Motivation

• Build a model of an open economy to study the determinants of the trade balance and the current account.

• Study the response of the trade balance and the current account to a variety of economic shocks
  – Changes in income
  – Changes in the world interest rate
  – Changes in commodity prices (e.g., oil, grain).

• Pay special attention to how those responses depend on whether the shocks are perceived to be temporary or permanent.
A Small Open Economy

What does ‘small’ and ‘open’ mean in this context?

- An economy is small when world prices and interest rates are independent of domestic economic conditions.
- An economy is open when it trades in goods and financial assets with the rest of the world.
- Most countries in the world are small open economies:
  - Examples of developed small open economies: the Netherlands, Switzerland, Austria, New Zealand, Australia, Canada, Norway.
  - Examples of emerging small open economies: Chile, Peru, Bolivia, Greece, Portugal, Estonia, Latvia, Thailand.
  - Examples of large open economies: United States, Japan, Germany, and the United Kingdom.
  - Examples of large emerging economies: China, India
  - Examples of closed economies: Perhaps the most notable cases are North Korea, Venezuela, and to a lesser extent Cuba and Iran.
- Economic and geographic size not necessarily related: Australia and Canada vs. UK and Japan.
The Model Economy

• A two-period small open economy: periods 1 and 2.

• Households receive endowments $Q_1$ and $Q_2$ in periods 1 and 2, respectively.

• Initial wealth $(1 + r_0)B_0^*$ inherited from the past. Here, $B_0^*$ are bonds that paid the interest rate $r_0$.

• In period 1, households choose consumption, $C_1$, and bond holdings, $B_1^*$, which pay the interest rate $r_1$. 
Sequential Budget Constraints

The period-1 budget constraint

\[ C_1 + B_1^* - B_0^* = r_0 B_0^* + Q_1. \]  (1)

The period-2 budget constraint

\[ C_2 + B_2^* - B_1^* = r_1 B_1^* + Q_2, \]  (2)

Because the world ends after period 2, no one is going to be around to pay or collect debts. So bond holdings must be nil at the end of period 2, that is,

\[ B_2^* = 0. \]  (3)

This expression is known as the transversality condition.
The Intertemporal Budget Constraint

Combine (1), (2), and (3) to eliminate $B_1^*$ and $B_2^*$. This yields
\[ C_1 + \frac{C_2}{1 + r_1} = (1 + r_0)B_0^* + Q_1 + \frac{Q_2}{1 + r_1}. \]  
(4)

This is the intertemporal budget constraint. It says that the present discounted value of the endowment plus the initial financial wealth (the right-hand side) must be enough to pay for the present discounted value of consumption. (the left-hand side).

The following figure provides a graphical representation of the the intertemporal budget constraint.
The intertemporal budget constraint

\[ (1+r_1)Q_1 + Q_2 = - (1+r_1) \]

Slope: \(- (1+r_1)\)
Observations On The Intertemporal Budget Constraint

• It’s slope is \(-(1+r_1)\), because if you sacrifice one unit of consumption and put it in the bank for one period, you get \(1+r_1\) units next period.
• The set of feasible consumption baskets are those inside or at the borders of the triangle formed by the vertical line, the horizontal line, and the intertemporal budget constraint.
• Points outside that triangle are infeasible.
• What feasible point will the household choose depends on its preferences. We turn to this issue next.
The Lifetime Utility Function
We assume that the household happiness increases with consuming goods in periods 1 and 2. We assume that the lifetime utility function is of the form

$$\ln C_1 + \ln C_2,$$

where ln denotes the natural logarithm. Other specifications are possible.

Indifference Curves
An indifference curve is the set of consumption baskets \((C_1, C_2)\) that delivers the same level of welfare.

The following figure displays examples of indifference curves.
Indifference Curves
Properties of Indifference Curves

• If $C_1$ and $C_2$ are goods (i.e., objects for which more is preferred to less), indifference curves are downward sloping.
• An indifference curve located northeast of another one yields higher utility.
• Through each point crosses one indifference curve; they densely populate the positive quadrant.
• Indifference curves do not cross one another. • Indifference curves we focus on are convex. If you are consuming a lot in period 1 and almost nothing in period 2, you are not willing to give up much period-2 consumption for an additional unit of consumption in period 1. But if you are consuming almost nothing in period 1 and a lot in period 2, you are willing to give up much period-2 consumption for an additional unit of consumption in period 1. This is known as diminishing marginal rate of substitution of $C_2$ for $C_1$. 
The Household Utility Maximization Problem

- The household chooses consumption in periods 1 and 2 to maximize its utility function, subject to its intertemporal budget constraint.
- The next slide provides a graphical representation of how the optimal consumption basket is determined. For simplicity, the graph is drawn assuming zero initial assets, $B_0^* = 0$. The optimal consumption basket is point $B$. This point is on the intertemporal budget constraint and belongs to an indifference curve that is tangent to the intertemporal budget constraint.
- At point $B$, the household consumes more than its endowment. This means that it must borrow in period 1. In period 2, the household consumes less than his endowment, and uses the difference to pay back its debt including interest.
- The optimal level of consumption does not need to be higher than the endowment. Whether consumption is higher, equal, or lower than the endowment depends on preferences, present and future endowments, initial wealth, and the interest rate.
The Optimal Consumption Basket
Deriving the Optimal Consumption Basket

Formally, the household problem is

$$\max_{\{C_1, C_2\}} \ln C_1 + \ln C_2$$

subject to

$$C_1 + \frac{C_2}{1 + r_1} = (1 + r_0)B_0^* + Q_1 + \frac{Q_2}{1 + r_1}.$$ 

The household takes as given all objects on the right-hand side of the intertemporal budget constraint. Therefore, to save notation, let’s call the right-hand side $W$ (for lifetime wealth). Solve the intertemporal budget constraint for $C_2$ to get

$$C_2 = (1 + r_1)(W - C_1) \quad (5)$$

Use this expression to eliminate $C_2$ from the lifetime utility function.
Deriving the Optimal Consumption Basket (Continued)

The household maximization problem then becomes

$$\max_{\{C_1\}} \ln C_1 + \ln[(1 + r_1)(W - C_1)]$$

To maximize this expression, take the derivative with respect to $C_1$, equate to zero, and solve for $C_1$. This yields

$$C_1 = \frac{1}{2} W.$$  \hspace{1cm} (6)

Intuitively, the household consumes half of its lifetime wealth. Combining (5) and (6) yields

$$C_2 = \frac{1}{2} W (1 + r_1).$$  \hspace{1cm} (7)

This is also intuitive. The household consumes half of $W$ in period 1 and puts the other half in the bank, receiving $\frac{1}{2} W (1 + r_1)$ for consumption in period 2.
Deriving the Optimal Consumption Basket (Continued)

Now recall that \( W = (1 + r_0)B_0^* + Q_1 + \frac{Q_2}{1 + r_1} \) to write (6), as

\[
C_1 = \frac{1}{2} \left[ (1 + r_0)B_0^* + Q_1 + \frac{Q_2}{1 + r_1} \right]
\]

According to this expression, consumption is increasing in \( Q_1 \), \( Q_2 \), and \( (1 + r_0)B_0^* \), and decreasing in the interest rate \( r_1 \).

It is clear from the that the response of consumption to an increase in current output depends crucially on what households expect to happen with future consumption. If the increase in \( Q_1 \) is temporary, so that \( Q_2 \) is not expected to change, then consumption increase by \( 1/2 \) the change in output. Households the other leave half for future consumption. But if the increase in \( Q_1 \) is expected to be associated with an equal increase in \( Q_2 \), household consume most of the output increase (a fraction \( (1 + r_1/2)/(1 + r_1) \)). In this case there is no need to leave much for tomorrow, because output will also be high next period.

We do not observe \( Q_2 \) in period 1, so the reaction of \( C_1 \) allows us to infer whether the change in \( Q_1 \) is temporary or permanent.
The Trade Balance and the Current Account

We can now answer the question posed at the beginning: What determines the trade balance and the current account? The trade balance is the difference between output and consumption, \( TB_1 = Q_1 - C_1 \). If desired consumption is less than output, the economy exports goods to the rest of the world. If output falls short of desired consumption, the economy imports goods from the rest of the world.

Replacing \( C_1 \) by its optimal value, we obtain

\[
TB_1 = \frac{1}{2} \left[ -(1 + r_0)B_0^* + Q_1 - \frac{Q_2}{1 + r_1} \right]
\]

The current account equals the trade balance plus investment income, given by \( r_0 B_0^* \). Thus,

\[
CA_1 = \frac{1}{2} \left[ -(1 - r_0)B_0^* + Q_1 - \frac{Q_2}{1 + r_1} \right]
\]
Free Capital Mobility and the Determination of the Interest Rate

We assume that there is free international capital mobility. That is, households can borrow and lend in the international financial market. Let $r^*$ be the world interest rate. Then, free capital mobility guarantees that the domestic interest rate be equal to the world interest rate. That is,

$$r_1 = r^*$$

Any difference between $r_1$ and $r^*$ to give rise to an arbitrage opportunity that would allow someone to make infinite profits. For instance if $r_1 > r^*$, then one could make infinite amounts of profits by borrowing in the international market and lending in the domestic market. Similarly, if $r_1 < r^*$, unbounded profits could be obtained by borrowing domestically and lending abroad. These opportunities disappear when $r_1 = r^*$. 
Effect of a Temporary Output Shock on the Current Account

Suppose that output increases in period 1, but is expected not to change in period 2. That is, assume that

\[ \Delta Q_1 > 0 \text{ and } \Delta Q_2 = 0 \]

Then, differentiating the expression for the current account obtained in the previous slide, we have

\[ \Delta CA_1 = \frac{1}{2} \Delta Q_1 \]

The current account improves by half the increase in output. Households know the output increase is temporary. So, because they like to smooth consumption over time, they save half of it for consumption next period.
Effect of a Permanent Output Shock on the Current Account

Suppose that output increases by the same amount in both periods 1 and 2. That is, assume that

$$\Delta Q_1 = \Delta Q_2 > 0$$

Then, differentiating the expression for the current account obtained in the previous slide, we have

$$\Delta CA_1 = \frac{1}{2} \left[ \Delta Q_1 - \frac{\Delta Q_2}{1 + r^*} \right]$$

Since $\Delta Q_1 = \Delta Q_2$, we can write

$$\Delta CA_1 = \frac{1}{2} \frac{r^*}{1 + r^*} \Delta Q_1$$

The increase in the current account is now only a fraction $\frac{1}{2} \frac{r^*}{1 + r^*}$ of output, much smaller than in the case of a temporary shock. Why save a large part of the output increase if output is also expected to increase next period.
A General Principle

If you lose your lunch money one day, it’s not a problem. You simply borrow from a friend. Next time, you pay his lunch. However, if you father cuts your monthly allowance, you will have to make plans to reduce your spending accordingly. We have seen that a similar principle is at work with the current account. We summarize this principle as follows:

*Finance temporary output shocks (by running current account deficits or surpluses without much change in spending) and adjust to permanent output shocks (by changing spending, without much change in the current account).*
Terms-of-Trade Shocks

Thus, far we have assumed that there is just one good that can be consumed, imported, or exported. In reality, the final goods a country imports are different from the goods it exports. Consider, for instance, an oil producing country that exports oil and oil derivatives and imports consumption goods, such as food, textiles, electronics, etc.

Changes in the relative price of exports can have macroeconomic effects on consumption, the trade balance, and the current account. We will show that these effects are very similar to endowment shocks.

The relative price of exportable goods in terms of importable goods is known as the terms of trade. Letting $P^X$ denote the price of exportables and $P^M$ the price of importables, the terms of trade, which we denote by $TT$, are given by

$$TT = \frac{P^X}{P^M}$$
Importable Goods, Exportable Goods, and the Terms of Trade

Suppose that the endowment $Q_1$ is a good that households do not consume, say oil. However, households can export this good at the world price $P^X_1$. The country does not produce consumption goods, say food, but can import them at the world price $P^M_1$. Before, bonds were denominated in the single consumption good. Now, assume that bonds are denominated in units of importable goods. The budget constraint of the household in period 1 is then given by

$$P^M_1 C_1 + P^M_1 B_1^* - P^M_1 B_0^* = P^M_1 r_0 B_0^* + P^X_1 Q_1.$$  

Dividing both sides by $P^M_1$, we obtain

$$C_1 + B_1^* - B_0^* = r_0 B_0^* + TT_1 Q_1. \tag{8}$$

Similarly, in period 2, the budget constraint of the household is

$$C_2 + B_2^* - B_1^* = r_1 B_1^* + TT_2 Q_2. \tag{9}$$
Terms-of-Trade Shocks Are Just Like Endowment Shocks

Combining (8) with (9) and the transversality condition (3), we obtain the the intertemporal budget constraint

\[ C_1 + \frac{C_2}{1 + r_1} = (1 + r_0)B_0^* + TT_1Q_1 + \frac{TT_2Q_2}{1 + r_1}. \]  

This expression is identical to its counterpart in the one-good model (see equation (4)), except that the endowments \( Q_1 \) and \( Q_2 \) in the one-good model are replaced by \( TT_1Q_1 \) anbd \( TT_2Q_2 \). By multiplying \( Q_1 \) by \( TT_1 \), we are expression the endowment of exportable goods (oil) in terms of importable goods (food), so that in the budget constraint all terms are measured in the same units.

The present economy is small, so it takes \( TT_1 \) and \( TT_2 \) as given, just as it takes as given \( Q_1 \) and \( Q_2 \). It follows that changes in the terms of trade are just like changes in the endowment.
Effect of Term-of-Trade Shocks on the Current Account

We have shown that terms-of-trade shocks are just like endowment shocks. It follows that the effect of a terms-of-trade shocks on the trade balance and the current account depend crucially on whether the terms-of-trade shock is perceived as temporary or permanent. Temporary changes in the terms of trade will tend to have large effects on the trade balance and the current account and permanent terms-of-trade shocks will tend to have a small effect.

*Finance temporary terms-of-trade shocks shocks (by running current account deficits or surpluses without much change in spending) and adjust to permanent terms-of-trade shocks shocks (by changing spending, without much change in the current account).*

We now test how this principle works in real life.
Temporary versus Permanent Terms of Trade Shocks

A Case Study of the Copper Price in Chile 2001-2013

Take a look at the next slide, which shows the real price of copper between 2001 and 2013.

Copper accounts for more than 50 percent of Chilean exports. Thus, variations in world copper prices represent important terms of trade shocks for Chile.
Real Price of Copper, Chile, 2001Q1-2013Q4

Data Source: Fornero and Kirchner, 2014.
Observations on the figure.

The copper price starts increasing in 2003 and stays high until 2013 (except for a short dip in 2009, during the Great Recession).

Look at the units on the vertical axis. Between 2003 and 2007 the real price of copper increases by almost 400 percent! This is an enormous price increase.

And this price increase was of the permanent variety, in the sense that the copper price stayed that high from 2006 to 2013.

What does our theory of current account determination say, should have happened to the CA between 2003 and 2007 in response to the copper price increase?

Recall the principle, "finance temporary shocks and adjust to permanent ones." Our theory thus predicts that the current account should be little changed.
Or if we assume that forward looking agents were anticipating the gradual increase of the copper price between 2003 and 2007 they should have initially borrowed against this permanent terms of trade appreciation. So our model predicts either no CA change or, if anything, a CA deterioration.

Let’s look if this prediction of our model is borne out in the data. What happened to the CA between 2003 and 2007?
... but the current account improved

The Current Account, Chile, 2001-2012

Source: Fornero and Kirchner, 2014.
What to make of this? Is the model wrong? Or was the model right but the change in the copper price was not the main shock hitting the Chilean economy at that point?

Is there a way that our model would predict that the CA response to the terms of trade appreciation is a current account appreciation?

Yes, our model would predict that provided the terms of trade appreciation was considered to be temporary. We already saw that the copper price increase was of a permanent type. But for our model what counts is not what is true ex post but what people were thinking while the copper price was sky-rocketing, that is, during 2003-2007.

Look at the next figure. It shows the 10-year ahead forecast of the price of copper, that is, the 2003 observations gives the forecast for the year 2013, and so on. Did people think the copper price increase was temporary or permanent.
... People expected the copper price increase to be **temporary**!

Ten-Year Forecast and Actual Real Price of Copper, Chile, 2001-2013

Data Source: Fornero and Kirchner, 2014.
Observations on the figure.

The circled-line shows the 10-year ahead forecast of the real copper price. This forecast remained at the 2003 level throughout the period 2003 to 2007. In 2003 the forecasted price for 2013 was 100, that is, the same price it had in 2003, and in 2007 it was only slightly higher, at 137. At that time the actual copper price was at 400. So, the figure shows clearly that agents did not expect the copper price increase to last.

That is, agent’s thought the copper price increase was temporary. In that case, our model predicts that the current account should appreciate, which is was indeed was observed.
Effect of an Interest Rate Shock

An increase in the world interest rate, $r^*$, has multiple, potentially conflicting, effects on consumption, the trade balance and the current account.

- **The Substitution Effect:** An increase in the interest rate makes savings more attractive, so households substitute present consumption with future consumption. Thus, consumption falls and the trade balance and the current account improve.

  \[
  \text{Substitution Effect: } r^* \uparrow \Rightarrow C_1 \downarrow, TB_1 \uparrow, CA_1 \uparrow
  \]

- **Wealth Effect:** An increase in the interest rate makes debtors poorer and creditors richer.

  \[
  \text{Wealth Effect: } r^* \uparrow \Rightarrow \begin{cases} 
  C_1 \downarrow, TB_1 \uparrow, CA_1 \uparrow & \text{if debtor} \\
  C_1 \uparrow, TB_1 \downarrow, CA_1 \downarrow & \text{if creditor}
  \end{cases}
  \]

Which effect dominates? We will assume that the substitution effect always dominates. This is the case in the economy with log preferences, as we show next.
Substitution and Wealth Effects: Which Dominates?

Consider the economy with log preferences analyzed earlier. We reproduce the equilibrium expression for consumption, the trade balance, and the current account:

\[ C_1 = \frac{1}{2} \left[ (1 + r_0)B^*_0 + Q_1 + \frac{Q_2}{1 + r^*} \right] \]
\[ TB_1 = \frac{1}{2} \left[ -(1 + r_0)B^*_0 + Q_1 - \frac{Q_2}{1 + r^*} \right] \]
\[ CA_1 = \frac{1}{2} \left[ -(1 - r_0)B^*_0 + Q_1 - \frac{Q_2}{1 + r^*} \right] \]

The first expression shows that consumption falls as the interest rate increases, and the last two expressions show that both the trade balance and the current account improve. In this economy, the substitution effect clearly dominates the wealth effect.

The next graph illustrates what happens when \( r^* \) goes up.
Adjustment to a World Interest Rate Shock

\[
\text{slope} = -(1 + \hat{r} + \Delta)
\]
Observations on the Graph

- The initial position is point $B$, where the economy is borrowing and the trade balance and the current account are negative.
- The increase in $r^*$ makes the intertemporal budget constraint rotate clockwise around the endowment point $A$, becoming steeper.
- The negative wealth effect is reflected in the fact that point $B$ is no longer feasible. This induces households to consume less.
- The substitution effect goes in the same direction. The higher interest rate makes future consumption more attractive.
- The new equilibrium is a point $B'$. There, consumption is lower and the trade balance and the current account both improve relative to the initial position.
Capital Controls
Sometimes, governments try to curb current-account deficits on the grounds that, by causing debt to increase, are the harbinger of crises and reduced consumption in the future.
• In their more severe form, capital controls prohibit international borrowing.
• Milder forms include taxes on international borrowing or on interest on external debt.
• Questions: Are capital controls effective in boosting future consumption? Are capital controls welfare enhancing?
• Take the strong form of capital controls; a regulation requiring that \( B_1^* \geq 0 \)
According to this regulation, it is allowed to lend to the rest of the world, but not to borrow from the rest of the world.
Capital Controls (continued)
The graph on the next page illustrates the situation. For simplicity, the figure assumes no initial debt or assets ($B_0^* = 0$)
• The unconstrained equilibrium is at point $B$. This point is located southeast of the endowment point $A$. This means that $C_1 > Q_1$ and that the economy is borrowing from the rest of the world ($B_1^* < 0$).
• When capital controls are imposed, the welfare maximizing consumption basket is the endowment, point $A$. There, borrowing is zero ($B_1^* = 0$).
• Answers to the questions posed above: yes, the restriction is effective in boosting future consumption (see the figure). No, capital control policy is not welfare enhancing. The indifference curve that crosses $A$ is down and to the left of the one that crosses $B$. 
Equilibrium Under Capital Controls

slope = $- (1 + r^*)$

slope = $- (1 + r_1)$
Capital Controls (continued)

Because the government prohibits international borrowing, the domestic interest rate no longer needs to be equal to the world interest rate ($r_1 \neq r^*$). At the interest rate $r^*$ everybody wants to borrow, but the government does not allow the funds to enter the country. Thus, the internal interest rate rises above the world interest rate. How much above? To a level that makes everybody happy not borrowing. Graphically, the internal interest rate is given by negative the slope of the indifference curve that crosses at point the endowment point $A$. To calculate $r_1$, divide equation (7) by equation (6) to get $C_2/C_1 = 1 + r_1$. Now recall that under capital controls $C_1 = Q_1$ and $C_2 = Q_2$, to get

$$r_1 = \frac{Q_2}{Q_1} - 1$$

This is one equation in one unknown, $r_1$. Intuitively, the lower is current output relative to future output, the more households want to borrow against future income, which, given the capital controls, pushes rates up.