We have previously examined the static consumption-leisure choice, incorporated it into a model of intertemporal choice of consumption and leisure, as well as money demand.

In the current section, we will look at many agents making these choices at the same moment in time.

From their interaction, we will see how the price level and the interest rate are determined, and what are the corresponding quantities of money, goods and bonds which clear the money, commodity and bonds markets.

The novelty is the equilibrium concept:
Relating individual decision to their impact on market clearing prices.
1 Competitive Equilibrium

- Consider a Crusoe-type of household.
  - Crusoe has a production function. He may choose how many hours to work and, therefore, how much to produce.
  - He can sell his production in the marketplace in exchange for currency.
  - With money, he can buy bonds and accumulate goods for tomorrow.

- We want to consider many economic agents like Crusoe and look into their interaction in the marketplace.

- We will use the term “generalized Crusoe economy” to designate the economy of households choosing labor supply, consumption, bond holdings and real balances simultaneously.

- In this setup, we will define a competitive equilibrium as follows:

**Definition 1** A Competitive Equilibrium (CE) in the generalized Crusoe economy is a set of prices \((P, R)\) and quantities \((c, l, b, \bar{m})_{i,t}\), for all households \(i = 1, \ldots, N\) and time periods \(t = 1, 2\), such that, i) Given prices \((P, R)\), the quantities \((c, l, b, \bar{m})_i\) solve household \(i\)'s problem (to be specified below); ii) The markets of goods, bonds and money clear.
• Market clearing implies that:
  
  – Total demand of goods equals total supply;
  
  – Aggregate bond holdings are zero (because any dollar borrowed must be lent by somebody);
  
  – Money supply equals money demand.

  These are the “aggregate consistency conditions” in Barro.

• No “labor market” clearing because we are (for now) dealing with “home production.”
  The condition “labor demand equal labor supply” is for now solved at the household level.

• We will assume that the interest rate $R$ and the price $P$ adjust so that the quantities demanded and supplied in each of the three markets are equal. This is what Barro calls the “market-clearing approach.”

• When markets clear, every household can buy/sell as much as it wants of every commodity, and to extend or receive credit in the amount desired. When markets clear, $(R, P)$ will adjust to make sure that this is the case.

• We may ask ourselves whether it would be desirable to consider some other resource allocation device.

  – For example, suppose we gave all the goods produced in the economy to a government.

  – Could this government redistribute those resources in a way that each person had at least the same utility as before and maybe some got strictly more utility than initially?
• If the answer to this question were “yes,” then the CE we described would not be efficient:
People could be made strictly better off with the same resources available in the economy.

• If the government could do better than the market, then we would prefer some centralized system of resource allocation, where prices would play no role.

• It can be shown, under some conditions, that the CE described above is efficient in the sense that resources cannot be redistributed and make someone better off without someone else being made worse off.
  
  – This amounts to assuming that the actions of market participants – in the pursuit of their selfish interests exclusively – will lead to efficient outcomes.

• Since the market achieves efficiency, we will stick to our Competitive Equilibrium/Market-Clearing approach and study its prices and quantities.
2 Walra’s Law of Markets

• Keep in mind our Crusoe (C) type of problem.

• C faces price \( P \) in the goods market; the interest rate \( R \) is the return for bonds.

• Let \( c^d_1 \) denote C’s first period consumption **demand**. This means that \( c^d_1 \) is the quantity C would like to consume in the first period, given prices \((P, R)\).

• Suppose he got \( y^s_1 \) goods from operating his production function. This quantity has superscript \( s \) because C will go on the market and sell those goods for money, at price \( P \).

• Let \( b^d_1 \) and \( \bar{m}^d_1 \) denote C’s first-period demand of bonds and money.

• If C’s household carries over \( b_0 \) and \( m_0 \) from period 0, his first-period resource constraint is:

\[
y^s_1 + b_0 (1 + R) / P + \bar{m}_0 / P = c^d_1 + b^d_1 / P + \bar{m}^d_1 / P. \tag{1}
\]

• Suppose we add these quantities across all households. If there were \( N \) households just like C, the total quantity of goods supplied in period 1, \( Y^s_1 \), would be \( N y^s_1 \).

• Summing over all other quantities in (1), we get:

\[
Y^s_1 + B_0 (1 + R) / P + M_0 / P = C^d_1 + B^d_1 / P + M^d_1 / P. \tag{2}
\]
• Since every dollar borrowed must correspond to a dollar lent, we must have 
  \[ B_0 = 0. \]

• Using this fact and rearranging (2), we get:
  \[ \left( C_1^d - Y_1^s \right) + \left( M_1^d/P - M_0/P \right) + B_1^d/P = 0. \]  
  \[ (3) \]

• Remember the market-clearing conditions associated with the CE of the 
  generalized Crusoe economy:
  - \( C_1^d = Y_1^s \) — goods' demand and supply are equal;
  - \( B_1^d = 0 \) — any dollar borrowed must be lent by somebody;
  - \( M_1^d = M_0 \) — people willingly hold the outstanding stock of money, \( M_0 \).

• Now suppose that the goods market and the money market clear:
  \[ C_1^d = Y_1^s \quad \text{and} \quad M_1^d = M_0. \]

• Then, from (3), we get that the third market clearing condition is auto-
  matically satisfied:
  \[ B_1^d = 0. \]

• In general, whenever we consider \( n \) markets, if \( n - 1 \) clear, then the \( n \)-th 
  market has to clear, as well.

• This condition is called the \textbf{Walra's Law of Markets}, after Léon Walras, 
  a french 19th century economist.
• The intuition for this is that the “imbalance” in one market must be compensated by some other imbalance in another market.

• If \( n - 1 \) markets clear, the \( n \)-th market must clear as well as there is no compensating imbalance anywhere else.

• We will therefore have to consider whether 2 of our 3 markets clear, only. It does not matter which specific 2 markets we examine, for this purpose.

• We will focus on the commodity market and the money market. But the results would not change if we considered the bonds' market instead.

3 The General Equilibrium Model

• We consider first the commodity market, and start with period 1.

• We have represented Crusoe’s production technology by the production function:

\[
y_t = f(l_t).
\]

For example,

\[
y_1 = A + Bl_1.
\]

• This is simply a statement about technology: Given values of \( A \) and \( B \), and a value for the input \( l_1 \), \( y_1 \) is the resulting output.
To get to the supply function of a household, we need to take into account how $l_1$ optimally responds to changes:
- Interest rate changes,
- Wealth effects (parallel shifts in the production function – summarized in $A$), and
- Changes in the curvature of the production function (combined changes in $A$ and $B$).

From the intertemporal choice section, we saw that interest rate changes had both wealth and substitution effects over consumption and leisure. The intertemporal substitution effect of a higher interest rate (where wealth was held fixed) made people want to consume more in the future and reduce current consumption; it also made people want to raise future leisure and reduce current leisure (raise current hours, reduce the future work load).

We also saw that the wealth effect associated with a higher interest rate was positive for a net lender and negative for a net borrower.

It is hard to predict how the wealth effect will alter aggregate consumption and leisure if we allow for heterogenous individuals, some of which borrow, some of which lend. For this reason, and also because the redistributive effects from heterogeneity are likely quantitatively small, we have considered the wealth effect for the average bond holding position: zero. For someone who is neither borrowing nor lending, the wealth effect was null. Therefore, we are left with the (pure) intertemporal substitution effect.

Therefore, higher interest rates have unambiguous effects:
- They reduce current consumption and raise future consumption, and
- They raise current hours worked and reduce the future workload.
• We conclude from the analysis that

\[ l_1^* = l_1^* \left( \frac{\mathbf{R}}{\mathbf{R}}, \ldots \right). \]

• Once we insert the optimal choice of hours given above into the production function \( y = f(l) \), we get a positively sloped supply curve:

\[ y_1^* = f \left( l_1^* \left( \frac{\mathbf{R}}{\mathbf{R}}, \ldots \right) \right). \tag{4} \]

• The aggregate supply function in our model, \( Y^s \left( \frac{\mathbf{R}}{\mathbf{R}}, \ldots \right) \), can be interpreted as the adding up over consumers of the relationship between \( y_1 \) and the interest rate \( R \), given in equation (4).

• It is no longer simply a technological equality. It already includes the optimal choice of labor in period 1, which we have already found and substituted in the production function. [Plot.]

• The dots in \( y_1^* \), which carried over to aggregate supply \( Y^s \left( \frac{\mathbf{R}}{\mathbf{R}}, \ldots \right) \), represent the other things that affect labor supply: Wealth effects and effects that come from the change in the curvature of \( f(l) \). When one of these other elements changes, they generate shifts (dislocations) of the supply curves (individual and aggregate), on the (output, \( R \)) plane.
• What about aggregate demand for period 1 consumption?

• Again, we evaluate individual demand for first period consumption at the average bond holding position, \( b_1 = 0 \).

• Given this, we know from the intertemporal substitution effect that a higher interest rate:
  – Reduces demand for current consumption and
  – Raises demand for future consumption:

\[
 c^*_1 = c^*_1(\bar{R}, \ldots).
\]

Therefore, individual demand is negatively sloped in the \((c, R)\) plane.

• Aggregate demand is the sum over households of the consumption demand given in (5):

\[
 C^d = C^d(\bar{R}, \ldots).
\]

The slope is of the same sign as that of individual demand.

• Once again, the dots on the right-hand side of the demand curves stand for the wealth and substitution effects arising from changes in the production function. Such changes cause the aggregate demand curve to shift in the \((output, R)\) plane.

• We may now plot both aggregate demand and aggregate supply in the \((output, R)\) plane. The response of aggregate supply and demand to changes in \(R\) can be read off movements along the respective curves.
• The intersection of both curves gives us the market clearing interest rate, \( R^* \).

• Formally, the equilibrium interest rate is such that:

\[
Y^S(R^*, \ldots) = C^d(R^*, \ldots),
\]

and market clearing in the goods’ market determines the equilibrium interest rate.

• Note that the price level \( P \) does not affect commodity market-clearing. We might have expected that higher \( P \) raised supply and discouraged demand. Below we examine some of the reasons why \( P \) does not affect the equilibrium in the good’s market.

• Changes in \( P \) do not affect real income earned from selling output, \( Pf(l)/P \). Therefore, given that these changes do not affect real income, we know that consumption demand and labor supply will not be affected by \( P \).

• Holding fixed the interest rate, “once-and-for-all” changes in the price level do not affect the relative cost of consumption and leisure over different periods. Thus, once again, \( P \) does not affect aggregate demand and supply.
• We have another yet equilibrium condition to examine, concerning the money market.

• In the previous section, we derived the aggregate demand for real balances as

\[ \frac{M^d}{P} = \Phi \left( -\frac{1}{R}, C, \ldots \right). \]

This function was obtained by adding up over individual households’ average money demand functions.

• Recall that \( \Phi_R < 0, \Phi_C > 0, \Phi_{\gamma/P} > 0. \)

• Since \( C = Y \) in equilibrium, we will in fact use the notation \( \Phi (R, Y, \ldots) \) to denote the aggregate demand for real balances.

• Nominal money demand was obtained by multiplying \( \Phi (\cdot) \) by the price level:

\[ M^d = P \Phi (R, Y, \ldots). \]

The dots in the demand for real balances indicate other things that shift the demand for money.
One example is transactions costs.

• Since \( R_{CE} \) and \( C \) are determined through the goods market-clearing condition, we are able to pin down the price level by imposing that the existing nominal money stock be willingly held:

\[ M = P \Phi (R, Y, \ldots) \iff P = \frac{M}{\Phi (R, Y, \ldots)}. \quad (6) \]

• The quantity \( M \) is the nominal money stock.
• On the \((\text{Money}, P)\) space, the money demand equation is a positively sloped line.
  
  The stock of money \(M\) is simply a vertical line.
  
  The intersection point gives us the equilibrium price level, \(P^*\).

\[ \text{3.1 A Mathematical Excursion} \]

• Here, we find analytical solutions to the general equilibrium model we have been discussing.

  Given the assumption that the costs from holding money do not affect the desired amount of consumption, we focus on the goods market only.

• Consider an economy formed of people just like Crusoe, denoted \(C\) for simplicity.

• We will consider \(C\) making choices over two periods.
  
  We can think of these two periods as “now” vs later; today vs the future.
• He can choose how much to consume and work in periods 1 and 2: \((c_1, l_1, c_2, l_2)\).
  As usual, \(l_j \in [0, 1], \ j = 1, 2\).

• He can also choose how much to save: \(b_1\).

• His production function in period 1 is given by:
  \[y_1 = A_1 + B_1l_1,\]
  and similarly for the production function in period 2.

• The reason to consider different parameters \(A\) and \(B\) in the two periods
  is to be able to separate between temporary and permanent effects.

• Crusoe’s utility function is:
  \[u(c, l) = \ln(c_1) + \ln(1 - l_1) + \beta [\ln(c_2) + \ln(1 - l_2)],\]  
  \((7)\)
  with \(\beta \in (0, 1)\).

• The constraints faced by Crusoe are:
  \[P[A_1 + B_1l_1] = Pc_1 + b_1\]  
  \((8)\)
  \[b_1 (1 + R) + P[A_2 + B_2l_2] = Pc_2.\]  
  \((9)\)

• Solving (8) for \(b_1\) and substituting in (9), we get the familiar present-value
  resource constraint:
  \[P \left[ A_1 + B_1l_1 + \frac{A_2 + B_2l_2}{1 + R} \right] = P \left[ c_1 + \frac{c_2}{1 + R} \right].\]  
  \((10)\)
Crusoe’s problem is, of course, to maximize (7) by choice of consumption and labor in both periods, subject to (10).

As usual, we will use (8) (or (9)) to recover optimal savings, \( b_1 \), by plugging in the optimal consumption and labor choices.

The Lagrangian is given by:

\[
L(c_1, c_2, l_1, l_2, \lambda) = \ln(c_1) + \ln(1-l_1) + \beta [\ln(c_2) + \ln(1-l_2)] + \lambda P \left[ A_1 + B_1 l_1 + \frac{A_2 + B_2 l_2}{1+R} - c_1 - \frac{c_2}{1+R} \right].
\]

First-order conditions include:

\[
\frac{1}{c_1} = \lambda P \tag{11}
\]

\[
\frac{1}{1-l_1} = \lambda P B_1 \tag{12}
\]

\[
\beta \frac{1}{c_2} = \frac{\lambda P}{1+R} \tag{13}
\]

\[
\beta \frac{1}{1-l_2} = \frac{\lambda P B_2}{1+R} \tag{14}
\]

The derivative with respect to \( \lambda \) delivers the present-value budget constraint, (10).
Using (11) and (12) we get:

\[ l_1 = 1 - \frac{c_1}{B_1}. \]  \hspace{1cm} (15)

Using (11) and (13) we get:

\[ c_2 = c_1 \beta (1 + R). \]  \hspace{1cm} (16)

Using (13) and (14):

\[ l_2 = 1 - \frac{c_2}{B_2}, \]  \hspace{1cm} (17)

which, coupled with 16, yields:

\[ l_2 = 1 - \frac{c_1 \beta (1 + R)}{B_2}. \]  \hspace{1cm} (18)

We can use (15), (16) and (18) to substitute in the budget constraint and get an expression for \( c_1^* \):

\[
A_1 + B_1 \left[ 1 - \frac{c_1}{B_1} \right] + \frac{1}{1 + R} \left[ A_2 + B_2 \left( 1 - \frac{c_1 \beta (1 + R)}{B_2} \right) \right] = c_1 + \frac{c_1 \beta (1 + R)}{1 + R},
\]

which implies:

\[ c_1^* = \frac{1}{2(1 + \beta)} \left[ A_1 + B_1 + \frac{A_2 + B_2}{1 + R} \right]. \]  \hspace{1cm} (19)

We now plug (19) in (15), (16) and (18) to get the optimal choices of
second period consumption, as well as labor in periods 1 and 2:

\[ c_2^* = \frac{\beta (1 + R)}{2(1 + \beta)} \left[ A_1 + B_1 + \frac{A_2 + B_2}{1 + R} \right] \]  \hspace{1cm} (20)

\[ l_1^* = 1 - \frac{1}{2(1 + \beta)} \left[ \frac{A_1 + B_1}{B_1} + \frac{A_2 + B_2}{B_1 (1 + R)} \right] \] \hspace{1cm} (21)

\[ l_2^* = 1 - \frac{\beta}{2(1 + \beta)} \left[ (1 + R) \frac{(A_1 + B_1)}{B_2} + \frac{A_2 + B_2}{B_2} \right]. \] \hspace{1cm} (22)

- Plugging the optimal labor supply in period 1, given by (21), into the period 1 production function:

\[ y_1^* = \frac{(1 + 2\beta)}{2(1 + \beta)} (A_1 + B_1) - \frac{1}{2(1 + \beta)(1 + R)} (A_2 + B_2). \] \hspace{1cm} (23)

- Finally, to obtain \( b_1^* \):

\[ b_1^* = P \left[ \frac{\beta}{1 + \beta} (A_1 + B_1) - \frac{1}{(1 + \beta)(1 + R)} (A_2 + B_2) \right]. \] \hspace{1cm} (24)

- The market clearing interest rate \( R_{CE} \), which makes \( b_1^* = 0 \) is:

\[ R_{CE} = \frac{A_2 + B_2}{\beta (A_1 + B_1)} - 1. \] \hspace{1cm} (25)

Note that we do not need to add across households and determine the aggregate demand for bonds in order to find \( R_{CE} \). The reason is that the equilibrium condition requires every household’s bond demand to be zero (since they are all identical). Given this, imposing \( b_1^* (R, \ldots) = 0 \) is equivalent to imposing \( B_1^* (\cdot) = 0 \).
• Equations (19) through (24) give us the equilibrium quantities in the real side of our model. 
Equation (25) gives us the market-clearing interest rate. 
This is all we need to characterize the real side of the economy.

• From the previous section, we had that the individual demand for real balances was:

\[
\frac{\bar{m}}{P} = \phi \left( R, c, \frac{\gamma}{P} \right) = \sqrt{\frac{\gamma}{2PR}}.
\]

The aggregate demand for \( N \) households identical to this one is:

\[
\frac{M^d}{P} = N \sqrt{\frac{\gamma}{2PR}} = \sqrt{\frac{N \gamma}{2PR}} = \sqrt{\frac{N \gamma Y}{2PR}}.
\]

• Therefore, the equilibrium condition in the money market is:

\[
M = P \sqrt{N \frac{\gamma Y}{2PR}},
\]

and the equilibrium price level \( P^* \) is

\[
P^* = \frac{M}{\sqrt{N \frac{\gamma Y}{2PR}}}.
\]
4 Supply Shocks

4.1 Temporary Parallel Shift in the Production Function

- Consider initially a reduction in $A_1$. This causes the production function in period 1 to shift downward in a parallel fashion (on the $(l, y)$ plane).

- This initial change in the production function output is simply a technological fact. Maybe it was caused by a drought (in the US, 1988), a coal strike (UK), an oil shock...

- Since there was no change in the slope of the production function, this is a pure (negative) wealth effect.

- C would like to reduce $(c_1, c_2)$ and reduce leisure — which implies raising $(l_1, l_2)$ — assuming that consumption and leisure in all periods are normal goods.

- Because of the technological shock, with the same inputs (labor) the economy generates less output.

- This causes the $Y^s(R, \ldots)$ to shift to the left: for the same interest rate, the economy produces less.
• It is important to note that the shift of the $Y^s(R,\ldots)$ schedule is smaller than the reduction of output if labor was held constant.

• On the $(Y,L)$ plane, we may depict the change in output caused by the reduction in $A_1$.
  Consider the reduction in output that takes place for fixed $L$.
  This reduction is of greater magnitude than the dislocation of $Y^s(R,\ldots)$ to the left.

• The reason for this smaller change in output compared to the technological shift, for fixed interest rates, is the fact that the negative wealth effect induces people to work more.

• Since $Y^s(R,\ldots)$ already includes the optimal labor choices — which incorporate the negative wealth effect — the shift to the left is smaller than the technological reduction in production, *holding labor fixed*.

• Since there is a negative wealth effect, $C$ also wants to consume less.

• This causes the $C^{d}(R,\ldots)$ schedule to shift to the left, as well.

• For the initial interest rate (the value of $R$ which cleared the commodity market before $A_1$ changed), $C$ is thinking of reducing his bond holdings.

• By doing this, he intends to divide the negative wealth effect between today and tomorrow.
• Based on this intuition, we conclude that the horizontal shift of the $Y^s (R, \ldots)$ schedule is greater than that of the $C^d (R, \ldots)$ schedule.

• (You can check this is the case by verifying that $|dy_1/dA_1| > |dc_1/dA_1|$, using equations (23) and (19).)

• This implies that, at the going interest rate, there is excess demand for goods.

• Since the economy as a whole cannot borrow, the interest rate must go up to make people want to consume less today and work (even) more.

• As a consequence, the new interest rate that clears the commodity market $(R^*)'$ is now higher than initially:

$$ (R^*)' > R^*.$$

• The higher interest rate reinforces the increase in labor already in place due to the negative wealth effect.

• Equilibrium output is now unambiguously lower: $(Y^*)' < Y^*$.
  Labor supply is unambiguously higher: $(L^*)' > L^*$.

• In this case, we have a counterfactual outcome:
  Labor and output move in opposite directions.
  Over the business cycle, this is not so:
  Labor is a strongly procyclical variable.

• What about money holdings?

• We now that real balances depend negatively on the interest rate $R$ and positively on consumption (output $Y'$).
• Both changes (lower output and higher interest rate) make people want to hold less money, in real terms.

• This causes the curve $P\Phi (R,Y,\ldots)$ to shift upward (or to the left).

• Since the money stock is constant, the general price level will go up to restore equilibrium in the money market.

• We see that negative shocks to the production function lead to opposing effects on output (negative) and prices (go up).

• Adjustment process?
  
  – People want to save less (or borrow from tomorrow).

  – Pressure on the loans market induces interest rate to rise.

  – Excess demand for commodities induces producers to raise prices, which causes general price level to go up.

• Suppose that the negative shock on the production function comes from an increase in the price of oil.

• The raise in the price level and the higher interest rate are consistent with recent US experience associated with the oil shocks of the 1973-74 and 1979.
• One should not conclude that a higher price in a particular commodity causes the general price level to rise. Oil is an extremely important input in the production of most economic sectors. Because it is an important input in production (source of energy), higher oil prices tend to deter the production of many goods. In addition, net oil importers (most countries) experience a reduction in the disposable income for consumption. These effects were captured in our negative wealth effect.

• Other goods need not have similar effects at all. If there is a scarcity of grain in Europe, say, because of climate related reasons, a country such as the US – a net exporter of cereal – will benefit: The price of cereal will go up, raising the revenue from exports.

• In the US, the grain shortage will amount to a temporary upward shift in the production function. This generates an increase in the real quantity of money demanded, leading to a reduction in the general price level.
4.2 Temporary Rotation of the Production Function

- Suppose we consider a temporary downward rotation in the production function.
  This would correspond to a decline in $B_1$.

- We saw earlier that this kind of substitution effect can be decomposed into a wealth effect and a “pure” substitution effect.
  The “pure” substitution effect would amount to a downward rotation of the production function going through the original output choice.
  The wealth component would then be the parallel downward shift of the intermediary production function toward the new production function with lower $B_1$.

- We have already analyzed what happens after a pure wealth effect.
  That takes care of the first part of the downward rotation in the production function.
  We next consider the changes that come from the pure substitution effect, only.
• What are the new effects that we must add to our analysis?

• The reduction in the marginal product of labor causes people to want to substitute towards higher leisure today and reduce current consumption: Leisure becomes relatively cheaper compared to current consumption.

• In addition, current leisure becomes also more attractive compared to future consumption and leisure. This intertemporal effect reinforces the shift toward current leisure and the reduction in hours worked. The reduction in hours worked leads to a reduction in current income. Households want to spread this reduction in income over current and future consumption.

• Compared to the changes arising from the wealth effect, we have the following modifications:
  – The supply schedule $Y^s (\cdot)$ moves to the left, again. This is the consequence of the reduction in hours worked.
  – Aggregate demand $C^d (\cdot)$ moves the left, again, but by less than the new dislocation of supply. This is the consequence of the reduction in income and the fact that the household will try to spread such a reduction over both periods.

• We get that the initial effects on output and the interest rate are reinforced:
  – The interest rate is now higher than before.
  – Output goes down even further.
• There is one difference, however, vis-a-vis the pure wealth effect:
The lower productivity of today's labor caused current labor to go down initially.

• Since the new market clearing interest rate is higher than before, work
effort in the new equilibrium is higher compared to the initial impact of
the reduction in the marginal product of labor.

• If the net effect on today's labor were negative (meaning that labor is
lower in the new equilibrium than it was before the pure substitution effect
associated with the change in $B_1$),
and the reduction in in hours worked outweighed the increment from the
negative wealth effect,
we would get labor varying in the same direction as output.

• In this case, labor is procyclical, a fact consistent with US business cycles.

• The intuition for the reduction of labor input is the fact that the low
productivity makes it not worth to work hard.

• Consider the case of a crop failure, for example.
People want to work hard to compensate for the bad weather effects but
since there is not much to collect, working harder does not raise output.

• What about the money market?

• Again, the higher interest rate and the lower output reinforce the contrac-
tion of money demand.
Prices rise even further.
4.3 Permanent Change in the Production Function

- Suppose now that both $A_1$ and $A_2$ decline.

- Since the decrease in wealth is permanent (tomorrow will not be any better than today):
  - The reduction in consumption is much stronger today and
  - The increase in labor (the reduction in leisure) is much higher as well.

- There is no reason to expect people to want to borrow more or less than before the shock: We expect quantities demanded and supplied to fall by roughly the same amount.

- This being the case, the horizontal shift of $Y^s(R,\ldots)$ and $C^d(R,\ldots)$ should be about the same.

- Output falls but the market clearing interest rate should not change. Consumption goes down because of the wealth effect. Labor increases because of the wealth effect as well.

- Since output declines, real money demand goes down as well.

- The price level must rise to restore equilibrium in the money market.

- The main difference between this effect and the temporary change in the production function is the stable interest rate associated with the permanent effect.
• Higher interest rates indicate that the cost of using resources today is higher, compared to tomorrow:
  Today’s consumption and leisure are costlier in terms of tomorrow’s consumption and leisure, when interest rates go up.

• Therefore, for temporary changes in the production function, it makes sense that interest rates rise:
  Higher interest rates convey the scarcity of resources today compared to the future.

• When the changes are permanent, today is just as bad as tomorrow will be.
  There is no reason to expect higher interest rates.

• Adding a permanent change in the slope of the production function gives the same results, in general.

• There is still no reason to expect interest rates to change.

• The total effect (wealth plus substitution) on labor is ambiguous:
  – The wealth effect tends to make labor go up.
  – The lower productivity of labor tends to make people substitute towards more leisure.
5 Changes in the Stock of Money

• What happens if the stock of money changes?

• Say the Central Bank prints some new bills today. What are the implications for our analysis?

• Market clearing in the commodity market does not depend on the price level or stock of money:
  \[ Y^s (R, \ldots) = C^d (R, \ldots) . \]
  Therefore, nothing in the real side of the economy changes in response to a larger stock of money.

• Let us rewrite the condition that money be willingly held:
  \[ M = P \Phi (R, Y, \ldots) . \]
  The demand for real balances does not depend on \( M \), and the variables it does depend on – the interest rate, output, ... – have not changed.

• For the market for money to clear, it must be the case that prices adjust. If \( M \) rises, it must be the case that \( P \) goes up in the same proportion. [Plot.]

• These results display one important property, the neutrality of money. One time changes in the stock of money affect nominal variables but do not have real effects: If \( M \) doubles, the price level rises two-fold and so does the nominal value
of consumption, $PC$. But real output (and consumption) $Y$ does not change, neither do real balances $M/P$. The interest rate $R$ does not change as well. As the price of today’s consumption relative to tomorrow’s, it is more appropriate to think of the interest rate as a real variable.

- Our results agree with the predictions of the Quantity Theory of Money, which we examined earlier. Quantity “theorists” often think of monetary neutrality as a good description of long-run data; they allow for money to have real effects in the short-run, however. At this stage, our model does not allow for differentiated effects.

- **Monetarism** refers to a modern version of the quantity theory. As quantity theorists, monetarists view the quantity of money as the major determinant of the price level in the long run. They stress the necessity to control the quantity of money as a means of attaining price stability. They also view money as having important short-term effects over real variables. However, monetarists regard the short-term effects of money on the real activity as largely unpredictable and recommend a stable quantity of money as the best policy for avoiding erratic movements in real variables.

- The rise of monetarism in mainstream economics was due to Milton Friedman’s work. He was perhaps the greatest exponent of the Chicago School of Economics,
and won a Nobel Prize in 1976 for his achievements in the fields of consumption analysis, monetary history and theory and for his demonstration of the complexity of stabilization policy.
Friedman was extremely influential as an Economist, serving as an economic advisor to several American presidents – for example Ronald Reagan – and known for his influence over other important statespeople toward the implementation of monetarist ideas (the case of Margaret Thatcher).