Slides for Chapter 4: Terms of Trade, the World Interest Rate, Tariffs, and the Current Account

Columbia University

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These are the slides for the textbook, "International Macroeconomics: A Modern Approach," by Stephanie Schmitt-Grohé, Martín Uribe, and Michael Woodford, Princeton University Press, 2022, ISBN: 9780691170640.

Motivation

Thus far, we have studied the adjustment to endowment shocks.

Other important shocks for open economies are shocks to

- the terms of trade
- the world interest rate
- tariffs

What happens with consumption, the trade balance, and the current account in response to these shocks?

Terms-of-Trade Shocks

Thus far, we have studied an economy with a single good. Households consume and are endowed with, say, bananas. Sometimes the country exports bananas and sometimes it imports bananas.

However, the goods countries export may be different from the goods the country imports. Some oil producing countries, for example, export mostly oil and import consumption goods such as food, electronics, and automobiles.

Let's make the model more realistic and study an economy in which households like to consume a good different from the good they are endowed with.

The relative price of exports in terms of imports is known as *the terms of trade.*

The Terms of Trade

Let P_1^X and P_1^M be the prices of exports and imports in period 1.

The terms of trade in period 1, denoted TT_1, is

$$TT_1 \equiv \frac{P_1^X}{P_1^M}.$$

Continuing with the example of an oil exporter, if the price of oil is \$90 per barrel and the price of wheat is \$10 per bushel, then $P_1^X = 90$, $P_1^M = 10$, and the terms of trade is 9, or $TT_1 = 9$. Here, TT_1 represents the price of oil in terms of wheat and indicates the amount of wheat that the country can afford to import if it exports one barrel of oil. Put differently, $TT_1 = 9$ means that with one barrel of oil the country can buy 9 bushels of wheat.

The Intertemporal Budget Constraint

The budget constraint in period 1 is

$$C_1 + B_1 - B_0 = r_0 B_0 + TT_1 Q_1.$$

The budget constraint in period 2 is

$$C_2 + B_2 - B_1 = r_1 B_1 + TT_2 Q_2.$$

Using the transversality condition $B_2 = 0$ and combining the two budget constraints to eliminate B_1, yields the intertemporal budget constraint

$$C_1 + \frac{C_2}{1 + r_1} = (1 + r_0) B_0 + TT_1 Q_1 + \frac{TT_2 Q_2}{1 + r_1}.$$

Note that it is **identical** to its counterpart in the one-good economy, except that here we have $TT_1 Q_1$ and $TT_2 Q_2$ instead of Q_1 and Q_2.

Effects of Terms-of-Trade Shocks

We just deduced that terms-of-trade shocks are just like output shocks. If income in period 1, TT_1Q_1, goes up, the household doesn't care whether this is due to an increase in TT_1 or Q_1.

Consequently, the adjustment to terms of trade shocks is identical to the adjustment to endowment shocks:

The country finances temporary changes in the terms of trade by changing the current account (upwardly if the shock is positive and downwardly if it is negative), to smooth consumption over time.

The country adjusts to permanent terms-of-trade shocks by mostly changing consumption (upwardly if the shock is positive and downwardly if it is negative), with little movement in the current account.

Terms-of-Trade Shocks and Imperfect Information

When a shock hits the economy, it is not easy to tell whether it is permanent or temporary.

Agents must form expectations about the duration of the shock, which may or may not be validated by future developments.

When expectations are not fulfilled, the behavior of the economy may ex-post look at odds with the prediction of the intertemporal theory of current account determination.

Suppose that initially $TT_1 = TT_2 = TT$ and $Q_1 = Q_2 = Q$. Suppose now that in period 1 the terms of trade appreciate by $\Delta > 0$ in period 1 and by $2 \times \Delta$ in period 2.

How does the current account adjust to this development?

If households expect the improvement in period 1 to be transitory ($TT_2 = TT$), then the current account in period 1 will improve, $CA_1 \uparrow$.

But if households correctly anticipate that the future terms of trade will be even better by rising to $TT + 2 \times \Delta$ in period 2, then the current account in period 1 will deteriorate, $CA_1 \downarrow$, as households will borrow against their higher expected future income.

The takeaway from this hypothetical example is that what matters for the determination of the current account is the expected path of income, not just current income.

This point is important for analyzing actual historical episodes, as the example on the next slide illustrates.

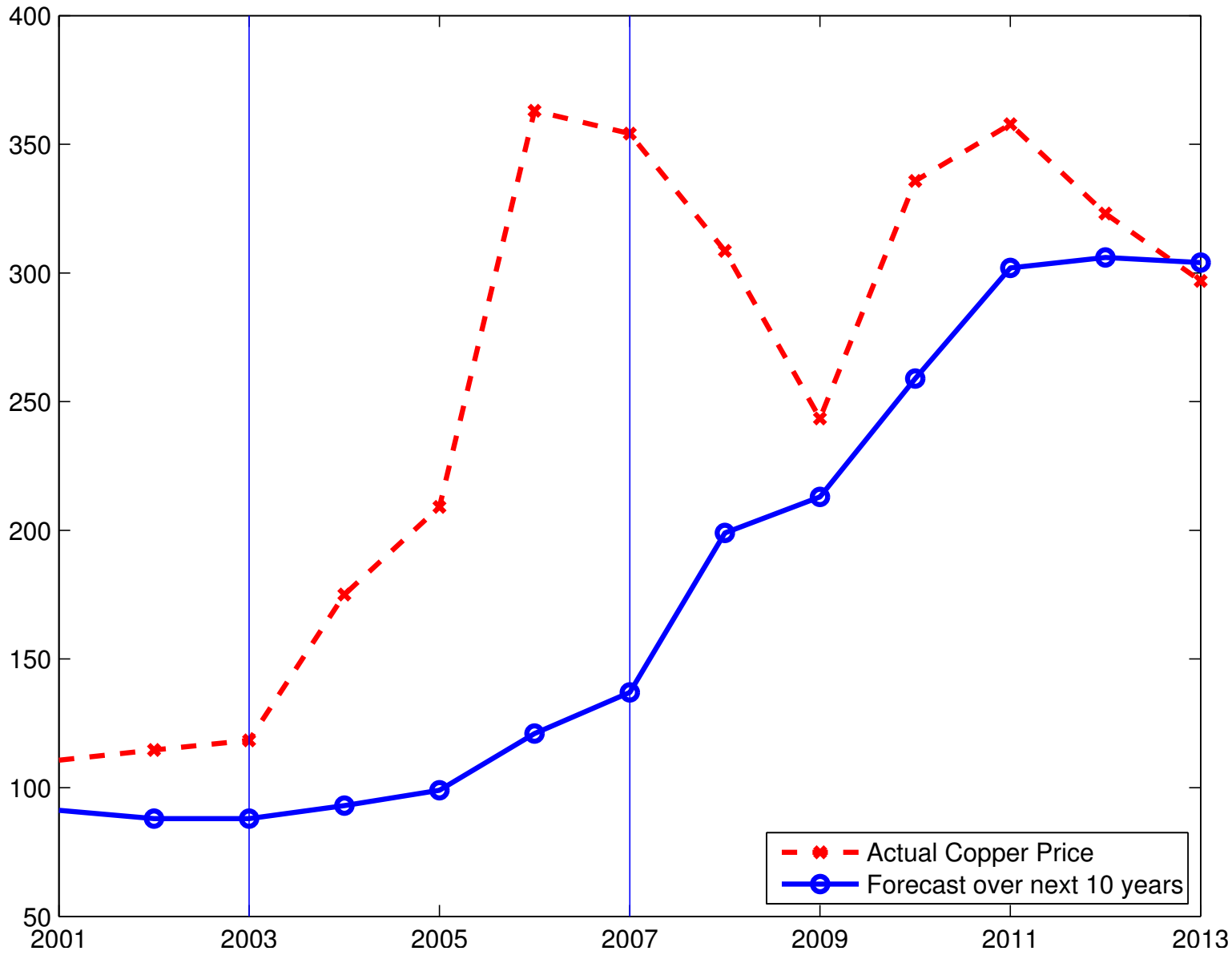
Imperfect Information, the Price of Copper and the Chilean Current Account

We will look at the dynamics of the Chilean current account during the copper price boom of the early 2000 and argue that the observed dynamics are consistent with the predictions of the intertemporal theory of the current account if one takes into account that Chile underestimated how long the copper price boom would last and to what heights the copper prices would rise.

Copper is the main export product of Chile (more than 50% of exports). Thus, an increase in the world copper price represents a positive terms-of-trade shock for Chile.

In the early 2000s, the price of copper began to rise vigorously (it more than tripled) after it had been relatively stable during the preceding two decades. (See the figure on the next slide.)

Forecast versus Actual Price of Copper, Chile, 2001–2013



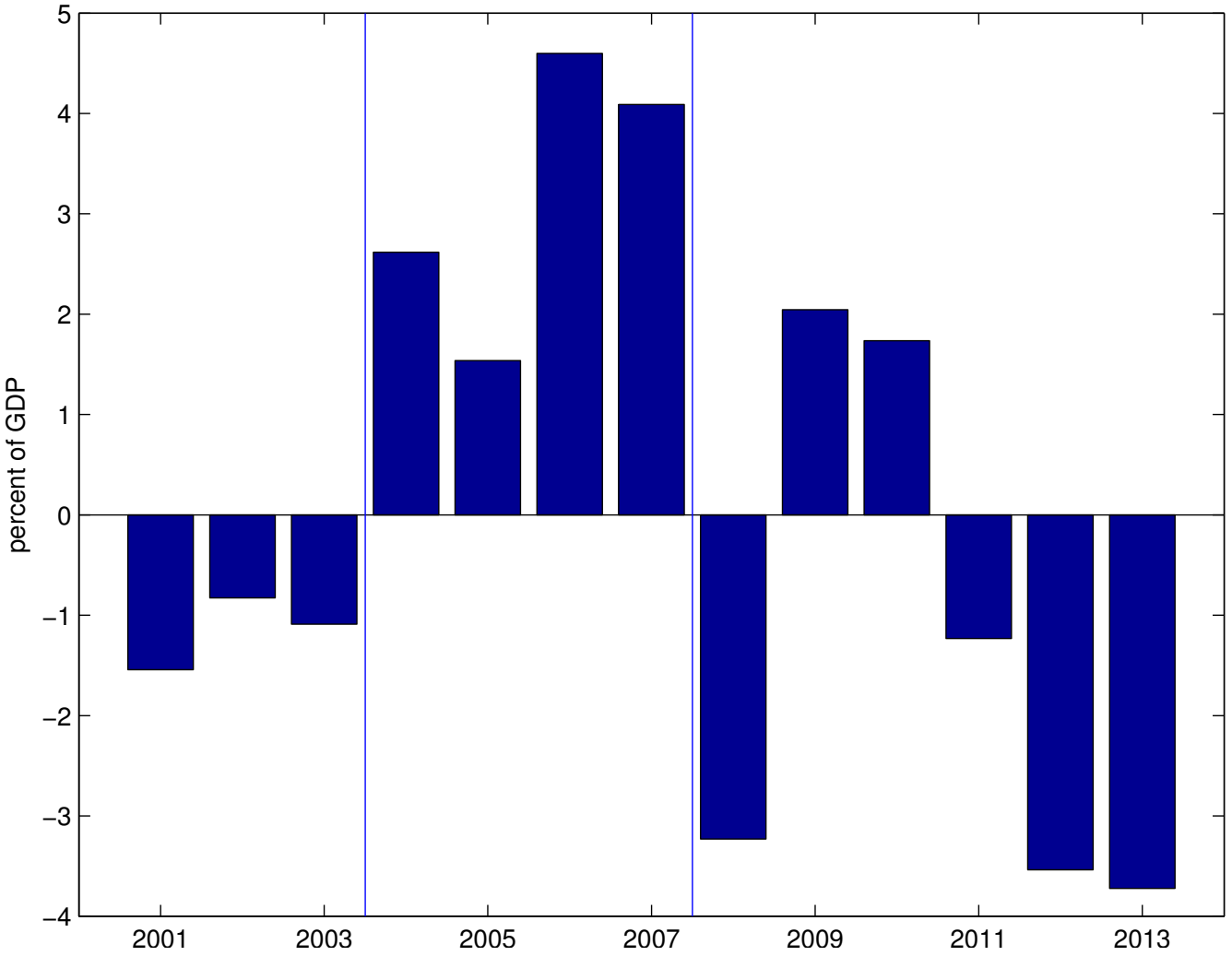
Observations on the figure: (1) The crossed broken line shows the actual real price of copper in U.S. dollar cents of 2015 per metric pound from 2001 to 2013. (2) Between 2003 and 2007, the copper price rose from 120 to over 350 cents and then stayed that high until the end of the sample, 2013. [Yes, there was a dip during the global financial crisis of 2008, but it was temporary.]

Mapping this episode into our model, we can think of the period 2003-2007 as period 1 and the years after 2007 at period 2, and that TT_1 increased and that TT_2 also increased by as much as TT_1 if not more.

The intertemporal theory of the current account, then predicts that CA_1 should **not** have improved, it should either have stayed the same (under the interpretation that TT_1 and TT_2 both went up by about the same) or it should have deteriorated (under the interpretation of the data that TT_1 went up and TT_2 went up by even more).

Let's take a look at the graph on the next slide to see if this is what actually happened.

The Current Account, Chile, 2001-2013



The figure on slide 12 shows the Chilean current account experienced a significant improvement between 2003 and 2007 from deficits of around one percent of GDP to surpluses of about three percent of GDP.

This behavior of the CA contradicts, on the face of it, the predictions of the intertemporal theory of the current account. However, this prediction of the model hinges on the assumption that people had perfect foresight about the copper price. But the assumption that people could forsee that the rise of the price of copper would be long lasting turns out to be wroing.

How do we know? Take again a look at the figure on slide 10.

It also plots the forecast of the average real price of copper over the next ten years produced by Chilean economic experts.

The plot reveals that until 2007 the experts expected the increase in the copper price to be transitory. For example, in 2005 experts predicted that the average copper price between 2005 and 2015 would be below 100. Only by 2013, did forecasters seem to believe that high copper prices were there to stay.

In light of these expectations about the path of the price of copper, the behavior of the current account is no longer in conflict with the predictions of the intertemporal model. For it predicts that in response to an improvement in the terms of trade that is expected to be temporary, the current account should improve, which is what indeed happened.

World Interest Rate Shocks

Movements in world interest rates have been identified as important factors driving business cycles and the external accounts in economies that are open to trade in goods and financial assets.

What happens when the interest rate changes? Two potentially opposing effects:

Substitution Effect: A higher interest rate makes bonds more attractive $\Rightarrow$ consumption falls and saving increases.

Income Effect:
– If households are borrowing, the interest rate hike makes them poorer (income effect is negative) $\Rightarrow$ consumption falls and saving increases. In this case, the income and substitution effects reinforce each other.

– If households are lending, the interest rate hike makes them richer (income effect is positive) $\Rightarrow$ consumption increases and saving falls. In this case, the income and substitution effects oppose each other.

[When the income and substitution effect oppose each other, we assume that preferences are such that the substitution effect dominates to ensure that saving is always an increasing function of the interest rate.]

Adjustment to an Increase in the World Interest Rate

The next figure displays the effect of an increase in the world interest rate on consumption.

• Prior to the interest rate increase, the optimal consumption path is point B.

• Then the world interest rate increases from r^* to $r^* + \Delta$. This causes the intertemporal budget constraint to rotate clockwise around the endowment point A (we are assuming that $B_0 = 0$).

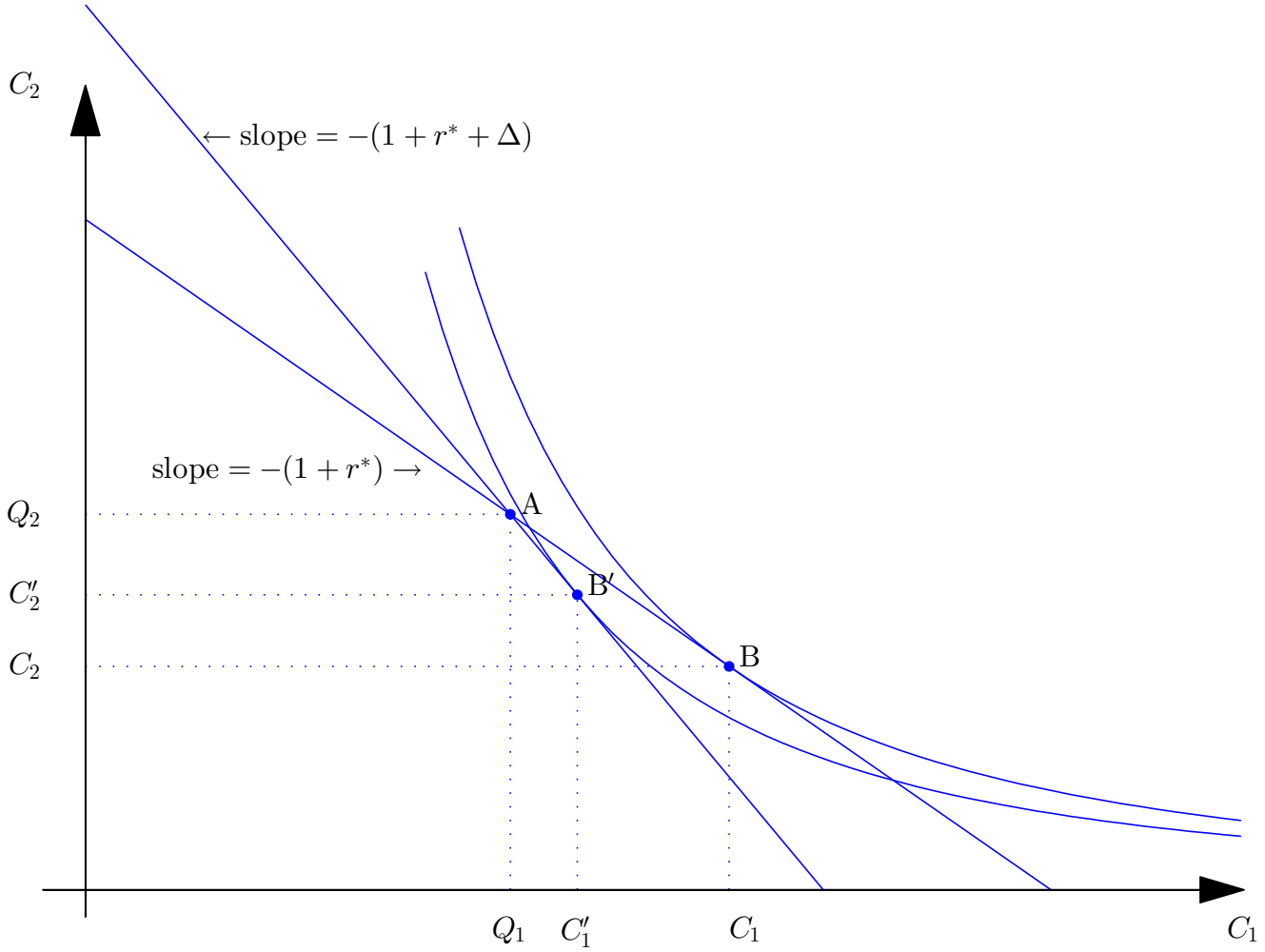
• The new optimal consumption path is point B′.

• The increase in the interest rate causes period-1 consumption to fall from C_1 to C_1' and period-2 consumption to increase from C_2 to C_2'.

• Thus, the trade balance $TB_1 = Q_1 - C_1$ and the current account $CA_1 = TB_1 + r_0 B_0$ both improve.

Adjustment to an Increase in the World Interest Rate

$(B_0 = 0)$



Import Tariffs

Does an increase in import tariffs reduce imports and thereby improve the trade balance?

It turns out that an increase in import tariffs can have either a positive, a negative, or no effect on a country's trade balance.

What matters is not the import tariff per se but how it compares to expected future import tariffs.

Intuitively, if the current import tariff is higher than the future one, then imports are relatively expensive in the current period and import demand should fall. This would improve the trade balance in the current period.

But if the imposition of import tariffs is permanent, then there is no reason to shift consumption across time periods, and the import tariff will have no effect on the trade balance.

How to embed an import tariff in our model?

• Assume that there are two goods, an export good and an import good as in the analysis of terms-of-trade shocks.

• Assume that the government rebates the revenues generated by the import tariff to households in a lump sum fashion.

• Let τ_t denote the import tariff in period $t = 1, 2$.

• Let L_t denote the lump sum transfer in period $t = 1, 2$.

Household budget constraints in periods 1 and 2:

$$(1+\tau_1)C_1 + B_1 = TT_1Q_1 + L_1 + (1+r_0)B_0 \tag{1}$$

$$(1+\tau_2)C_2 = TT_2Q_2 + L_2 + (1+r_1)B_1. \tag{2}$$

The intertemporal budget constraint:

$$(1+\tau_1)C_1 + \frac{(1+\tau_2)C_2}{1+r_1} = \tilde{Y}, \tag{3}$$

where

$$\tilde{Y} = (1+r_0)B_0 + TT_1Q_1 + L_1 + \frac{TT_2Q_2 + L_2}{1+r_1}$$

is lifetime wealth, which the household takes as given.

The Household's Maximization Probem

$$\max_{\{C_1,C_2\}} U(C_1) + \beta U(C_2)$$

subject to (3). Solve (3) for C_2 and use resulting expression to replace C_2 from the household's lifetime utility function. This yields

$$\max_{\{C_1\}} \quad U(C_1) + \beta U\left(\frac{1+r_1}{1+\tau_2}(\tilde{Y} - (1+\tau_1)C_1)\right).$$

The first-order condition associated with this problem is the Euler equation

$$U'(C_1) = \frac{1+\tau_1}{1+\tau_2}\beta(1+r_1)U'(C_2). \tag{4}$$

The government rebates any revenue from the import tariff to households in a lump sum fashion

The government budget constraint in period $t = 1, 2$:

$$L_t = \tau_t C_t$$

Combining this expression with the households' intertemporal budget constraint (2) gives the economy-wide resource constraint

$$C_1 + \frac{C_2}{1 + r^*} = (1 + r_0)B_0 + TT_1 Q_1 + \frac{TT_2 Q_2}{1 + r^*}, \tag{5}$$

which is the same as in the economy without tariffs. This is intuitive because the government returns the tariff revenue to its citizens (who paid for the tariffs).

An equilibrium is a consumption path (C_1, C_2) and a domestic interest rate r_1 such that the Euler equation (4) holds, the economy wide resource constraint (5) is satisfied and interest rate parity holds, that is,

$$U'(C_1) = \frac{1+\tau_1}{1+\tau_2}\beta(1+r_1)U'(C_2) \tag{4}$$

$$C_1 + \frac{C_2}{1+r^*} = TT_1Q_1 + (1+r_0)B_0 + \frac{TT_2Q_2}{1+r^*} \tag{5}$$

and

$$r_1 = r^*, \tag{6}$$

given τ_1, τ_2, TT_1Q_1, TT_2Q_2, $(1+r_0)B_0$, and r^*.

We are now ready to analyze the adjustment to changes in import tariffs.

A Temporary Increase in Import Tariffs

Experiment: Initially $\tau_1 = \tau_2 = 0$.

Then a temporary tariff is imposed: $\Delta\tau_1 > 0$ and $\Delta\tau_2 = 0$.

The figure on the next slide shows the adjustment:

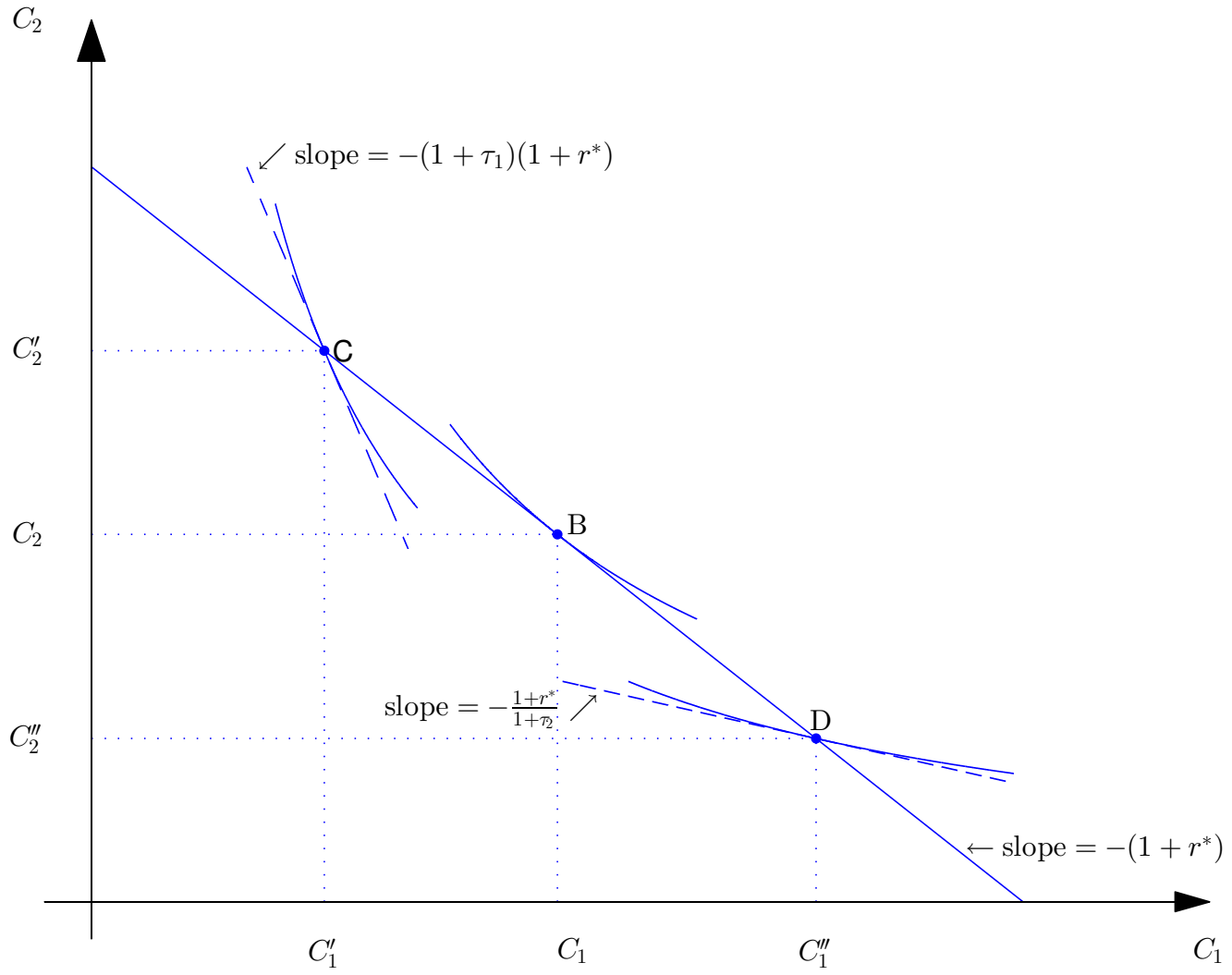
Prior to the imposition of import tariffs ($\tau_1 = \tau_2 = 0$) the optimal consumption path is at point B.

Changes in import tariffs leave the intertemporal resource constraint (the downward sloping solid line) unchanged.

A temporary increase in import tariffs ($\Delta\tau_1 > 0$ and $\Delta\tau_2 = 0$) pushes the optimal consumption path to point C, where the slope of the indifference curve (the broken line) is steeper than at point B, $(1 + \tau_1)(1 + r^*) > (1 + r^*)$. The increase in import tariffs causes period-1 consumption to decline ($C_1' < C_1$), and the trade balance in period 1 to improve ($TT_1Q_1 - C_1' > TT_1Q_1 - C_1$).

The indifference curve associated with point C lies southwest of that associated with point B implying that the tariff is welfare reducing.

Adjustment to changes in import tariffs



A Permanent Increase in Import Tariffs

Experiment: Initially $\tau_1 = \tau_2 = 0$.

Then a permanent tariff is imposed: $\Delta\tau_1 = \Delta\tau_2 > 0$.

The permanent increase in import tariffs has no effect on the equilibrium consumption path because the import tax rates cancel out of the Euler equation (4).

An Anticipated Future Increase in Import Tariffs

Experiment: Initially $\tau_1 = \tau_2 = 0$.

In period 1, agents learn that a tariff will be imposed in period 2: $\Delta\tau_1 = 0$ and $\Delta\tau_2 > 0$.

The figure on slide 26 shows the adjustment.

Prior to the imposition of import tariffs ($\tau_1 = \tau_2 = 0$) the optimal consumption path is at point B. Changes in import tariffs leave the intertemporal resource constraint (the downward sloping solid line) unchanged.

An anticipated future increase in import tariffs ($\Delta\tau_2 > 0$ and $\Delta\tau_1 = 0$) pushes the optimal consumption path to point D, where the slope of the indifference curve is flatter, $(1 + r^*)/(1 + \tau_2) < (1 + r^*)$. The expected future increase in import tariffs causes period-1 consumption to increase from C_1 to C_1'' and the trade balance to deteriorate in period 1.

The indifference curve associated with point D lies southwest of that associated with point B implying that the tariff is welfare reducing.

Summing Up (1/3)

This chapter analyzes the effects of terms-of-trade shocks and interest-rate shocks in the context of the intertemporal model of the current account developed in chapter 3.

• The terms of trade is the relative price of export goods in terms of import goods.

• Terms-of-trade shocks have the same effects as endowment shocks: the economy uses the current account to smooth consumption over time in response to temporary terms of trade shocks, and adjusts consumption with little movement in the current account in response to permanent terms-of-trade shocks.

Summing Up (2/3)

• Interest rate shocks have a substitution and an income effect.

• By the substitution effect, an increase in the interest rate discourages current consumption and incentivizes savings causing the current account and the trade balance to improve.

• The income effect associated with an increase in the interest rate depends on whether households are borrowing or lending.

• If households are borrowing, an increase in the interest rate has a negative income effect, as it makes borrowers poorer. As a result, consumption falls and the trade balance and the current account improve. In this case, the income and substitution effect go in the same direction.

• If households are lending, the income effect associated with an increase in the interest rate is positive and leads to higher consumption and a deterioration in the trade balance and the current account. In this case, the income and substitution effects go in the opposite direction, partially offsetting each other. Under log-preferences the substitution effect dominates.

Summing Up (3/3)

• An increase in import tariffs need not improve the trade balance or the current account. Only if import tariffs are temporary, will they lead to an improvement in the trade balance and the current account. Future expected increases in import tariffs deteriorate the trade balance. Permanent changes in tariffs leave the trade balance unchanged.

• In the present framework, import tariffs are welfare decreasing.