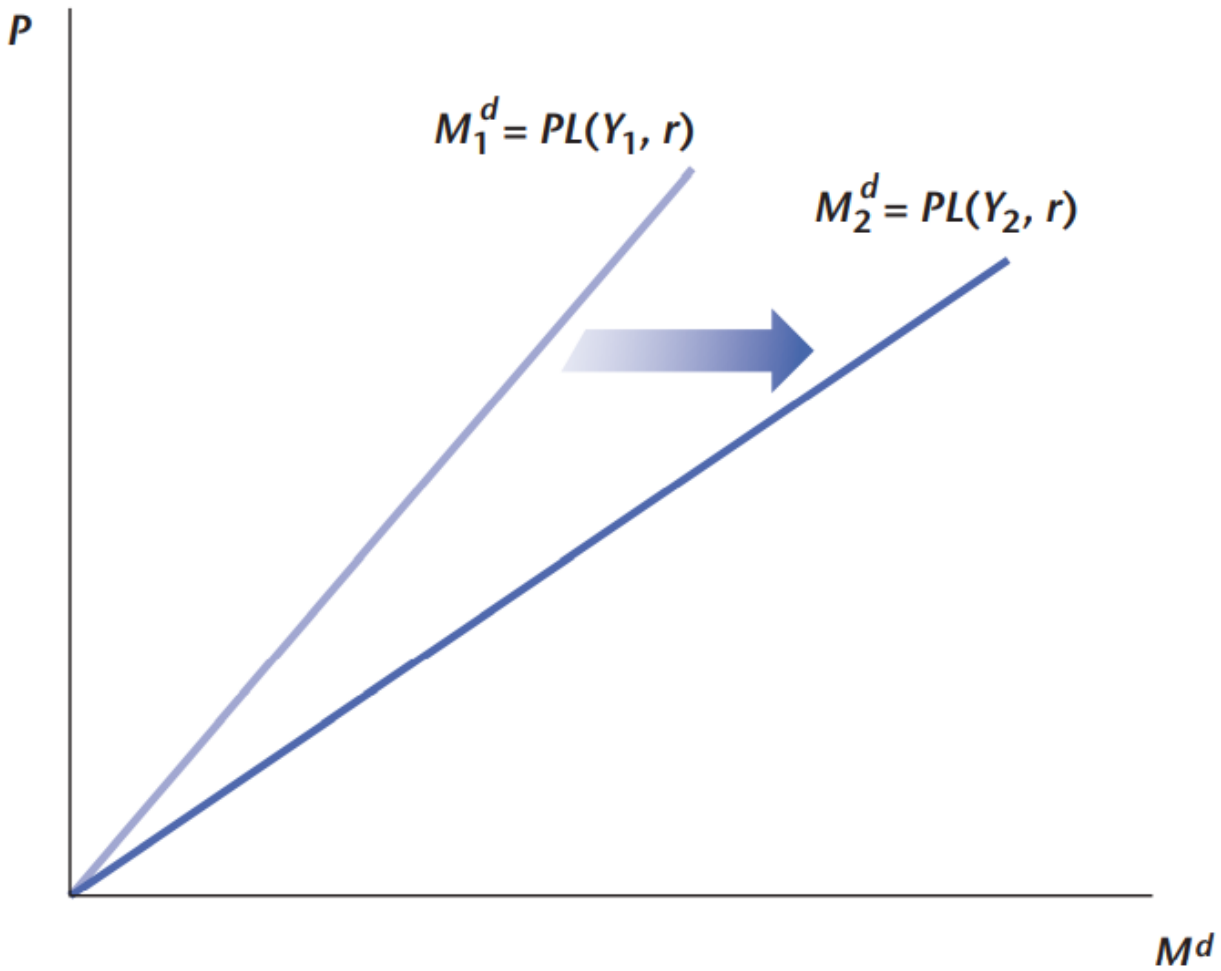
- If inflation rate is constant, it would be harmless to write the equation above as

$$M^d = PL(Y, r).$$

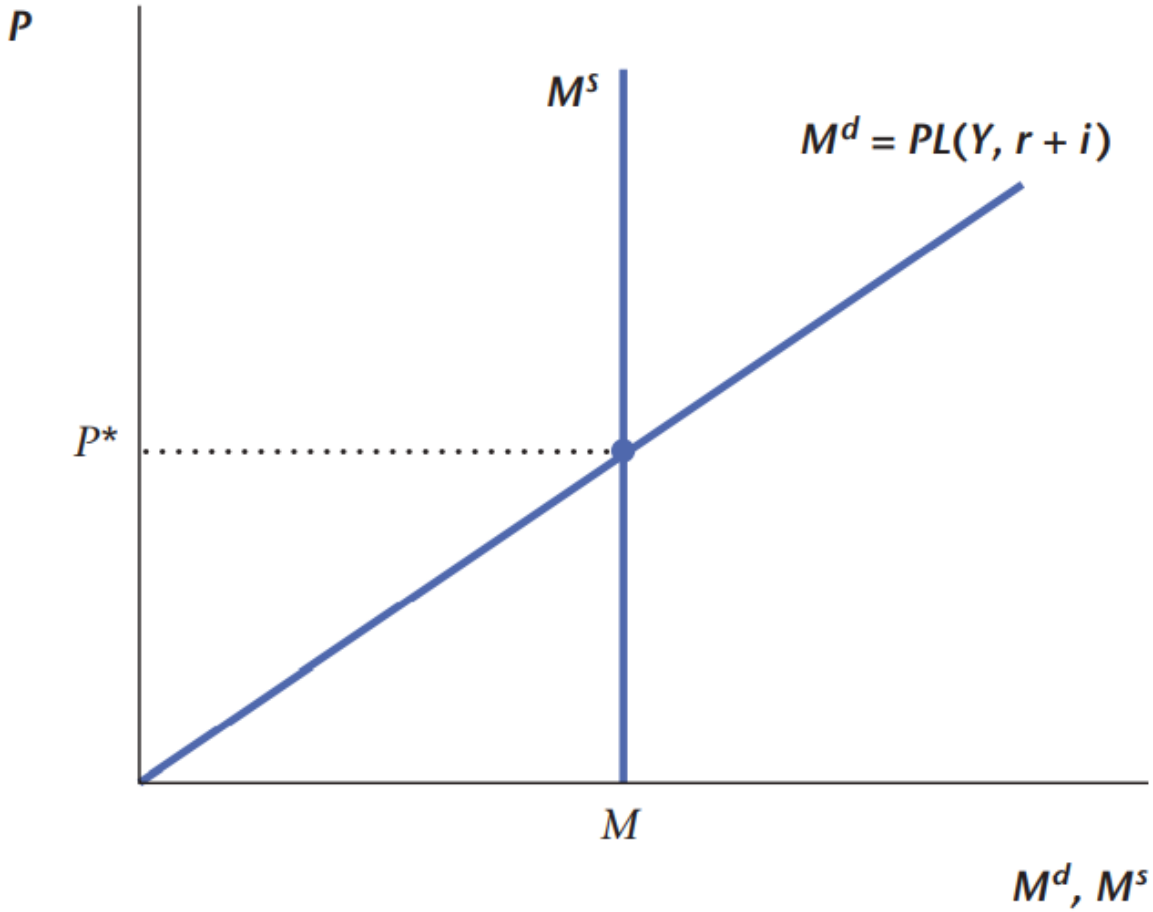
The Nominal Money Demand Curve



The Effect of an Increase in Current Real Income



The Nominal Money Supply Curve and Money Market Equilibrium



- We assume that the money supply M^s is determined exogenously by the government as $M^s = M$.
- The equilibrium price level P^* is determined by the intersection of the nominal money demand and nominal money supply curves.

The Role of Government

- For our convenience, we assume that there is a single institution in our model called the government, which is responsible for both fiscal and monetary policy. (U.S. Treasury + the Federal Reserve System).

- In the current period, the government purchases G goods and pays the nominal interest and principal on the government debt outstanding from the last period, $(1 + R^-)B^-$, where B^- is the quantity of one-period nominal bonds issued by the government in the previous period, which come due with a nominal interest rate R^- in the current period.

- Current government purchases and the interest and principal on government debt, which sum to total current government outlays, are financed through taxation, the issue of new bonds, and by printing money.

- The nominal government budget constraint in the current period is, therefore, given by

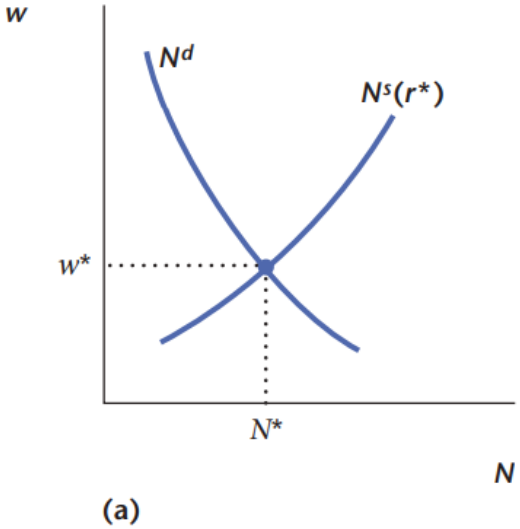
$$PG + (1 + R^-)B^- = PT + B + M - M^-,$$

where $M - M^-$ is the change in the nominal money supply.

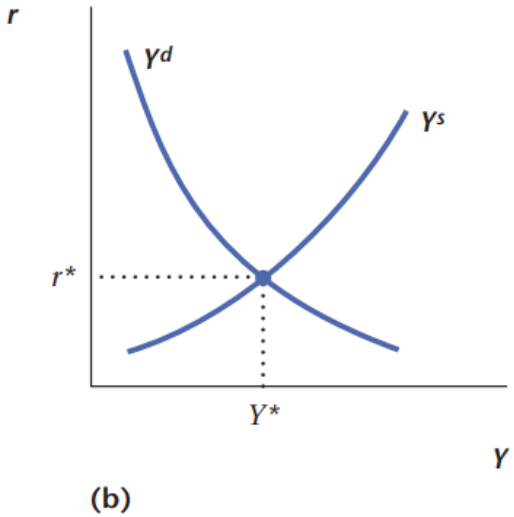
Competitive Equilibrium

- In this monetary intertemporal model there are three markets to consider:
  1. The market for current goods.
  2. The market for current labor.
  3. The money market.
- We will talk more about the goods and labor markets in this framework later.
- Sufficient to talk about money market.
- In adding money to the model, we needed to analyze the behavior of banks, consumers, and firms in the market for credit card balances.
- However, in the work we did above, we showed how all of that behavior can be summarized in a money demand function.
- And equilibrium in the money market will determine the general price level P^* in the economy.

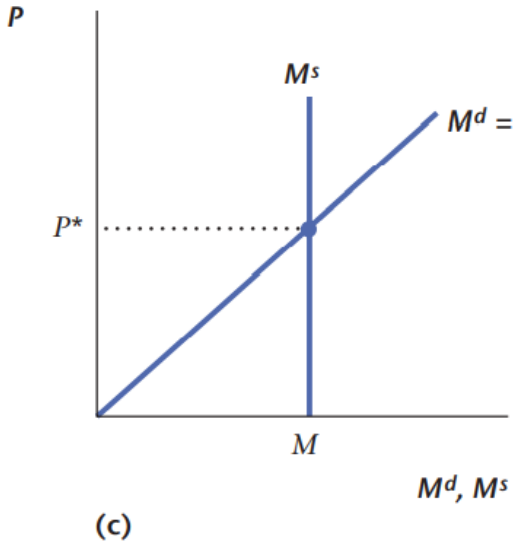
Competitive Equilibrium



Current Labor Market



Current Goods Market

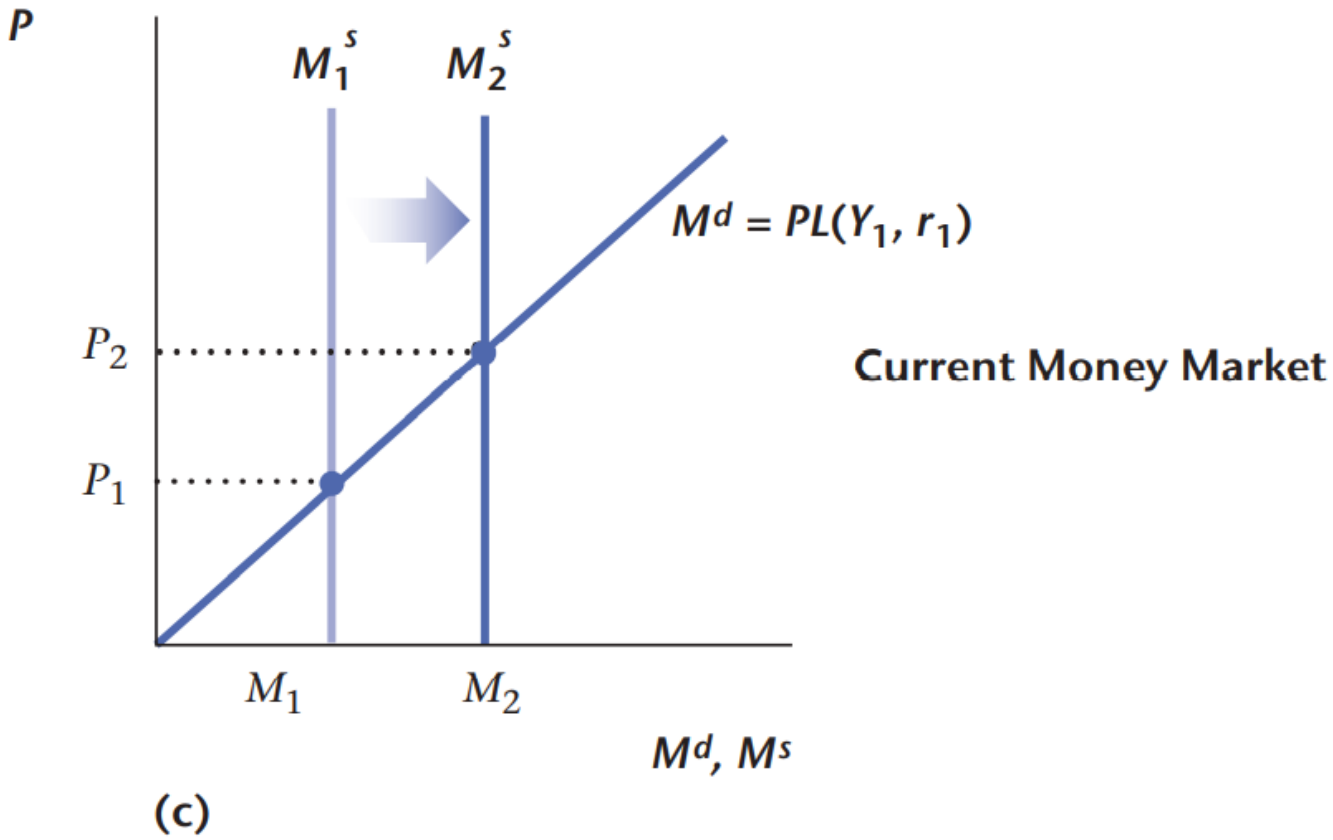


Current Money Market

Plan for this Class

1. A Monetary Intertemporal Model
2. **The Effects of Monetary Policies**

A Level Increase in the Money Supply and Monetary Neutrality



A Level Increase in the Money Supply and Monetary Neutrality

- From the government budget constraint, the change in the money supply is positive, and it needs to be offset by some other term in the equation,

$$PG + (1 + R^{-})B^{-} = PT + B + M - M^{-}.$$

- There are three possibilities:

1. The government could reduce current taxes T. ("Helicopter drop").
2. The government could reduce the quantity of bonds B that it issues during the current period. This is an open market operation, in particular, an open market purchase (why?).
3. The government could temporarily increase the quantity of government spending, G, in the current period. Effectively, the government would be printing money in order to finance government spending. ("Seigniorage" or "inflation tax").

- For our purpose, we assume the first option such that the increase in monetary supply is a lump-sum transfer to the consumers. The effects are neutral and only change the price level.

Measuring the Money Supply

- The most narrowly defined monetary aggregate is M0, which is sometimes referred to as the monetary base or outside money.
- The monetary base consists entirely of liabilities of the Fed. The liabilities making up M0 are U.S. currency outside the Fed and the deposits of depository institutions with the Fed (reserves).
- The quantity of M1 is obtained by adding travelers' checks, demand deposits, and other transactions accounts at depository institutions.
- The quantity of M2 is M1 plus savings deposits, small-denomination savings deposits, and retail money market mutual funds. These additional assets are not directly used in transactions, but they are easily exchanged for currency and transactions deposits, which can then be used in transactions.

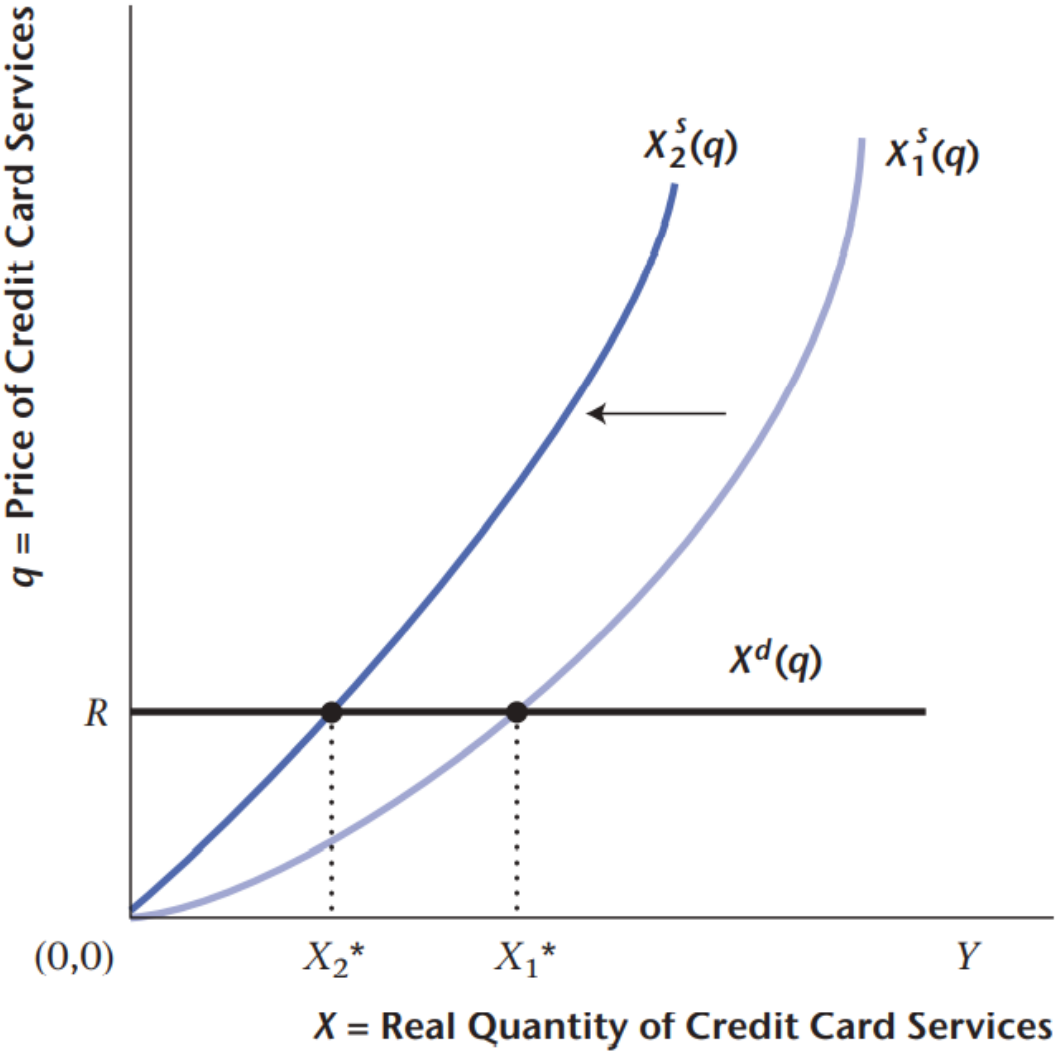
Shifts in Money Demand

- Any factor that affects either the demand or supply of credit card services will bring about a shift in the demand for money.
- One example would be the arrival of new information technologies for banking such as ATM machines or online banking.
- In here, we will focus on the effects of a shift in the supply of credit card services.
- Suppose that the supply curve for credit card services shifts to the left, as a result of a widespread power failure that shuts down communications between some retailers and credit card issuers.
- Recall that the nominal demand for money is given by

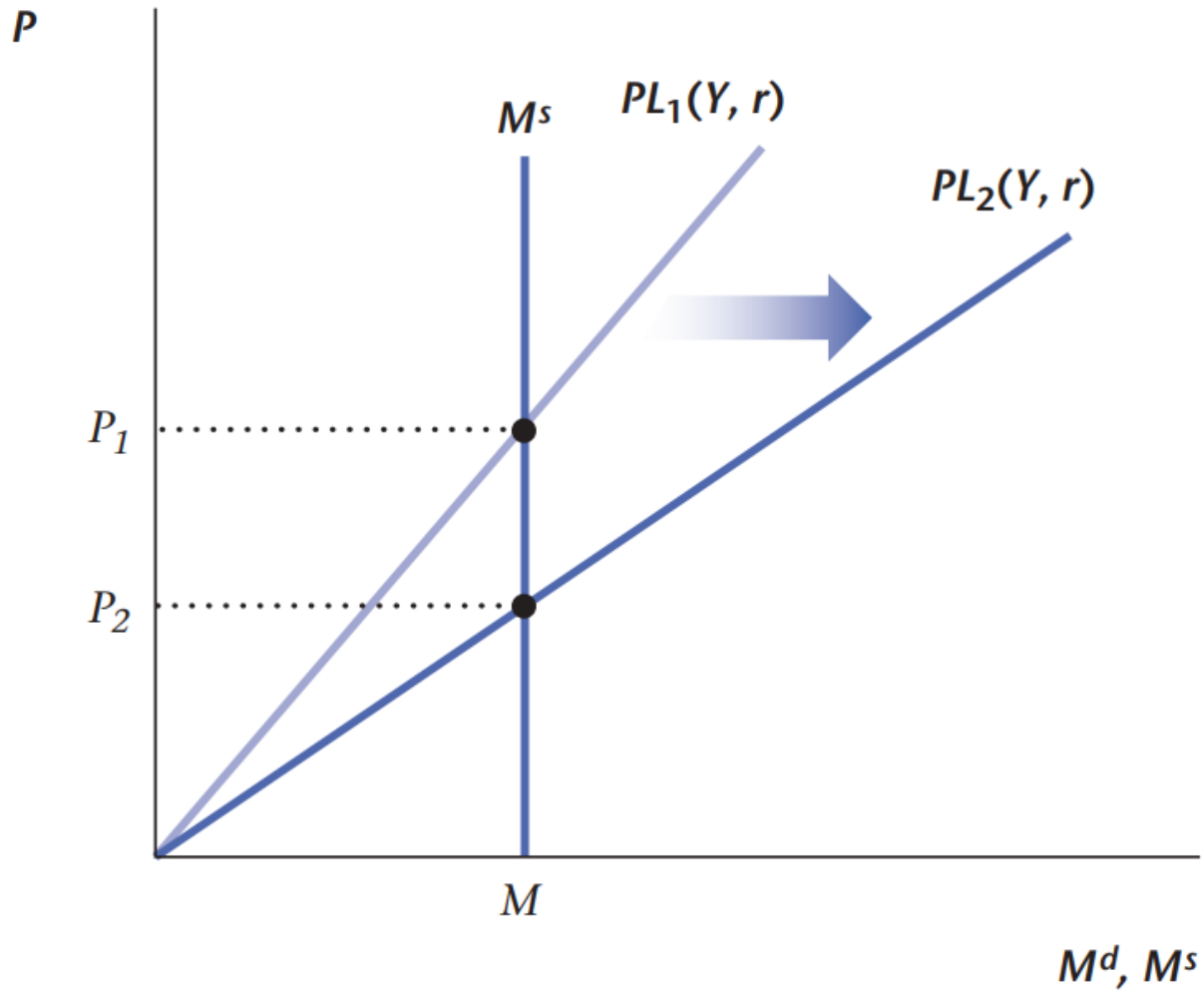
$$M^d = PL(Y, R) = P[Y - X^*(R)],$$

so the demand for money is now higher for each P, Y, and R.

A Shift in the Supply of Credit Card Services



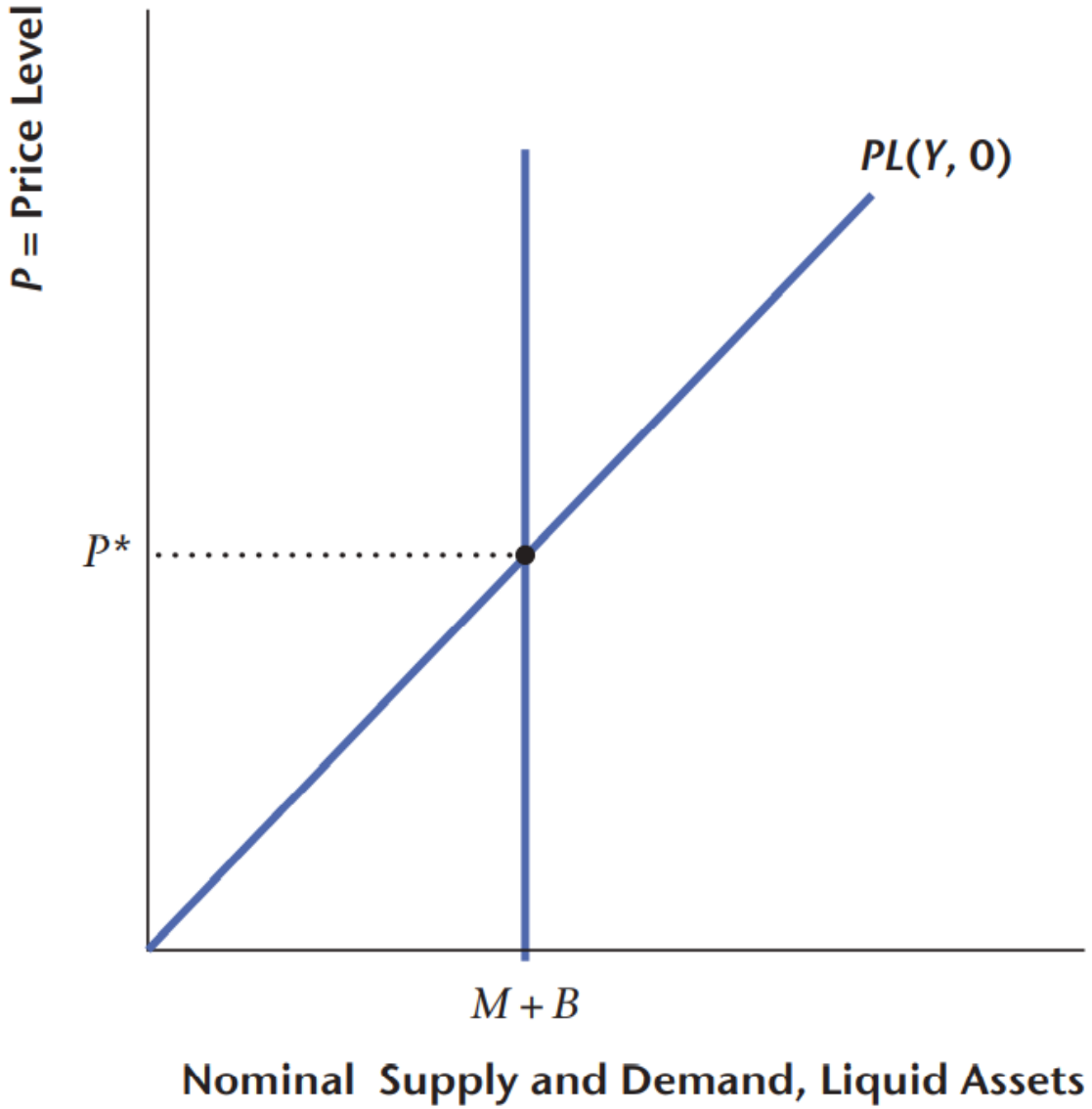
A Shift in the Demand for Money



Liquidity Trap, Quantitative Easing, and Negative Nominal Interest Rates

- Usually, there is a limit to how low the nominal interest rate can go. We assume this lower bound to be zero, or what we call the zero lower bond.
- If interest rate is at zero, then people would prefer to hold currency, rather than interest-bearing assets.
- Money issued by the central bank and government bonds become perfect substitutes.
- Instead of the supply of nominal liquidity being the money supply M, it is now $M + B$, where B is the nominal stock of liquid government debt.
- The money demand function when the nominal interest rate is zero is $L(Y, 0)$, and so the price level P^* in the figure is determined by money demand at the zero lower bound and the nominal stock of money plus liquid government debt.
- Open market operations does not affect the total $M + B$, and hence has no effect on the price level. A liquidity trap.

A Liquidity Trap



Liquidity Trap, Quantitative Easing, and Negative Nominal Interest Rates

- Since the 2008–2009 recession, many central banks in the world, including the Fed, have encountered the zero lower bound.
- In achieving their goals, the world's central banks in some cases decided that further "easing" of monetary policy at the zero lower bound was important. (For example, to avoid a Great Depression style deflation amid a severe recession.)
- Some of them resorted to unconventional means to accomplish such easing.
- This includes quantitative easing and negative nominal interest rates.

Quantitative Easing

- In a quantitative easing (QE) intervention by the central bank, rather than purchasing short-term government securities (e.g., U.S. Treasury bills, which mature in less than a year), the central bank purchases long-term government securities (e.g., Treasury bonds and notes).
- This increases the liquidity of government debt.
- So even though this increases M, but B will reduce by a less than offsetting amount, so that $M + B$ increases and the price level goes up.
- In practice, for the Fed, the QE involved not only outright purchases of long-maturity Treasury securities, but also purchases of mortgage-backed securities, and swaps of shorter-maturity Treasury securities for longer-maturity security.
- Similar programs launched by other central banks such as the Bank of Japan, the Swiss National Bank, the Swedish Riksbank, the Bank of England, and the European Central Bank.
- Effectiveness debatable, e.g., Japan.

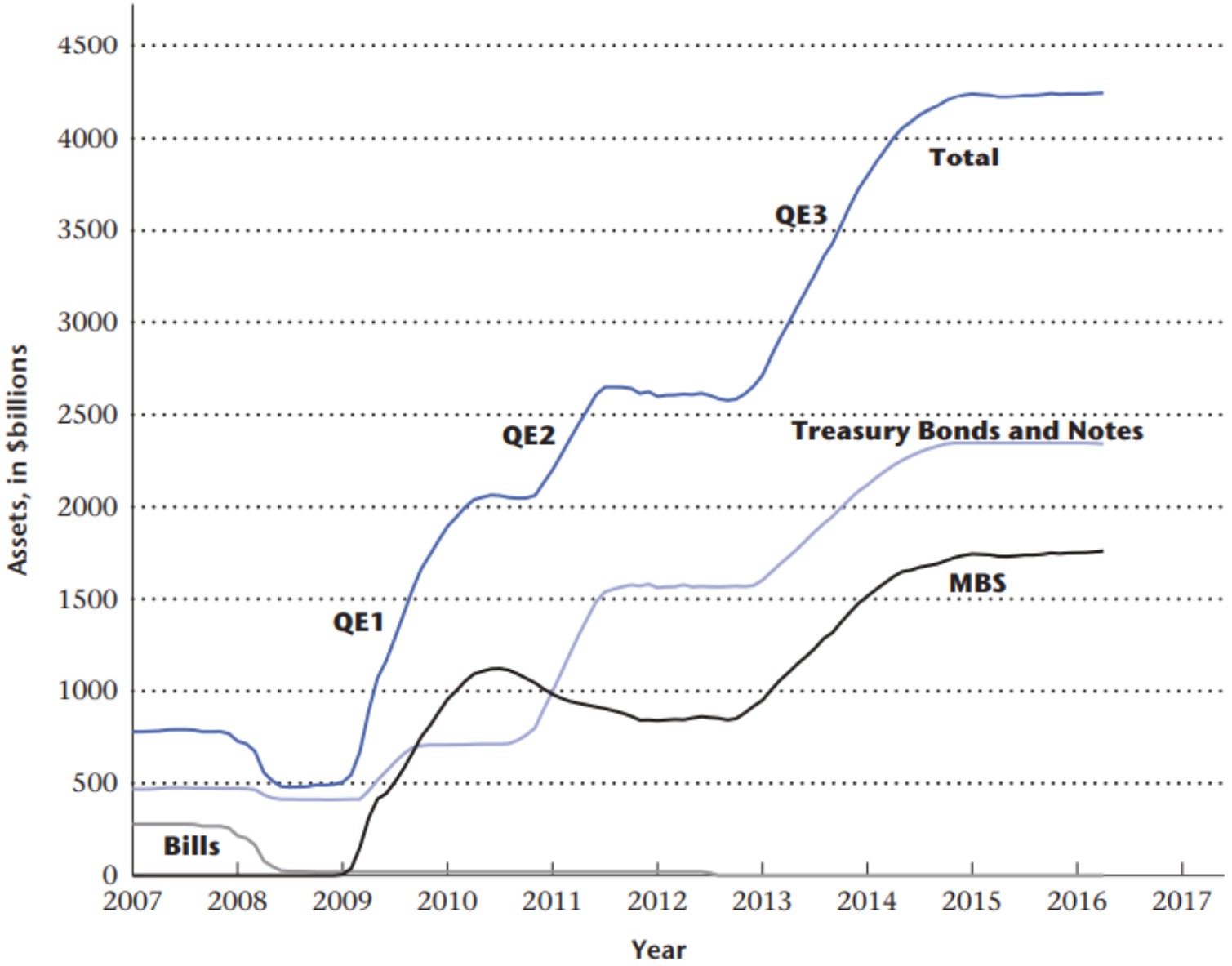
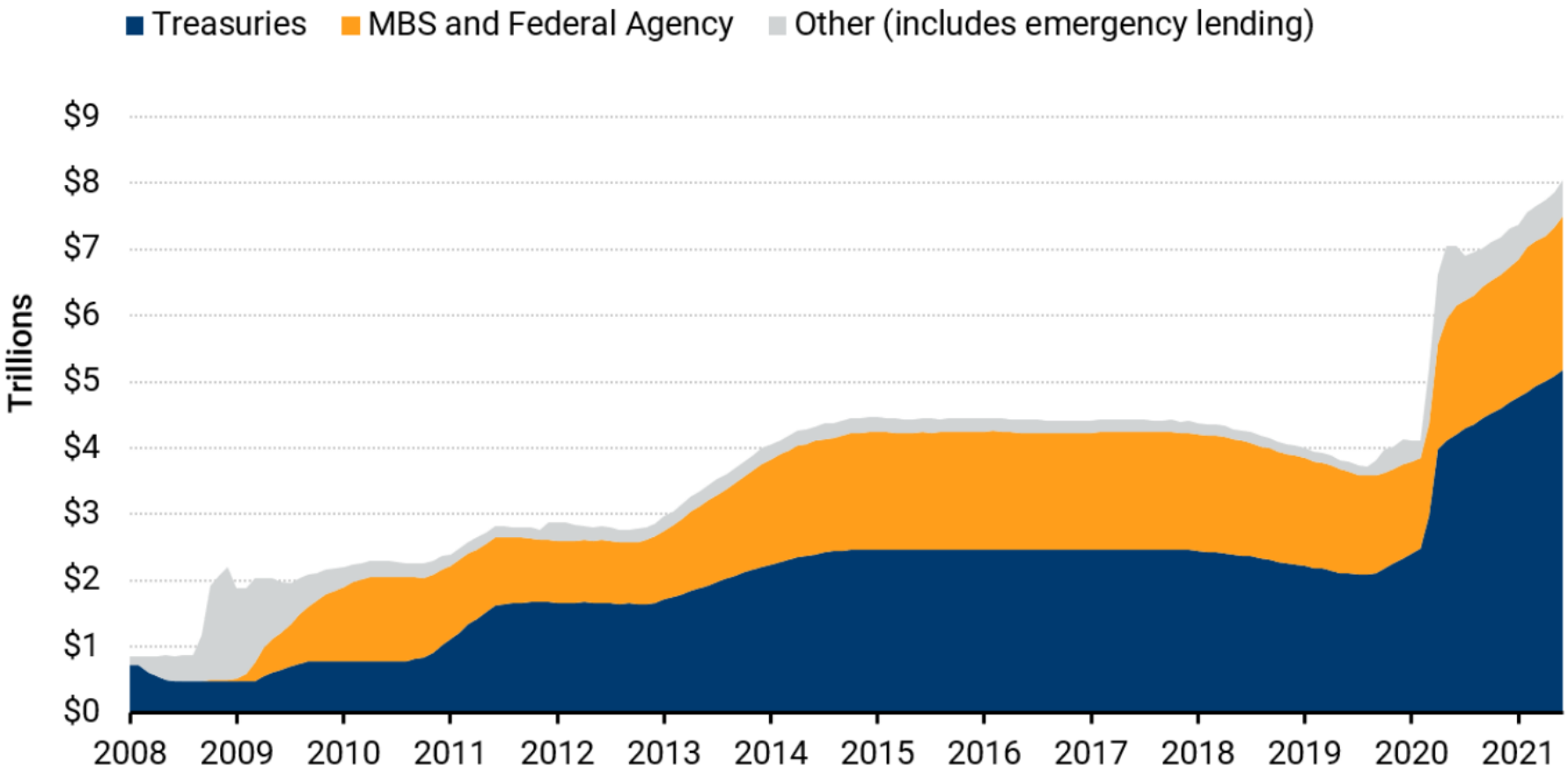

4500
4000
3500
3000
2500
2000
1500
1000
500
0
Assets, in $billions
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Year
Total
QE3
QE2
Treasury Bonds and Notes
MBS
QE1
Bills

FIGURE 1

Federal Reserve Balance Sheet: Assets



Source: Federal Reserve H.4.1 via Haver Analytics

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at BROOKINGS

Negative Nominal Interest Rates

- There are also arguments suggesting that the effective lower bound on nominal interest rate is negative.
- Currency can be a very inconvenient alternative to holding assets such as Treasury bills and bank reserves bearing negative interest.
- There could be a chance that my currency would be stolen (Treasury bills are issued as individual electronic accounts with the U.S. Treasury), and currency in large quantities takes up space and is hard to use in large payments (e.g., payments of thousands or millions of dollars).
- These people would argue that they would actually pay for holding assets.
- Central banks that have pushed nominal interest rates below zero include the Swedish Riksbank, the European Central Bank, the Swiss National Bank, and the Bank of Japan.
- But this only lowers inflation rate. (Mechanism not covered in this course).

Student Discussions (Page Intentionally Left Blank)

Summary

By the end of this class, you should be able to understand the following:

- The monetary intertemporal model.
- Derivation of the Fisher relation.
- Construction of the competitive equilibrium.
- The effects of changes in money supply and demand.
- The measurement of money supply.
- The concept of liquidity trap and quantitative easing policies.

Disclaimer

The slides for this course have been made available to students for the sole purpose of self study. They should not be disseminated without prior permission, nor should they be re-used for commercial purposes. The material draws on, among others:

- S. D. Williamson, Macroeconomics, Pearson Education, 5th edition.
- Andrew B. Abel, Ben S. Bernanke, and Dean Croushore, Macroeconomics, 9th edition, Pearson.