Slides for Chapter 10:

Determinants of the Real Exchange Rate

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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

• In chapter 9, we documented that the real exchange rate moves substantially over time—countries sometimes become cheaper than other countries and sometimes more expensive.

• This chapter investigates what causes the real exchange rate to move over time.

• It addresses this question from a short-run perspective, through a model called TNT (traded-nontraded), and from a long-run perspective, through a model called Balassa-Samuelson.

• In the short run, factors of production cannot move easily across sectors—e.g., an accountant cannot become a farmer from one month to the next. Technology is also fixed—e.g., it took decades for tractors to replace horses.

• Thus, in the short run, relative prices, and in particular the real exchange rate, are primarily determined by demand factors.

• In the long run, factors of production can move more freely across sectors—e.g., the accountant (or her children) can become a farmer. In addition, new technologies affect sectoral production possibilities.

• Thus, in the long run, relative prices, and in particular the real exchange rate, are determined primarily by supply factors.

The TNT Model

The TNT model is identical to the open economy model of Chapter 3 except that instead of a single tradable good it features two goods, one tradable and one nontradable.

The tradable good can be imported or exported without restrictions. By contrast, the nontradable good is not exchanged in international markets and must be produced and consumed domestically.

Consequently, the TNT model features a new endogenous variable in the model, the relative price of nontradable goods in terms of tradable goods.

As we saw in Chapter 9 this relative price plays a key role in determining the real exchange rate.

Households

The household's utility function is

$$\ln C_1 + \beta \ln C_2, \tag{1}$$

C_1 and C_2 denote consumption and are composite goods made up of tradable and nontradable consumption goods, with Cobb-Douglas aggregators

$$C_1 = (C_1^T)^{\gamma}(C_1^N)^{1-\gamma}, \tag{2}$$

and

$$C_2 = (C_2^T)^{\gamma}(C_2^N)^{1-\gamma}, \tag{3}$$

with $\gamma \in (0,1)$.*

*Can you show that in equilibrium the expenditure share of traded goods is equal to γ, that is, $\gamma = C_t^T/(C_t^T + p_t C_t^N)$.

Budget Constraints

In period 1, the household is endowed with tradable and nontradable goods, Q_1^T and Q_1^N, and can buy a bond, B_1, denominated in units of tradable goods:

$$P_1^T C_1^T + P_1^N C_1^N + P_1^T B_1 = P_1^T Q_1^T + P_1^N Q_1^N,$$

where P_t^T and P_t^N are the prices of tradable and nontradable goods in periods $t = 1, 2$.

In period 2, the household's budget constraint is given by

$$P_2^T C_2^T + P_2^N C_2^N = P_2^T Q_2^T + P_2^N Q_2^N + (1 + r_1) P_2^T B_1.$$

Express Budget Constraints in Units of Tradable Goods

Dividing the period-1 budget constraint by P_1^T and the period-2 budget constraint by P_2^T gives

$$C_1^T + p_1 C_1^N + B_1 = Q_1^T + p_1 Q_1^N$$

and

$$C_2^T + p_2 C_2^N = Q_2^T + p_2 Q_2^N + (1 + r_1) B_1,$$

where

$$p_t \equiv \frac{P_t^N}{P_t^T}$$

denotes the relative price of the nontradable good in terms of tradable goods in periods $t = 1, 2$.

The Intertemporal Budget Constraint

Combining these two budget constraints to eliminate B_1 yields

$$C_1^T + p_1 C_1^N + \frac{C_2^T + p_2 C_2^N}{1+r_1} = Q_1^T + p_1 Q_1^N + \frac{Q_2^T + p_2 Q_2^N}{1+r_1}. \tag{4}$$

For convenience, let

$$\bar{Y} \equiv Q_1^T + p_1 Q_1^N + \frac{Q_2^T + p_2 Q_2^N}{1+r_1},$$

which is taken as exogenous by the household. The intertemporal budget constraint then is

$$C_1^T + p_1 C_1^N + \frac{C_2^T + p_2 C_2^N}{1+r_1} = \bar{Y}.$$

The Household's Optimization Problem

The household chooses C_t, C_t^T, and C_t^N for $t = 1, 2$, to maximize

$$\ln C_1 + \beta \ln C_2, \tag{1}$$

subject to

$$C_1 = (C_1^T)^\gamma (C_1^N)^{1-\gamma}, \tag{2}$$

$$C_2 = (C_2^T)^\gamma (C_2^N)^{1-\gamma}, \tag{3}$$

and

$$C_1^T + p_1 C_1^N + \frac{C_2^T + p_2 C_2^N}{1 + r_1} = \bar{Y}. \tag{IBC}$$

Using (2), (3), and (IBC) to eliminate C_1, C_2, and C_2^T from the utility function (1), the household's optimization problem reduces to choosing C_1^T, C_1^N, and C_2^N to maximize

$$\gamma \ln C_1^T + (1-\gamma) \ln C_1^N + \beta\gamma \ln[(1+r_1)(\bar{Y} - C_1^T - p_1 C_1^N) - p_2 C_2^N] + \beta(1-\gamma) \ln C_2^N.$$

Optimality Conditions

Taking derivatives with respect to C_1^T, C_1^N, and C_2^N and equating them to zero gives

$$\frac{1}{C_1^T} - \frac{\beta(1+r_1)}{[(1+r_1)(\bar{Y} - C_1^T - p_1 C_1^N) - p_2 C_2^N]} = 0,$$

$$\frac{1-\gamma}{C_1^N} - \frac{\gamma\beta(1+r_1)p_1}{[(1+r_1)(\bar{Y} - C_1^T - p_1 C_1^N) - p_2 C_2^N]} = 0,$$

$$\frac{1-\gamma}{C_2^N} - \frac{\gamma p_2}{[(1+r_1)(\bar{Y} - C_1^T - p_1 C_1^N) - p_2 C_2^N]} = 0.$$

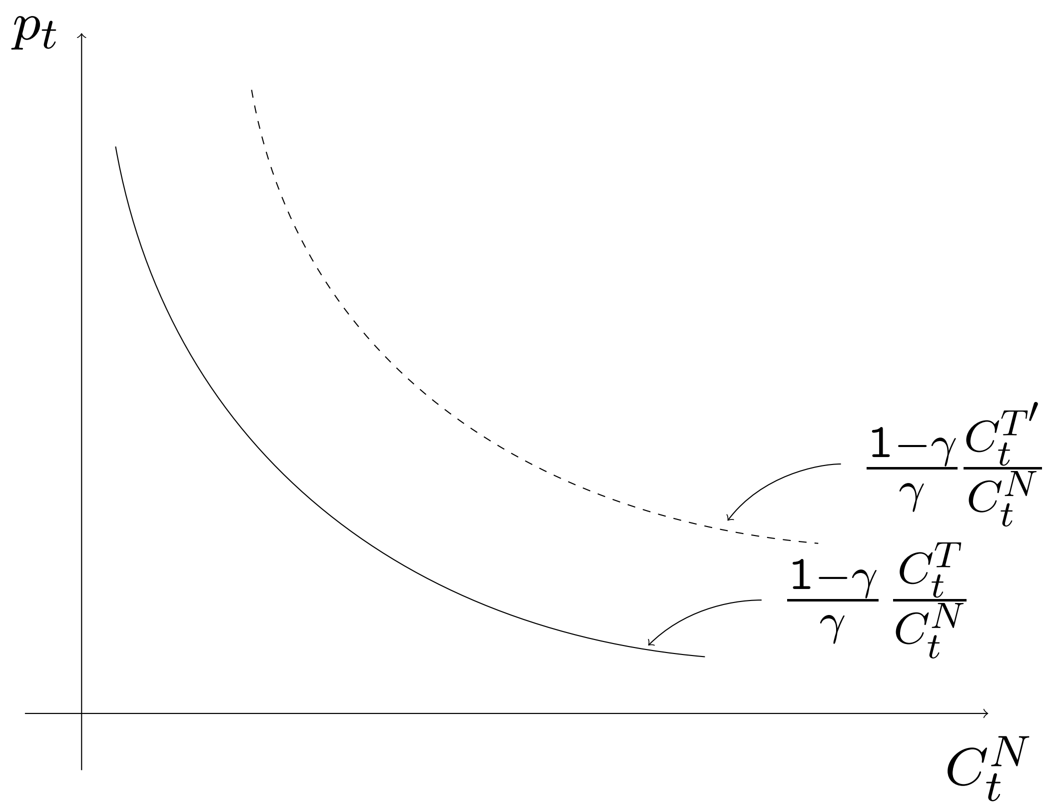
Use $C_2^T = [(1+r_1)(\bar{Y} - C_1^T - p_1 C_1^N) - p_2 C_2^N]$ and rearrange to get

$$C_2^T = \beta(1+r_1)C_1^T, \tag{5}$$

$$C_t^N = \frac{1-\gamma}{\gamma}\frac{C_t^T}{p_t}, \quad \text{for } t = 1, 2. \tag{6}$$

The first optimality condition is the Euler equation. The second is the demand function for nontradables and is plotted in the next slide.

The Demand Function for Nontradables



The figure depicts the demand schedule for nontradables in period t, $p_t = \frac{1-\gamma}{\gamma}\frac{C_t^T}{C_t^N}$. Holding constant consumption of tradables, C_t^T, the higher the relative price of nontradables, p_t, is, the lower the demand for nontradables, C_t^N, will be. An increase in the desired consumption of tradables from C_t^T to $C_t^{T'} > C_t^T$ shifts the demand schedule for nontradables out and to the right.

Equilibrium

Market Clearing

In equilibrium, the market for nontradable goods must clear

$$C_t^N = Q_t^N, \tag{7}$$

for $t = 1, 2$.

Free Capital Mobility

The country is assumed to have free capital mobility, so in equilibrium the domestic interest rate, r_1, is equal to the world interest rate, r^*,

$$r_1 = r^*.$$

The Intertemporal Resource Constraint

Using (7) to eliminate C_1^N and C_2^N from the intertemporal budget constraint (4) yields the following intertemporal resource constraint

$$C_1^T + \frac{C_2^T}{1+r^*} = Q_1^T + \frac{Q_2^T}{1+r^*},$$

which is the same as in Chapter 3.

Equilibrium Tradable Consumption

Combining this intertemporal resource constraint with the Euler equation (5) yields

$$C_1^T = \frac{1}{1+\beta}\left(Q_1^T + \frac{Q_2^T}{1+r^*}\right). \tag{8}$$

As in the one-good economy of Chapter 3: consumption of tradables is an increasing function of the current and the future expected endowments of tradables and a decreasing function of the interest rate. Summarizing:

$$C_1^T = C^T(\underset{-}{r^*}, \underset{+}{Q_1^T}, \underset{+}{Q_2^T}). \tag{9}$$

All variables on the right hand side (r^*, Q_1^T, and Q_2^T) are exogenous to the small open economy.

Note: An increase in Q_1^T causes an increase in C_1^T but less than one for one.

Equilibrium Trade Balance

The trade balance is given by $TB_1 = Q_1^T - C^T(r^*, Q_1^T, Q_2^T)$. So we can write

$$TB_1 = TB(\underset{+}{r^*}, \underset{+}{Q_1^T}, \underset{-}{Q_2^T}).$$

Note 1: The $+$ sign under Q_1^T is because when Q_1^T increases, C_1^T increases less than one for one.

Note 2: Because $B_0 = 0$, the current account equals the trade balance, $CA_1 = r_0 B_0 + TB_1 = TB_1$. So we can write

$$CA_1 = CA(\underset{+}{r^*}, \underset{+}{Q_1^T}, \underset{-}{Q_2^T}).$$

Note 3: The eqm determination of C_1^T, B_1, TB_1, and CA_1 is identical to Chapter 3.

The Equilibrium Relative Price of Nontradables, p_1

Use the equilibrium level of tradable consumption, $C_1^T = C^T(r^*, Q_1^T, Q_2^T)$, to eliminate C_1^T from the demand function for nontradables, $C_1^N = \frac{1-\gamma}{\gamma}\frac{C_t^T}{p_1}$ to get the equilibrium demand schedule for nontradables:

$$C_1^N = \frac{1-\gamma}{\gamma}\frac{C^T(r^*, Q_1^T, Q_2^T)}{p_1}, \tag{10}$$

plotted on the next slide. The figure also displays the exogenous supply of nontradables, Q_1^N (vertical line).

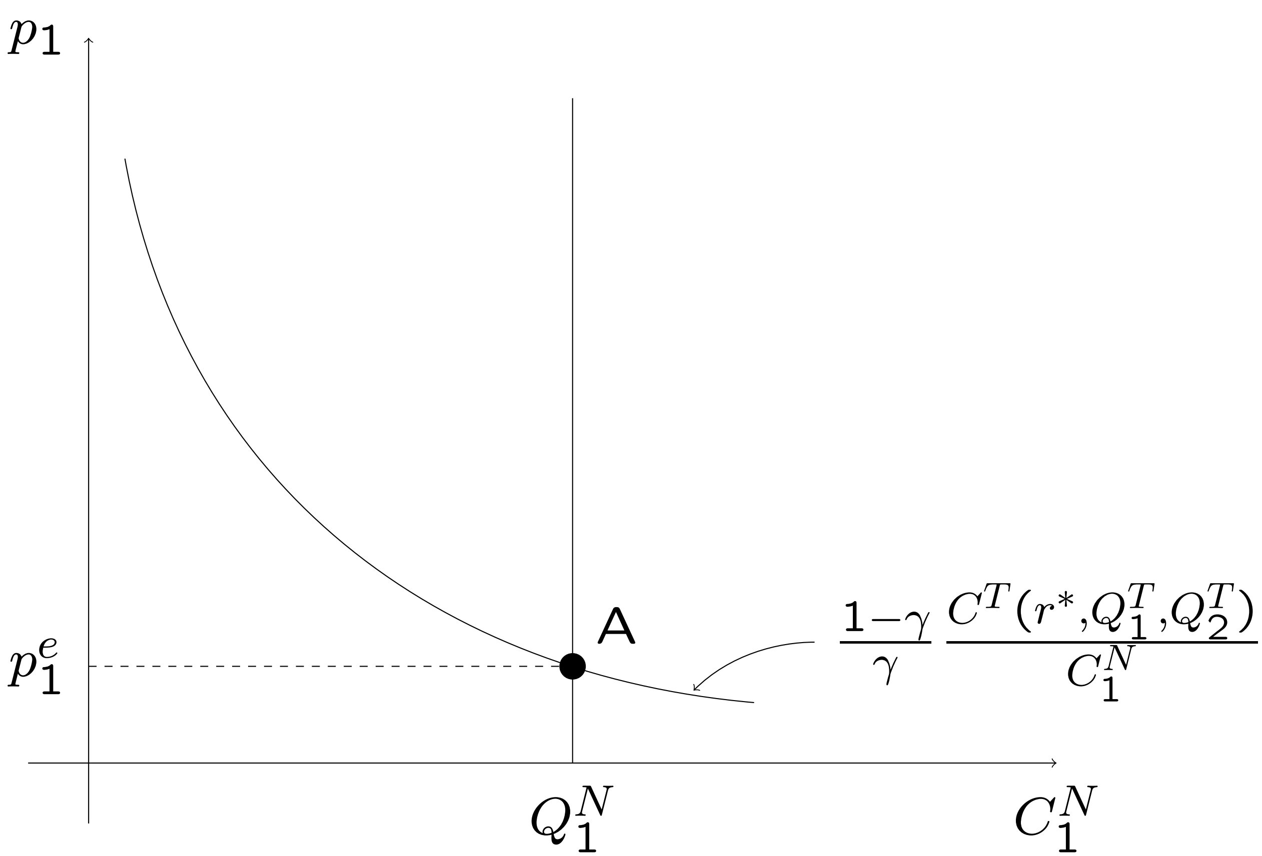
The equilibrium value of the relative price of nontradables, denoted p_1^e, is given by the intersection of the demand and supply schedules

$$Q_1^N = \frac{1-\gamma}{\gamma}\frac{C^T(r^*, Q_1^T, Q_2^T)}{p_1}.$$

This is one equation in one unknown, p_1. Solving for p_1 yields

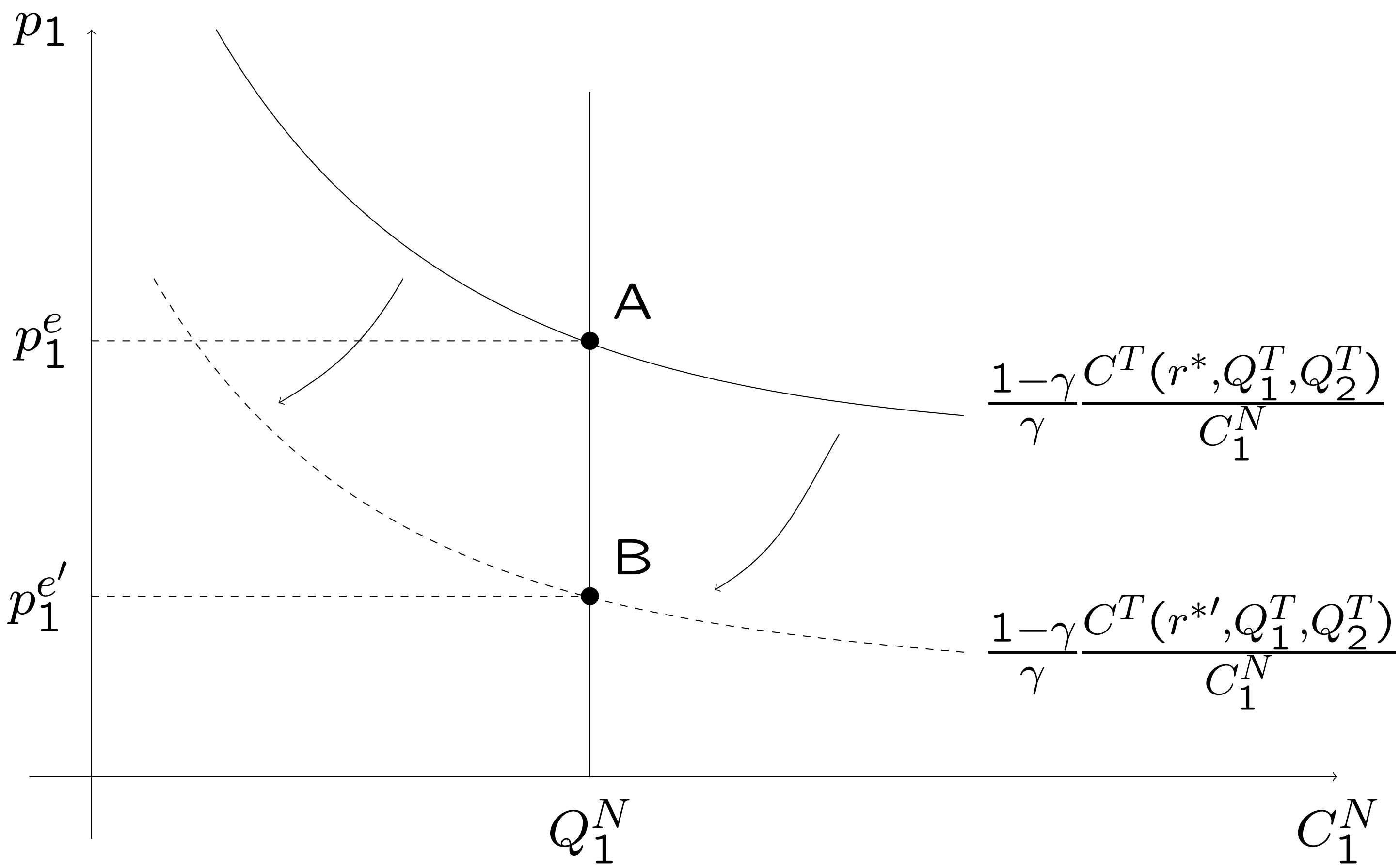
$$p_1 = p(r^*, Q_1^T, Q_2^T, Q_1^N)$$

The Equilibrium Relative Price of Nontradables



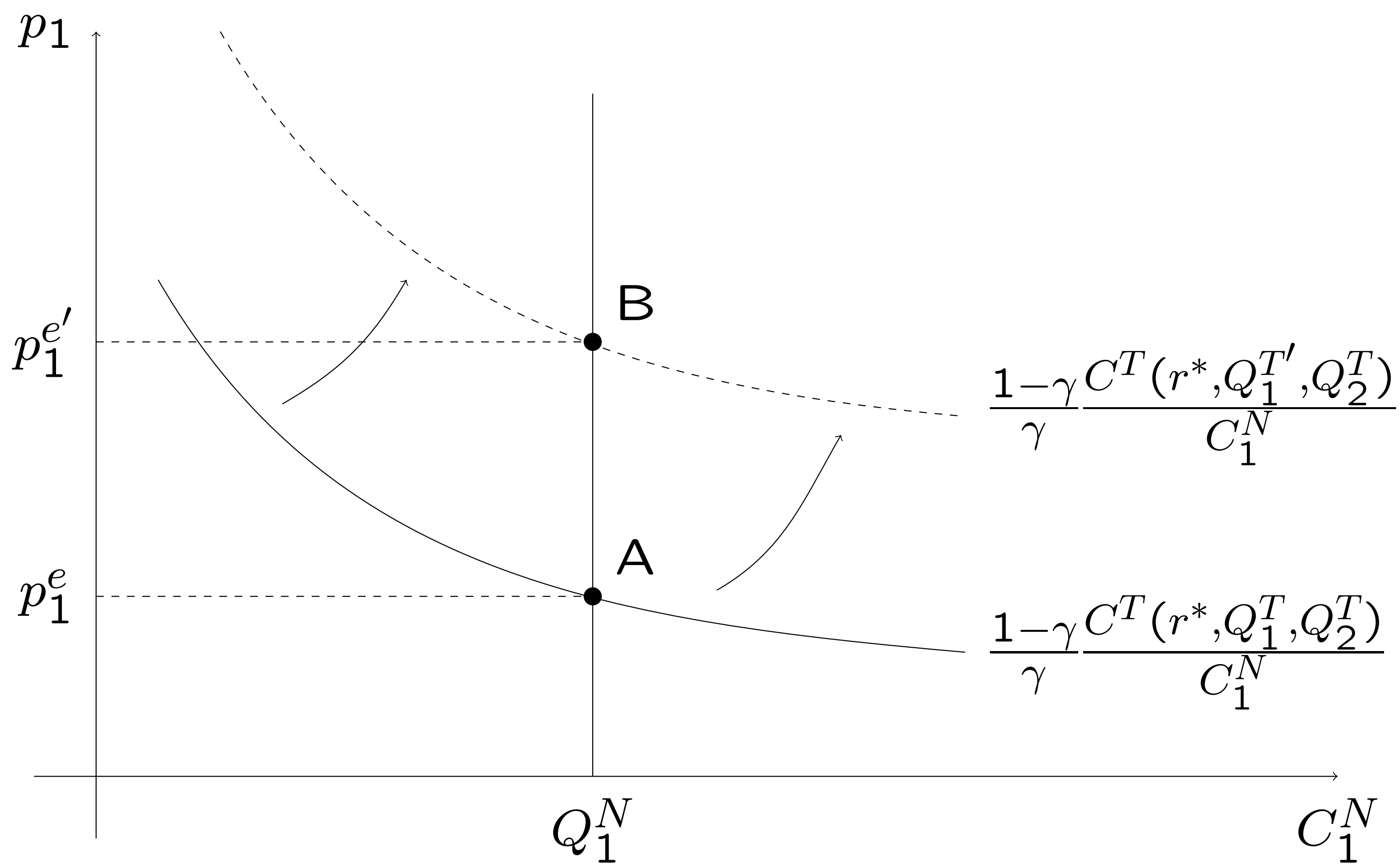
The figure depicts the demand and supply functions of nontradables. The demand for nontradables is downward sloping and the supply schedule is a vertical line. The equilibrium relative price of nontradables is p_1^e, given by the intersection of the demand and supply schedules, point A.

Effects of an Increase in the World Interest Rate on the Relative Price of Nontradables



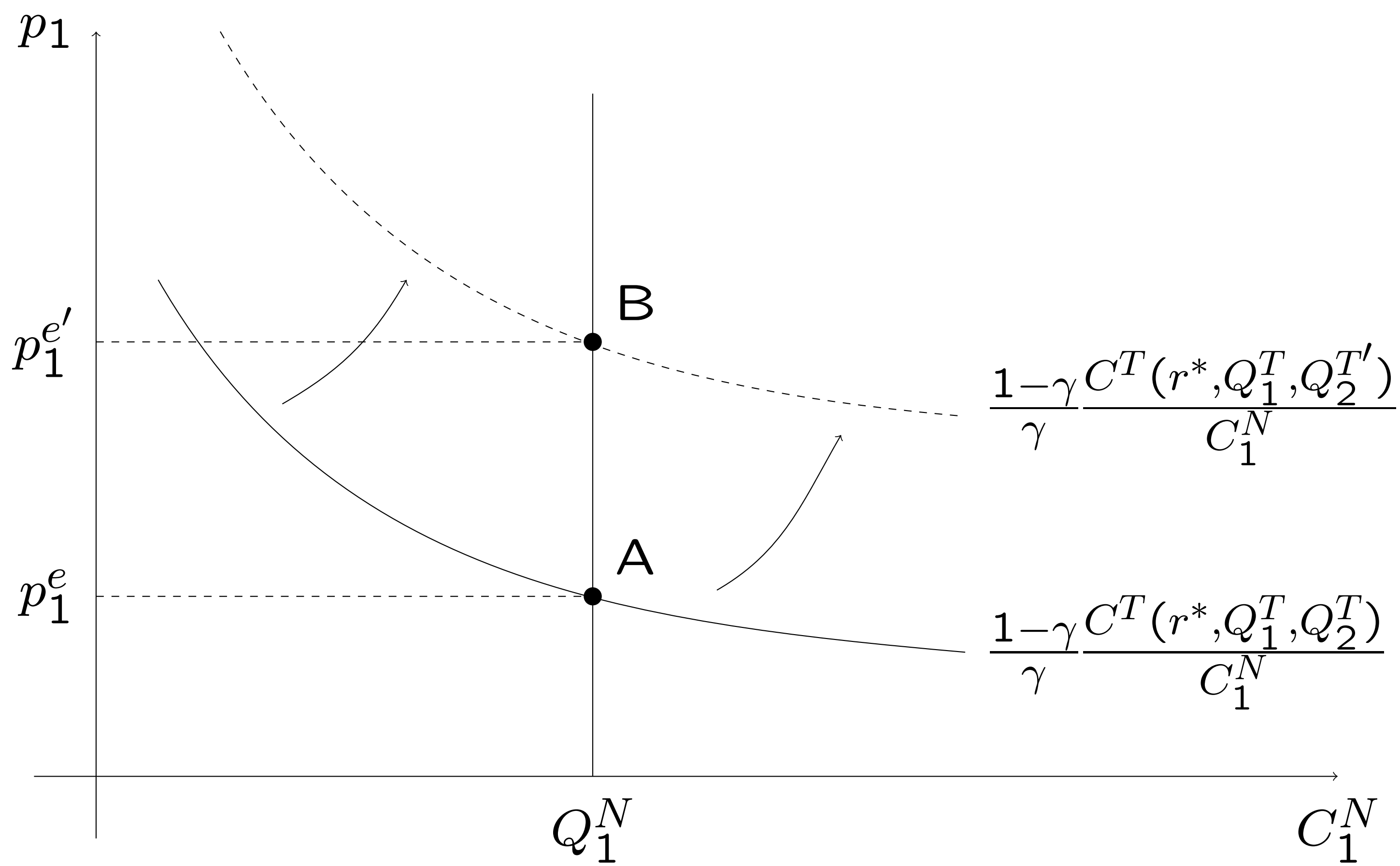
The figure shows that an increase in the world interest rate from r^* to $r^{*\prime}$ shifts the demand schedule down and to the left causing a fall in p_1. (Real depreciation.)

Effects of a Transitory Increase in the Endowment of Tradable on the Relative Price of Nontradables



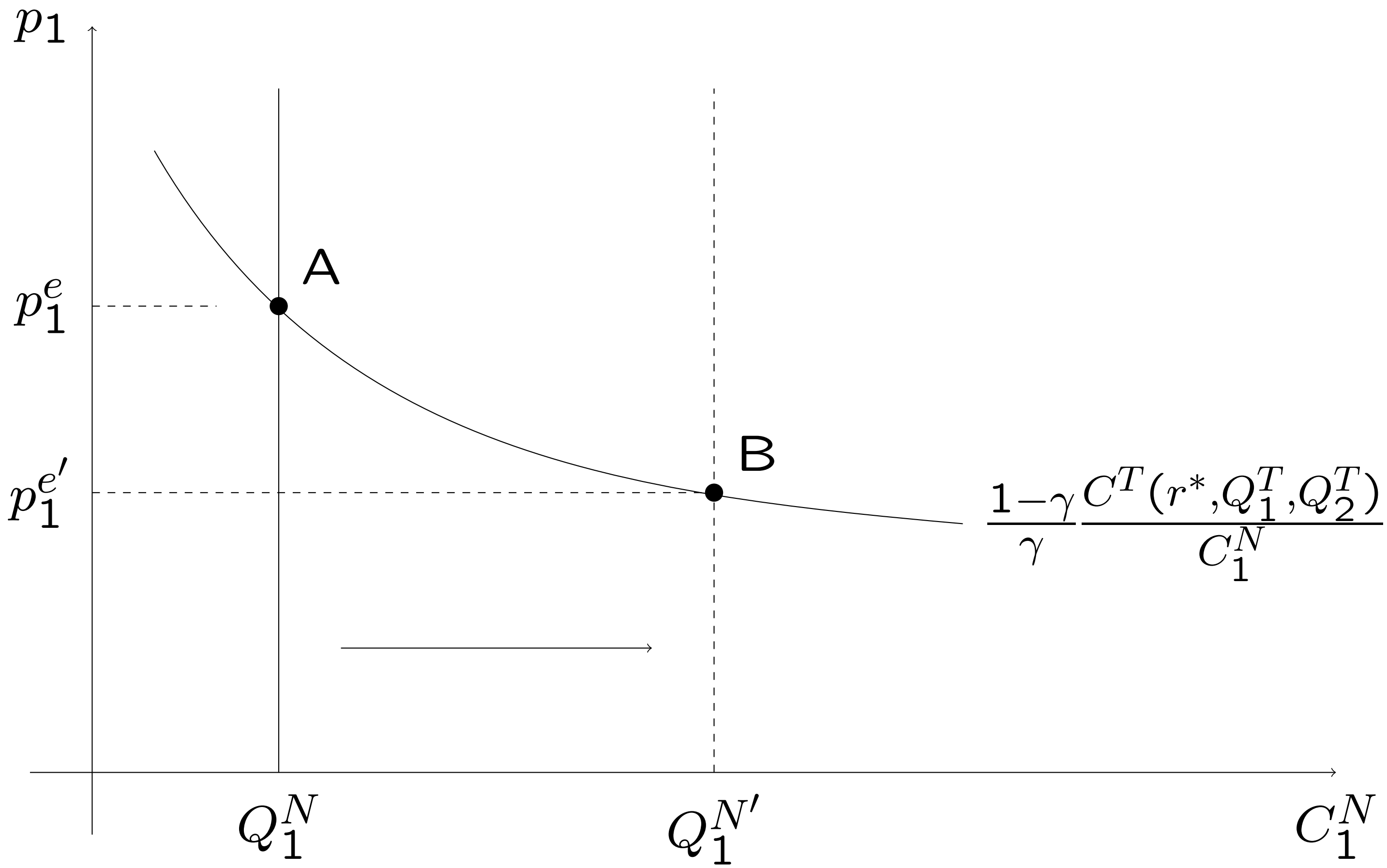
The figure shows that a temporary increase in the period-1 tradable endowment from Q_1^T to $Q_1^{T'} > Q_1^T$ shifts the demand schedule for nontradables out and to the right, driving p_1 up. (Real appreciation.)

Effects of an Expected Future Increase in the Endowment of Tradables on the Relative Price of Nontradables



The figure shows that an increase in the period-2 tradable endowment from Q_2^T to $Q_2^{T'} > Q_2^T$ shifts the demand schedule for nontradables out and to the right, driving p_1 up. (Real appreciation.)

Effects of an Increase in the Endowment of Nontradables on the Relative Price of Nontradables



The figure shows that an increase in the endowment of nontradables from Q_1^N to $Q_1^{N'} > Q_1^N$ shifts the supply of nontradables (vertical line) to the right. The demand schedule is unchanged. Thus in equilibrium the relative price of nontradables falls. (Real depreciation.)

Taking Stock:
Determinants of the Relative Price of Nontradables

Collecting the results of the last 4 figures, we can write the equilibrium relative price of nontradables as

$$p_1 = p(\underset{-}{r^*}, \underset{+}{Q_1^T}, \underset{+}{Q_2^T}, \underset{-}{Q_1^N}). \tag{11}$$

From the Relative Price of Nontradables to the Real Exchange Rate

There is a tight connection between the relative price of nontradables, p_t, and the real exchange rate, e_t.
Recall that the real exchange rate is defined as

$$e_t = \frac{\mathcal{E}_t P_t^*}{P_t},$$

where P_t and P_t^* are the domestic and foreign consumer price levels, and $\mathcal{E}_t$ is the nominal exchange rate.

$$P_t = \phi(P_t^T, P_t^N).$$

Recall from Chapter 9, Section 9.9 that when the aggregator function is Cobb-Douglas, as is the case here (see (2) and (3)), then

$$\phi(P_t^T, P_t^N) = (P_t^T)^\gamma (P_t^N)^{1-\gamma} A; \quad \text{with } A \equiv \gamma^{-\gamma}(1-\gamma)^{-(1-\gamma)}.$$

Similarly,

$$P_t^* = \phi(P_t^{T*}, P_t^{N*}).$$

So we can write

$$e_t = \frac{\mathcal{E}_t \phi^*(P_t^{T*}, P_t^{N*})}{\phi(P_t^T, P_t^N)}. \tag{12}$$

From p_t to e_t (cont.)

Because $\phi(\cdot,\cdot)$ and $\phi^*(\cdot,\cdot)$ are homogeneous of degree 1,

$$e_t = \frac{\mathcal{E}_t P_t^{T*} \phi^*(1, P_t^{N*}/P_t^{T*})}{P_t^T \phi(1, P_t^N/P_t^T)}.$$

Assume that the LOOP holds for tradables,

$$\mathcal{E}_t P_t^{T*} = P_t^T$$

So

$$e_t = \frac{\phi^*(1, p_t^*)}{\phi(1, p_t)}.$$

Result: Given the foreign relative price of nontradables, p_t^*, (which is exogenously determined in the rest of the world), the real exchange rate is a decreasing function of p_t. In other words, when nontradables become more expensive relative to tradables, the domestic economy becomes more expensive relative to the rest of the world.

From p_t to e_t (concluded)

The response of the real exchange rate to exogenous shocks can then be deduced from (11):

$$e_1 = e(\underset{+}{r^*}, \underset{-}{Q_1^T}, \underset{-}{Q_2^T}, \underset{+}{Q_1^N}, \underset{+}{p_1^*}).$$

Because of this tight connection, p_t is sometimes referred to as the real exchange rate.

The Terms of Trade and the Real Exchange Rate

Consider an economy that imports C_t^T, say food, and exports Q_t^T, say oil. How does an increase in the price of oil affect the relative price of nontradables (such health care or education) in terms of food?

In Chapter 4, we established that changes in the terms of trade are just like changes in the endowment of the exportable good.

This result allows us to easily analyze the effects of terms of trade shocks on the relative price of nontradables (p_1) and the real exchange rate (e_1).

We simply have to replace everywhere Q_t^T by $TOT_t Q_t^T$, where $TOT_t \equiv P_t^X / P_t^M$ is the terms of trade, P_t^X the price of the exported good (oil), and P_t^M the price of the imported good (food).

We then have that the equilibrium relative price of nontradables in terms of the tradable (now imported) good, $p_1 = \frac{P_1^N}{P_1^M}$, becomes

$$p_1 = p(\underset{-}{r^*}, \underset{+}{TOT_1 Q_1^T}, \underset{+}{TOT_2 Q_2^T}, \underset{-}{Q_1^N}),$$

and the real exchange rate becomes

$$e_1 = e(\underset{+}{r^*}, \underset{-}{TOT_1 Q_1^T}, \underset{-}{TOT_2 Q_2^T}, \underset{+}{Q_1^N}, \underset{+}{p_1^*}).$$

Immediate Result: An improvement in the current or future expected terms of trade (an increase in either TOT_1 or TOT_2) causes an increase in the equilibrium relative price of nontradables ($p_1 \uparrow$) and an appreciation of the real exchange rate ($e_t \downarrow$).

Intuition: the increase in the price of the export good makes households richer $\Rightarrow$ they increase the demand for both goods, tradables (imported) and nontradables. Because the supply of nontradables is fixed, the increased demand pushes its relative price up. In turn the increase in the relative price of nontradables makes the country more expensive relative to the rest of the world.

Sudden Stops

"It is not speed that kills, it is the sudden stop."

Bankers' adage

A sudden stop is a particular type of economic crisis that occurs when foreign lenders abruptly stop extending credit to a country.

A sudden stop manifests itself by a sharp increase in the interest rate that the country faces in international financial markets.

Three hallmark consequences of sudden stops are:
(a) a *current account reversal* from a deficit to a surplus or a sizable reduction in the current account deficit;
(b) a contraction in aggregate demand; and
(c) a real-exchange-rate depreciation.

This section shows that the TNT model can capture these three stylized facts.

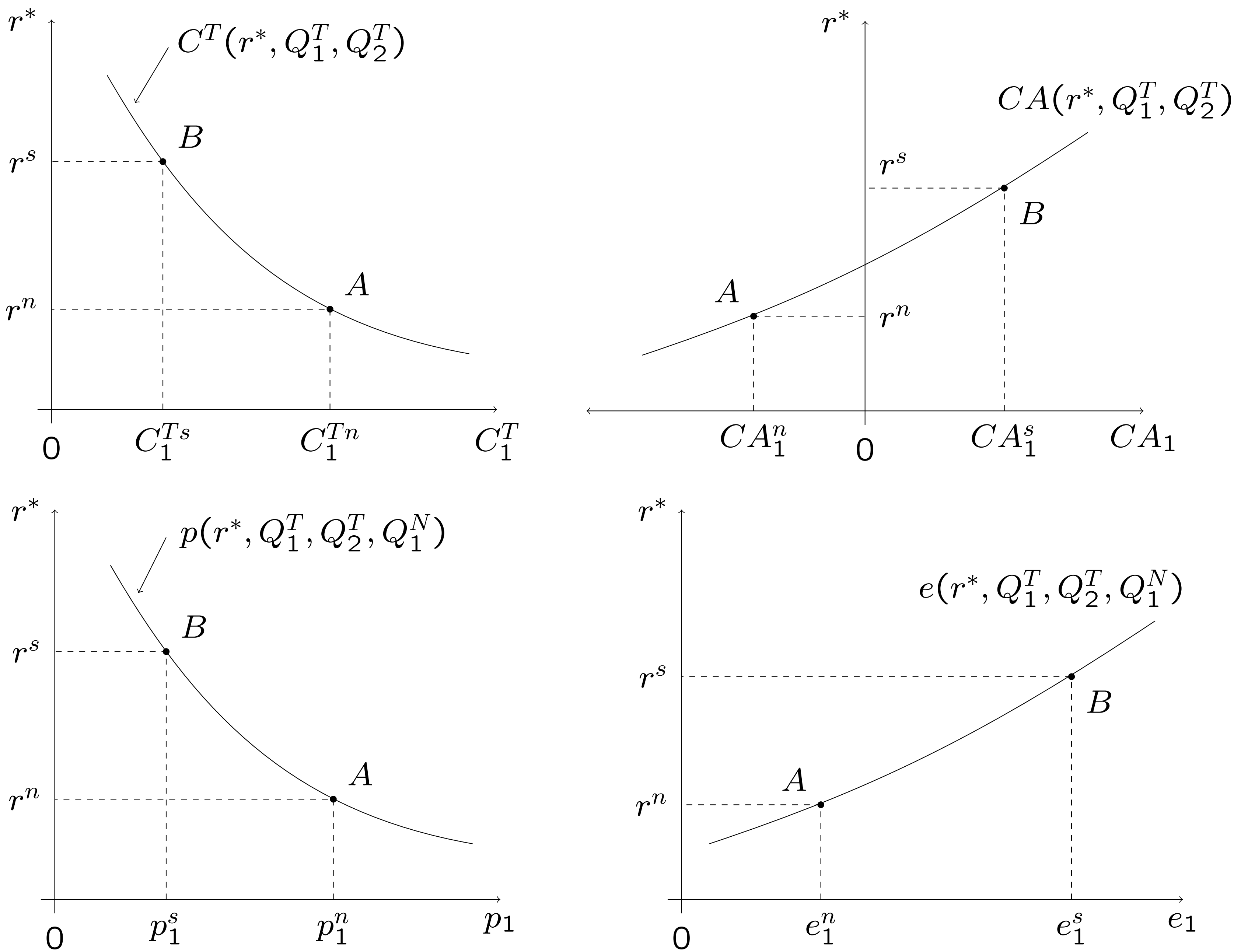
It then presents two case studies:
— The Argentine sudden stop of 2001
— The Icelandic sudden stop of 2008.

A Sudden Stop Through the Lens of the TNT Model

We model a sudden stop as an increase in the world interest rate, r^*.

The figure on the next slide summarizes the effects of an increase in the world interest rate on
– tradable consumption,
– the current account,
– the relative price of nontradables, and
– the real exchange rate
as predicted by the TNT model.

In the figure a sudden stop is modeled as an increase in the world interest rate from a normal level, denoted r^n, before the sudden stop, to a high level, denoted r^s, after the sudden stop.


r^*
$C^T(r^*, Q_1^T, Q_2^T)$
B
r^s
A
r^n
0
C_1^{Ts}
C_1^{Tn}
C_1^T
$CA(r^*, Q_1^T, Q_2^T)$
CA_1^n
CA_1^s
CA_1
$p(r^*, Q_1^T, Q_2^T, Q_1^N)$
p_1^s
p_1^n
p_1
$e(r^*, Q_1^T, Q_2^T, Q_1^N)$
e_1^n
e_1^s
e_1

The Figure Says That When A Sudden Stop Occurs . . .

• Top Left Panel: $r^* \uparrow \Rightarrow$ negative wealth effect (if the country is a debtor) and substitution effect away from present spending $\Rightarrow$ desired $C_1 \downarrow \Rightarrow C_1^T \downarrow$.

• Top Right Panel: $r^* \uparrow \Rightarrow C_1^T \downarrow$ and Q_1^T fixed, so $TB_1 = Q_1^T - C_1^T \uparrow$; $\Rightarrow CA_1 = r_0 B_0 + TB_1 \uparrow$. ($r_0 B_0$ is predetermined, so it is not affected by $r^* \uparrow$).

• Bottom Left Panel: $r^* \uparrow \Rightarrow$ desired $C_1 \downarrow \Rightarrow$ desired $C_1^N \downarrow$ but Q_1^N fixed, so $p_1 \downarrow$ required to clear the market. At the end, C_1^N does not change. $\Rightarrow C_1^N / C_1^T \uparrow$. This is called *expenditure switching* away from tradables and toward nontradables.

• Bottom Right Panel: $r^* \uparrow \Rightarrow p_1 \downarrow$, since the LOOP holds for tradables, the fact that nontradables became relatively cheaper means that the country became cheaper relative to the rest of the world, or $e_1 = \mathcal{E}_1 P_1^* / P_1 \uparrow$ (the real exchange rate depreciates)

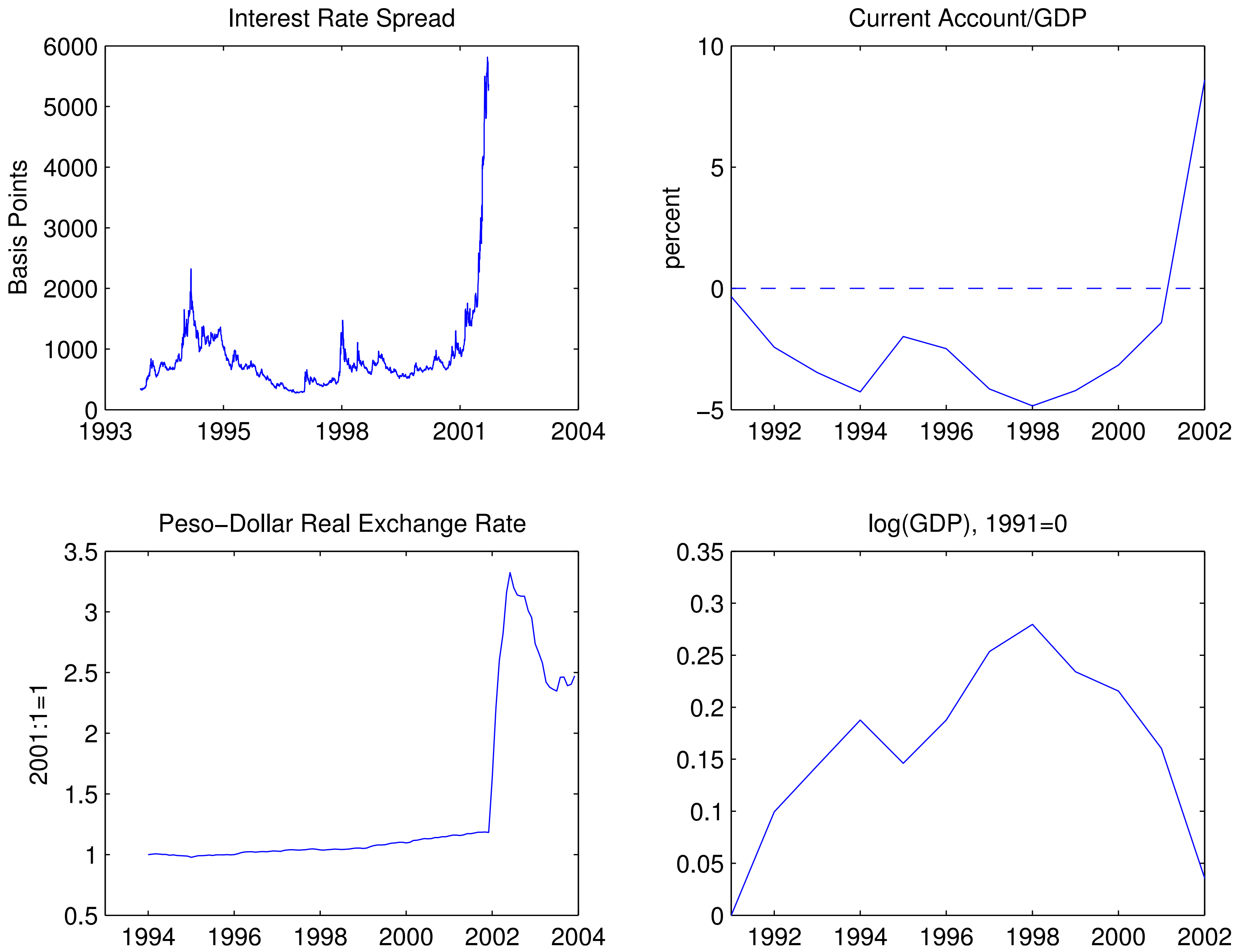
The Argentine Sudden Stop of 2001

In 1991 Argentina implemented an exchange-rate-based inflation stabilization plan. The plan consisted of pegging the peso to the U.S. dollar at a one-to-one parity (Convertibility Law) and lasted until 2001, when Argentina fell into a crisis that culminated in default and devaluation. The default isolated Argentina from international capital markets and hence capital inflows stopped abruptly.

The figure on the next slide shows the short-run effects of the sudden stop on:
– interest rates
– the current account
– the peso-dollar real exchange rate
– Argentine real GDP

... which are consistent with the predictions of the TNT model.

The Argentine Sudden Stop of 2001



Comments on the figure:

Top left panel: displays the interest rate spread of Argentine dollar-denominated bonds over U.S. Treasuries between 1994 and 2001. Prior to 2001, spreads fluctuated around 7 percent (700 basis points). In 2001 Argentine interest rate spreads exploded, reaching over 50 percent (or over 5,000 basis points) by late December. This suggests that in December 2001 Argentina suffered a sudden stop.

Top-right panel: From 1991 until 2000, Argentina ran current account deficits of around 3 percent of GDP on average. Thus, before the sudden stop the country was the recipient of sustained and sizable capital inflows. In 2002 the current account experienced a sharp and large reversal to 8 percent of GDP.

$\Rightarrow$ The observed behavior of the current account after the sudden stop is consistent with the predictions of the TNT model.

Comments on the figure (continued)

Bottom-left panel: displays the peso-dollar real exchange rate, $e_t = \mathcal{E}_t P_t^{US}/P_t^{AR}$. In December of 2001 the peso-dollar exchange rate shoots up from 1 peso per dollar to 3.5 pesos per dollar. In 2002, the Argentine consumer price index (P^{AR}) increased by 41 percent while the consumer price index in the United States grew by only 2.5 percent.

Percentage change in the peso-dollar real exchange rate

$$\begin{aligned}\left(\frac{e_t}{e_{t-1}} - 1\right) \times 100 &= \left[\frac{(\mathcal{E}_t/\mathcal{E}_{t-1})(P_t^{US}/P_{t-1}^{US})}{P_t^{AR}/P_{t-1}^{AR}} - 1\right] \times 100 \\ &= \left(\frac{3.5 \times 1.025}{1.41} - 1\right) \times 100 \\ &= 154.4 \text{ percent.}\end{aligned}$$

The Argentine peso depreciated in real terms 154 percent against the dollar. This is a large number.

$\Rightarrow$ The observed behavior of the real exchange rate after the sudden stop is consistent with the predictions of the TNT model.

The Icelandic Sudden Stop of 2008

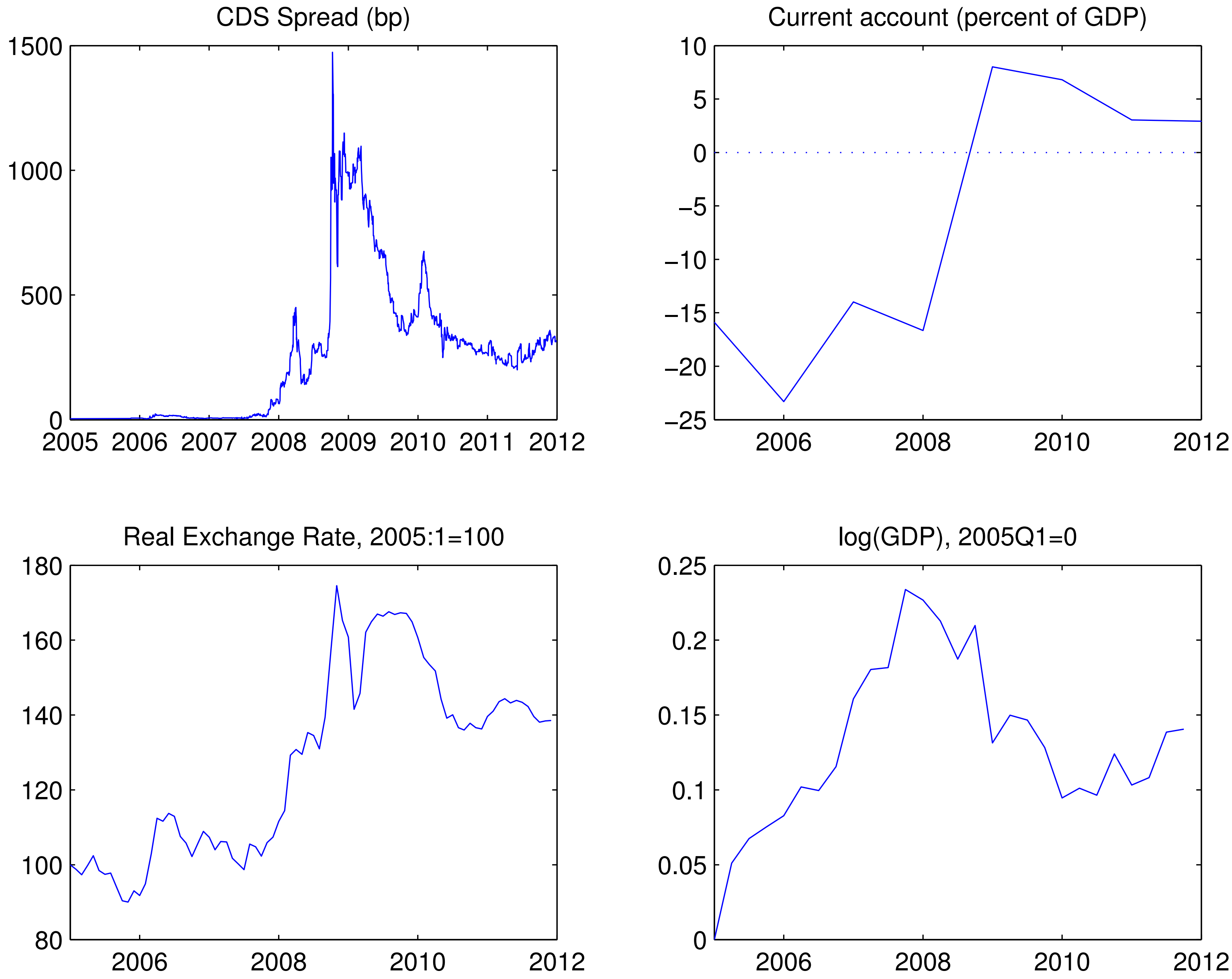
Sudden stops are not a phenomenon that pertains only to emerging countries. During the global financial crisis of 2007-2009 a number of medium- and high-income European countries with a history of large current account deficits also suffered sudden stops.

A case in point is Iceland. Between 2000 and 2008, this country ran large current account deficits, which combined increased its external debt by more than 50 percent of GDP. An immediate consequence of the disruption in global financial markets in 2008 was an abrupt cut in the flow of credit to small highly indebted economies in Europe, including Iceland, Ireland, Greece, Portugal, and Spain. The sudden stop in Iceland was particularly severe and thus we focus on it.

The root of the Icelandic crisis was its banking sector. The combined balance sheet of the major local banks stood at more than 10 times the country's GDP on the eve of the crisis. With the global financial crisis, the balance sheets of these banks deteriorated significantly as assets lost value relative to liabilities. Fearing default, foreign lenders to the Icelandic banking sector elevated the country's cost of credit.

The next slide shows the behavior of interest rates, the current account, the real exchange rate and output in Iceland around the sudden stop.

The Icelandic Sudden Stop of 2008



Comments on the figure

Top left panel: plots Iceland's credit default swap (CDS) spreads over the period 2005 to 2011. Typically countries are cut off from foreign credit during a sudden stop, so interest rates of newly issued debt might not be available. A good proxy of the effective country interest rates are CDS spreads. What are those? A CDS spread is the cost of insuring against default and is measured in basis points. For example, on September 1 2008, the Icelandic CDS spread was 200 basis points. This means that to insure 100 dollars of Icelandic debt against default, one had to pay 2 dollars per year. CDS spreads represent a measure of borrowing costs on debts with default risk relative to default free debt. Data on CDS spreads is useful because it is available even when the debtor does not issue new debt or when there are no liquid secondary debt markets. The figure shows that CDS spreads on Icelandic debt grew rapidly from 200 basis points in early September 2008 to over 1,400 basis points by mid October 2008. At this point Iceland was virtually cut off from the private international capital market. The economy was suffering a full blown sudden stop.

Comments on the figure (ctd.)

Top-right panel: Between 2008 and 2009 the current account balance went from a deficit of 17 percent of GDP to a surplus of 8 percent of GDP. Thus the Icelandic crisis conforms to a key characteristic of a sudden stop, namely, a sharp reversal of the current account.

Bottom-left panel: The krona-euro real exchange rate depreciated by 45 percent between January 2008 and January 2009, implying that Iceland became 45 percent cheaper relative to other countries in the euro zone in the aftermath of its sudden stop. This is consistent with the predictions of the TNT model according to which a sudden stop leads to a real depreciation of the domestic currency.

The TNT Model with Sectoral Production

Thus far, we have assumed that the outputs of tradable and nontradable goods are fixed.

This simplification is convenient but unrealistic for one would expect that shocks affecting the economy would have consequences for the sectoral levels of output and employment.

Example: we saw that an increase in the world interest rate causes a fall in the relative price of nontradables in terms of tradables, p_t. One would expect that firms in the tradable sector will expand production and employment while firms in the nontradable sector will shrink production and employment.

To capture this possibility, we now expand the TNT model to allow for sectoral production.

The Production Possibility Frontier

Assume that output in the traded and nontraded sectors is given by

$$Q_t^T = F_T(L_t^T) \quad \text{and} \quad Q_t^N = F_N(L_t^N), \tag{13}$$

where L_t^T and L_t^N denote labor in the traded and nontraded sectors in period $t = 1, 2$, and $F_T(\cdot)$ and $F_N(\cdot)$ are production functions.

Two assumptions:
(1) the marginal product of labor in each sector is positive (i.e., the production functions are increasing), $F_T' > 0$, $F_N' > 0$.
(2) Production exhibits diminishing marginal product of labor: $F_T'' < 0$, and $F_N'' < 0$ (i.e., the production functions are concave).

Suppose the total supply of labor is constant and equal to L. So we have the following resource constraint

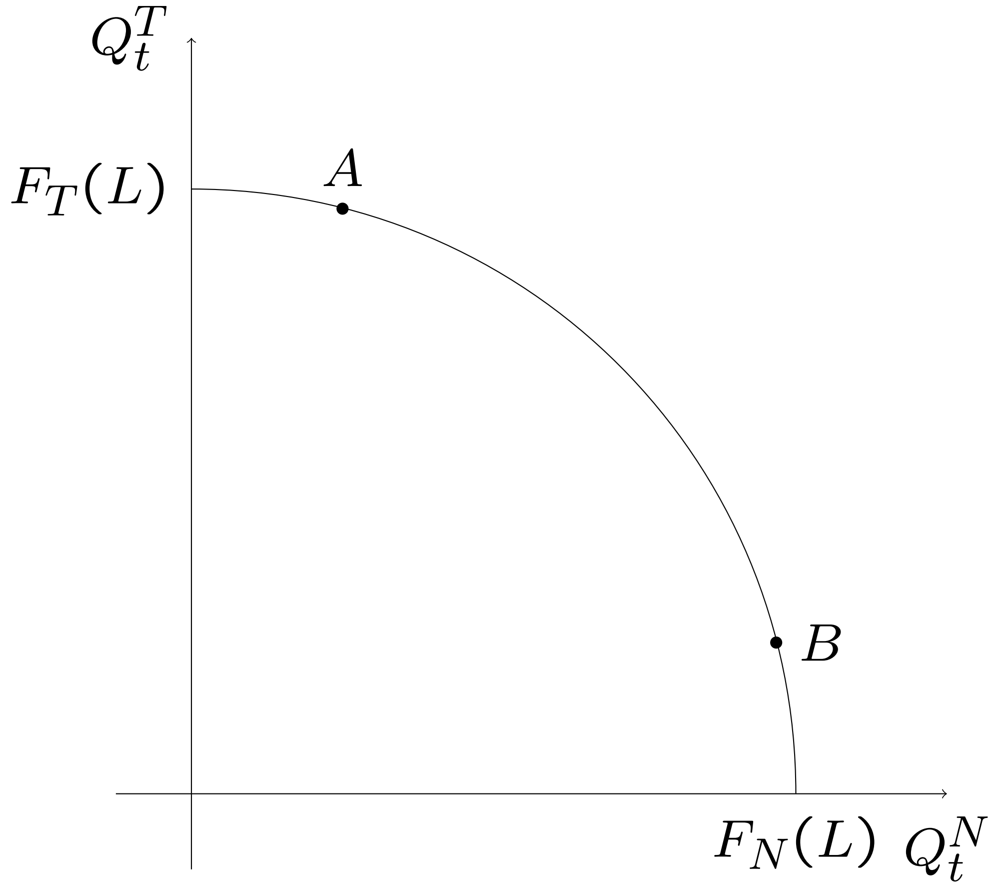
$$L_t^T + L_t^N = L. \tag{14}$$

The two production functions along with the resource constraint can be combined into a single relation between Q_t^T and Q_t^N known as the *production possibility frontier* (PPF):

$$F_T^{-1}(Q_t^T) + F_N^{-1}(Q_t^N) = L.$$

The next slide presents a graph of the PPF.

The Production Possibility Frontier (PPF)



The production possibility frontier (PPF) describes a negative relationship between output of nontradable goods, Q_t^N, and output of tradable goods, Q_t^T. Given the total amount of labor, L, increasing output in one sector requires reducing output in the other sector. If the sectoral production functions exhibit diminishing marginal products of labor, the PPF is concave.

The Slope of the PPF

Differentiate the resource constraint $L_t^T + L_t^N = L$ to get $dL_t^T + dL_t^N = 0$, or

$$\frac{dL_t^T}{dL_t^N} = -1.$$

Now differentiate the production functions $Q_t^T = F_T(L_t^T)$ and $Q_t^N = F_N(L_t^N)$ to get

$$dQ_t^T = F_T'(L_t^T)dL_t^T \qquad \text{and} \qquad dQ_t^N = F_N'(L_t^N)dL_t^N.$$

Combining the above three equations yields the slope of the PPF:

$$\frac{dQ_t^T}{dQ_t^N} = -\frac{F_T'(L_t^T)}{F_N'(L_t^N)}.$$

The Slope of the PPF (cont.)

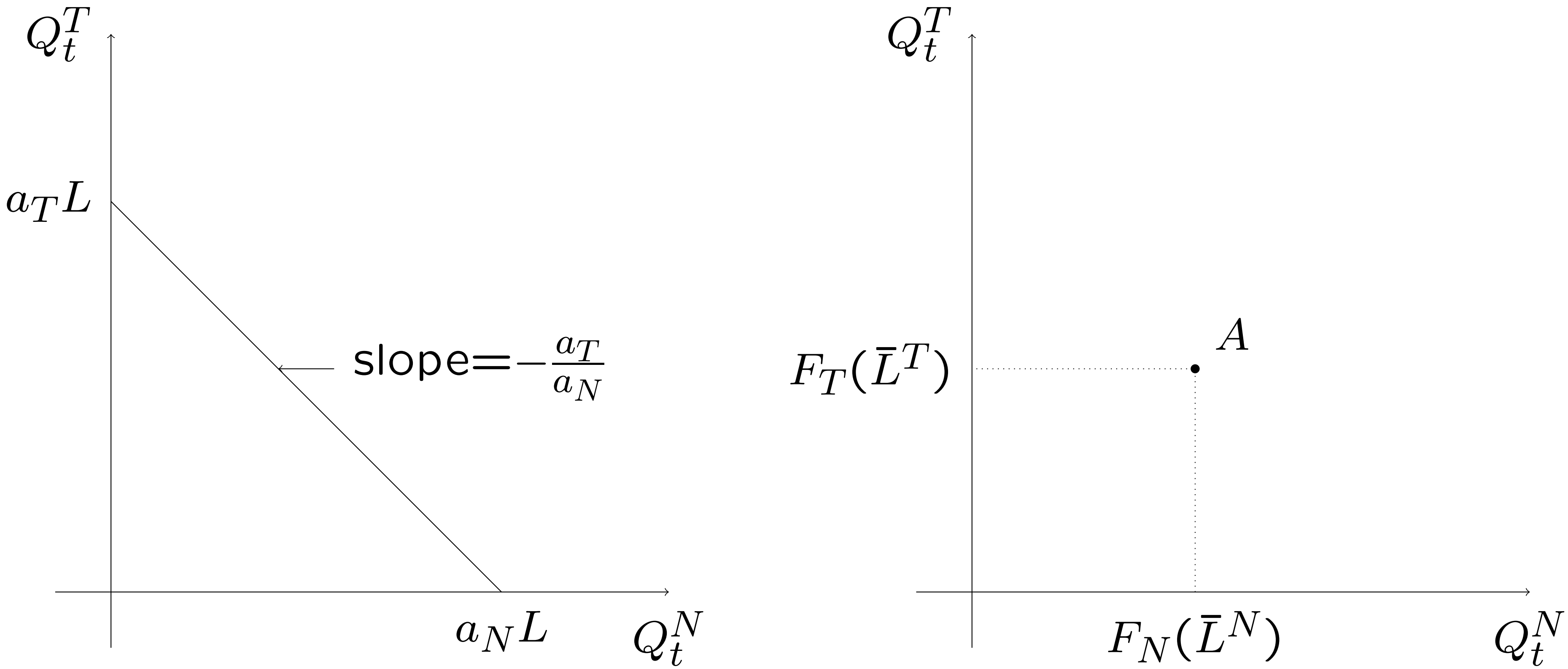
• Because the marginal products of labor $F_T'(L_t^T)$ and $F_N'(L_t^N)$ are positive, the slope of the PPF is negative.

• Because both production functions display diminishing marginal products of labor ($F_T''(L_t^T) < 0$ and $F_N''(L_t^N) < 0$) the PPF is concave.

• The curvature of the PPF depends on how quickly the marginal product of labor diminishes as employment increases.

• Two Special Cases (graphed on the next slide):
(a) Linear production functions, $Q_t^T = a_T L_t^T$ and $Q_t^N = a_N L_t^N$, where a_T and a_N are positive parameters. The PPF is linear with slope $-a_T/a_N$ (left panel).
(b) Full labor specialization. When each worker is productive in only one sector, the PPF becomes a single point (right panel).

The PPF: Two Special Cases



The slope of the PPF depends on the degree to which the marginal product of labor diminishes with employment. In the special case of a constant marginal product of labor, as when the technologies are $Q_t^T = a_T L_t^T$ and $Q_t^N = a_N L_t^N$, the PPF is linear as shown in the left panel. When labor is fully specialized in the production of one good, as with the technologies $Q_t^T = F_T(\overline{L}^T)$ and $Q_t^N = F_N(\overline{L}^N)$, the PPF collapses to a single point, as shown in the right panel.

Constructing the PPF: An Example

$$Q_t^T = \sqrt{L_t^T} \quad \text{and} \quad Q_t^N = \sqrt{L_t^N}.$$

Both production technologies display positive but diminishing marginal products of labor because the square root is an increasing and concave function.
Solving for labor yields

$$L_t^T = (Q_t^T)^2 \quad \text{and} \quad L_t^N = (Q_t^N)^2.$$

Using this to eliminate labor in the resource constraint $L_t^T + L_t^N = L$ yields the PPF

$$Q_t^T = \sqrt{L - (Q_t^N)^2}.$$

The slope of this PPF is the derivative of Q_t^T with respect to Q_t^N:

$$\frac{dQ_t^T}{dQ_t^N} = -\frac{Q_t^N}{Q_t^T}$$

Note: (i) the slope of the PPF is negative. (ii) as Q_t^N increases (and hence Q_t^T decreases), the slope becomes larger in absolute value.
Next you will see why the slope of the PPF is important.

The PPF and the Real Exchange Rate

Where on the PPF firms will operate depends on the relative price of nontradables in terms of tradables, p_t.

Profits of a firm in the traded sector, Π_t^T:

$$\Pi_t^T = P_t^T F_T(L_t^T) - W_t L_t^T, \tag{15}$$

where W_t = wage. The firm chooses L_t^T to maximize Π_t^T. The optimality condition is

$$P_t^T F_T'(L_t^T) - W_t = 0.$$

A firm in the nontraded sector does the same:

$$P_t^N F_N'(L_t^N) - W_t = 0.$$

The PPF and the Real Exchange Rate (cont.)

Combining the two optimality conditions yields

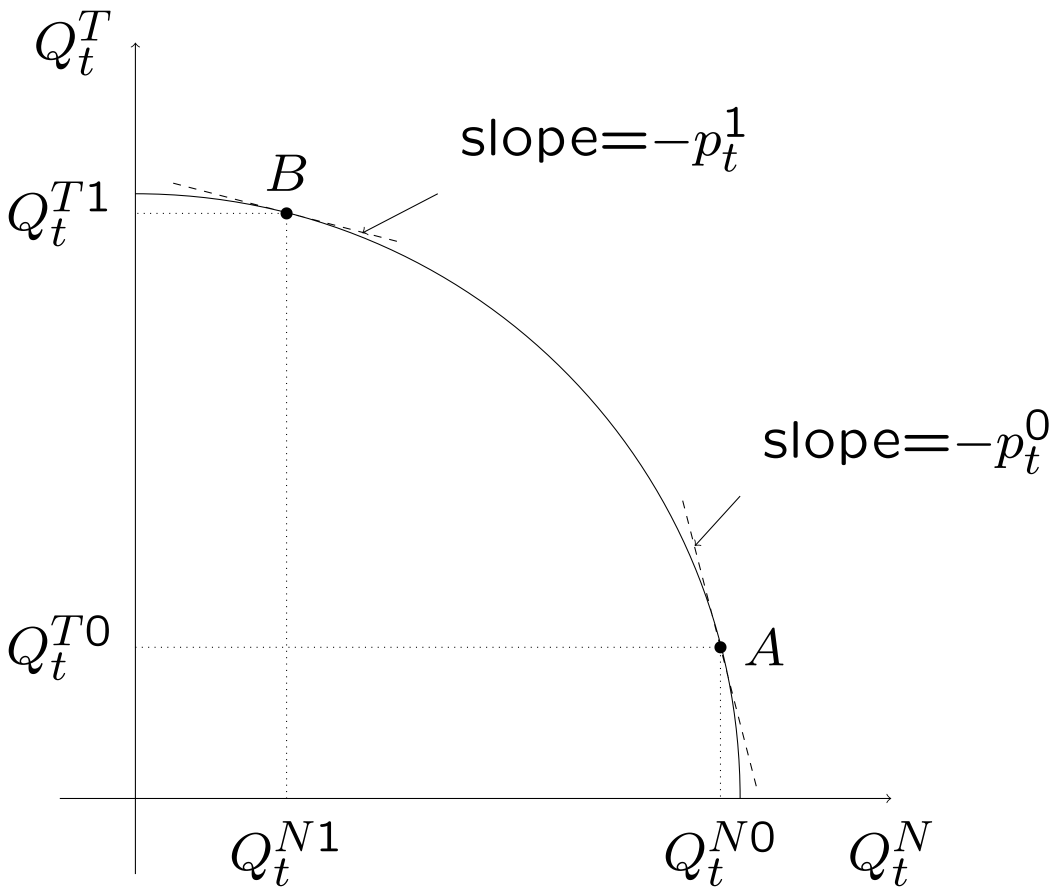
$$\frac{F'_T(L_t^T)}{F'_N(L_t^N)} = \frac{P_t^N}{P_t^T} \equiv p_t. \tag{16}$$

The left-hand side of this expression is (minus) the slope of the PPF, and the right-hand side is the relative price of nontradables in terms of tradables, p_t.

Thus the economy produces tradables and nontradables in quantities such that (minus) the slope of the PPF equals the relative price of nontradables in terms of tradables.

The graph on the next slide illustrates how sectoral output is reallocated as the relative price of nontradables changes.

The Optimal Production of Tradables and Nontradables



The optimal production of tradables and nontradable goods occurs at a point where (minus) the slope of the PPF equals the relative price of nontradables in terms of tradables. As the relative price of nontradables falls from p_t^0 to p_t^1 firms find it optimal to produce more tradables and less nontradables.

The Income Expansion Path

The Household's Optimization Problem

The household's utility function is, as before,

$$\ln C_1 + \beta \ln C_2, \tag{R1}$$

with C_t being a composite of C_t^T and C_t^N, as follows

$$C_1 = (C_1^T)^\gamma (C_1^N)^{1-\gamma} \quad \text{and} \quad C_2 = (C_2^T)^\gamma (C_2^N)^{1-\gamma}$$

The household's budget constraints in periods 1 and 2 are

$$\begin{aligned} P_1^T C_1^T + P_1^N C_1^N + P_1^T B_1 &= W_1 L + \Pi_1^T + \Pi_1^N \\ P_2^T C_2^T + P_2^N C_2^N &= W_2 L + \Pi_2^T + \Pi_2^N + (1+r_1) P_2^T B_1. \end{aligned}$$

where L_t denotes labor effort, and Π_t^T and Π_t^N denote profit income received from firms. Divide the period-t budget constraint by P_t^T, combine the resulting expressions to eliminate B_1, and rearrange to get

$$C_1^T + p_1 C_1^N + \frac{C_2^T + p_2 C_2^N}{1+r_1} = \bar{Y} \equiv \frac{W_1}{P_1^T} L + \frac{\Pi_1^T}{P_1^T} + \frac{\Pi_1^N}{P_1^T} + \frac{\frac{W_2}{P_2^T} L + \frac{\Pi_2^T}{P_2^T} + \frac{\Pi_2^N}{P_2^T}}{1+r_1}$$

First-Order Optimality Conditions

The household's utility function, the consumption aggregator, and the budget constraint are the same as in the endowment version of the TNT model. So the first-order conditions are also the same as in the endowment version of the TNT model:

$$C_2^T = \beta(1 + r_1)C_1^T$$

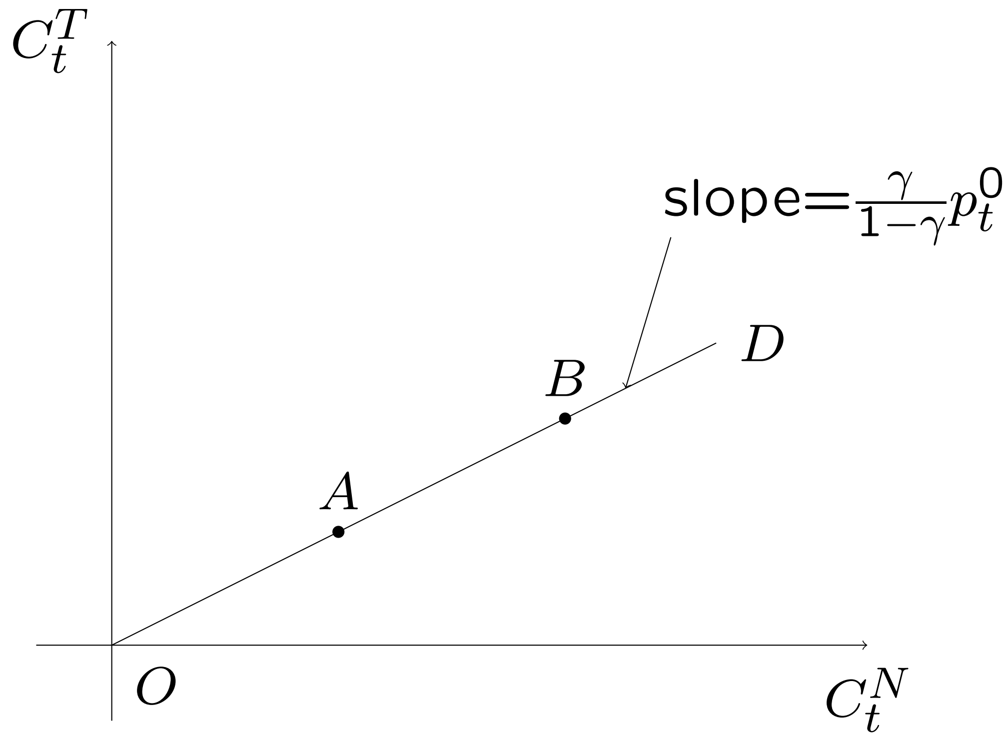
$$C_t^T = \frac{\gamma}{1-\gamma} p_t C_t^N.$$

The figure on the next slide plots the optimality condition $C_t^T = \frac{\gamma}{1-\gamma} p_t C_t^N$ in the space (C_t^N, C_t^T) for a given price p_t^0 as the ray $\overline{OD}$. This relationship is known as the *income expansion path*.

What point on the income expansion path the household will pick depends on how much income it allocates to consumption expenditure in period t.

Given p_t^0, the higher the amount of income allocated to consumption in period t is, the larger C_t^T and C_t^N will be, that is, the farther away from the origin the optimal consumption choice will lie.

The Income Expansion Path



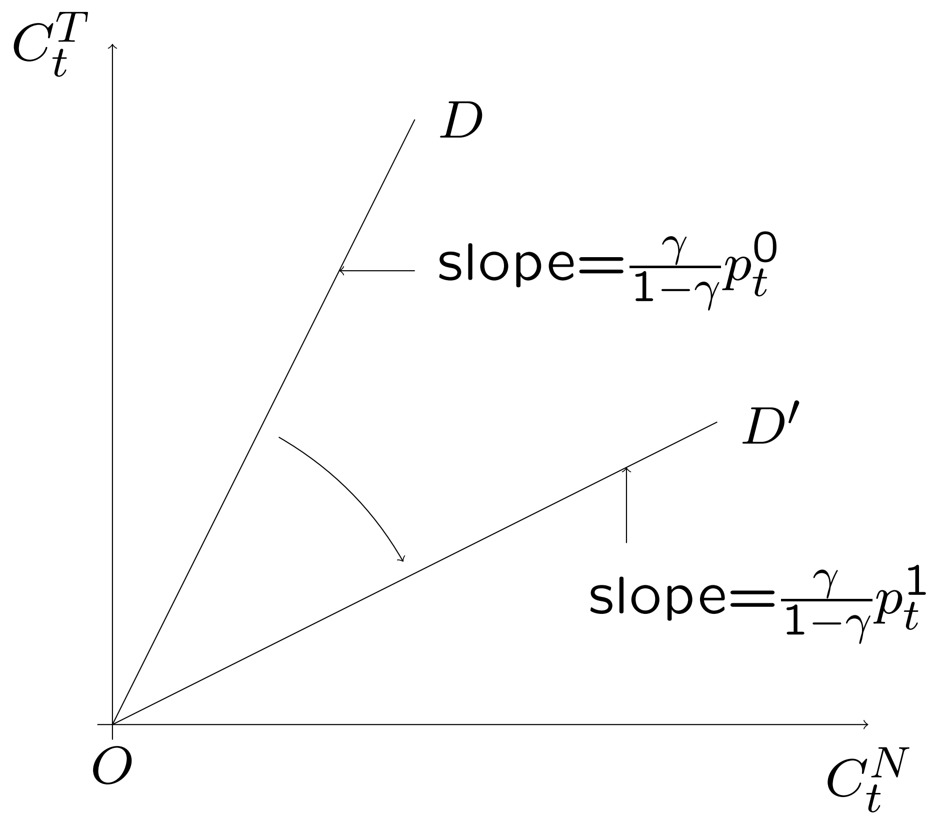
The figure depicts the income expansion path associated with the relative price p_t^0 as the ray $\overline{OD}$. Given p_t^0, the optimal combination of tradable and nontradable consumption must lie on the income expansion path. What point on the income expansion path the household will pick depends on how much income it allocates to consumption expenditure in period t. At point B, the household allocates more income to consumption in period t than at point A. If both goods are normal, the income expansion path is upward sloping.

The next figure illustrates that the slope of the income expansion path is increasing in the relative price of nontradables in terms of tradables, p_t.

The figure displays the income expansion paths associated with two relative prices, p_t^0 and $p_t^1 < p_t^0$ as the rays $\overline{OD}$ and $\overline{OD'}$.

As the relative price of nontradables falls from p_t^0 to p_t^1, the income expansion path pivots clockwise around the origin. This is intuitive, because a lower price of nontradables induces households to substitute nontradables for tradables in consumption.

The Relative Price of Nontradables and the Income Expansion Path



The figure displays the income expansion path associated with two values of the relative price of nontradables, p_t^0 and $p_t^1 < p_t^0$ as the rays $\overline{OD}$ and $\overline{OD'}$, respectively. A decline in the relative price of nontradables rotates the income expansion path clockwise around the origin. This rotation is a reflection of households substituting nontradable consumption for tradable consumption as tradables become relatively more expensive.

Partial equilibrium

• The next figure puts together the first two building blocks of the model, the production possibility frontier and the income expansion path.

• It represents the equilibrium in period t for a given relative price of nontradables, p_t^0. Because this price is an endogenous variable that we are taking as given, the analysis is called *partial equilibrium.*

• To determine production, we must find the output mix (Q_t^N, Q_t^T) at which the slope of the PPF is $-p_t^0$. Suppose this point is A.

• At point A, output of nontradables equals Q_t^{N0} and output of tradables equals Q_t^{T0}.

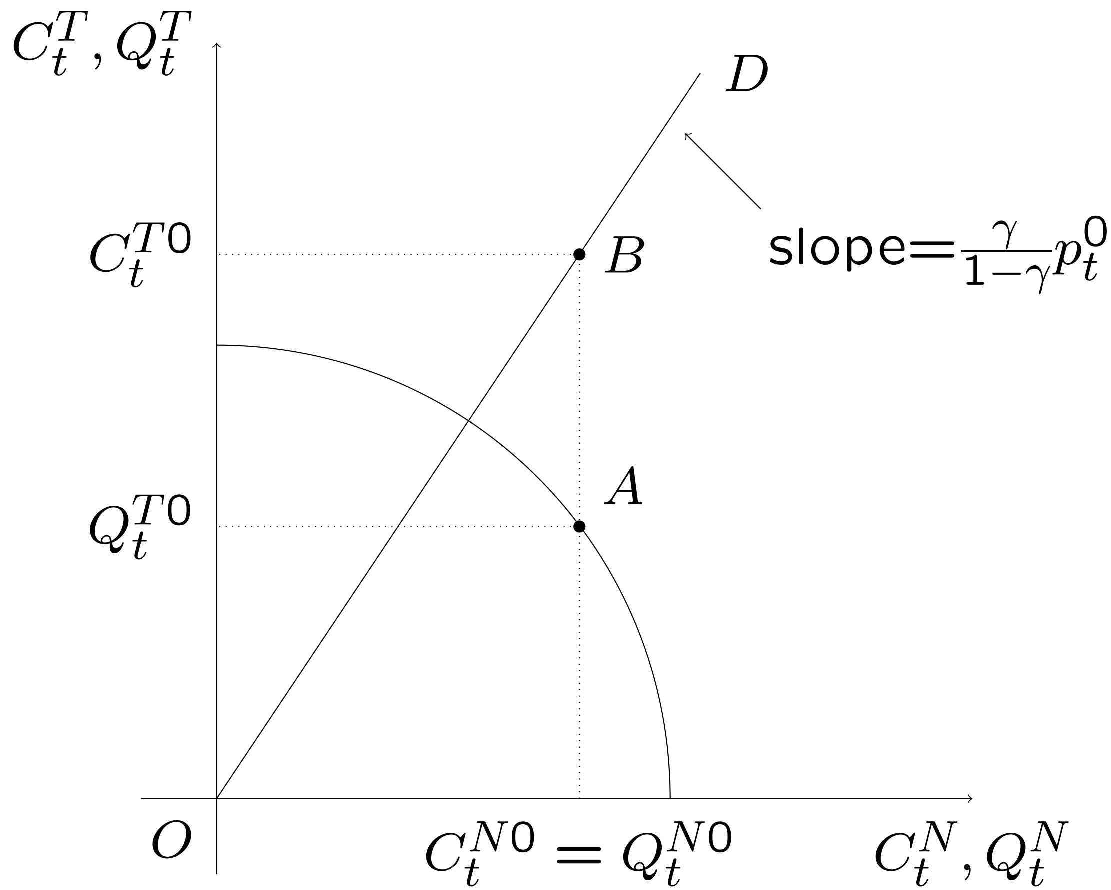
• The income expansion path corresponding to p_t^0 is the ray $\overline{OD}$.

• By definition, consumption of nontradables, C_t^{N0} must equal Q_t^{N0}.

• Given consumption of nontradables, the income expansion path determines uniquely the level of consumption of tradables, C_t^{T0}, at point B.

• The trade balance is the difference between production and consumption of tradables, $TB_t = Q_t^T - C_t^T$, which is the vertical distance between points A and B in the figure.

Partial Equilibrium



The figure displays the equilibrium for a given relative price of nontradables p_t^0. Production is at point A, where the slope of the PPF is $-p_t^0$. Consumption is at point B. The trade balance is the vertical distance between points A and B. Because consumption of tradables, C_t^{T0} is larger than output of tradables, Q_t^{T0}, the country is running a trade deficit in period t.

Partial Equilibrium Effect of a Real Exchange Rate Depreciation

• Suppose the relative price of nontradables falls from p_t^0 to $p_t^1 < p_t^0$. This is a depreciation of the real exchange rate, because it makes the economy becomes cheaper relative to the rest of the world.

• The next figure illustrates this situation.

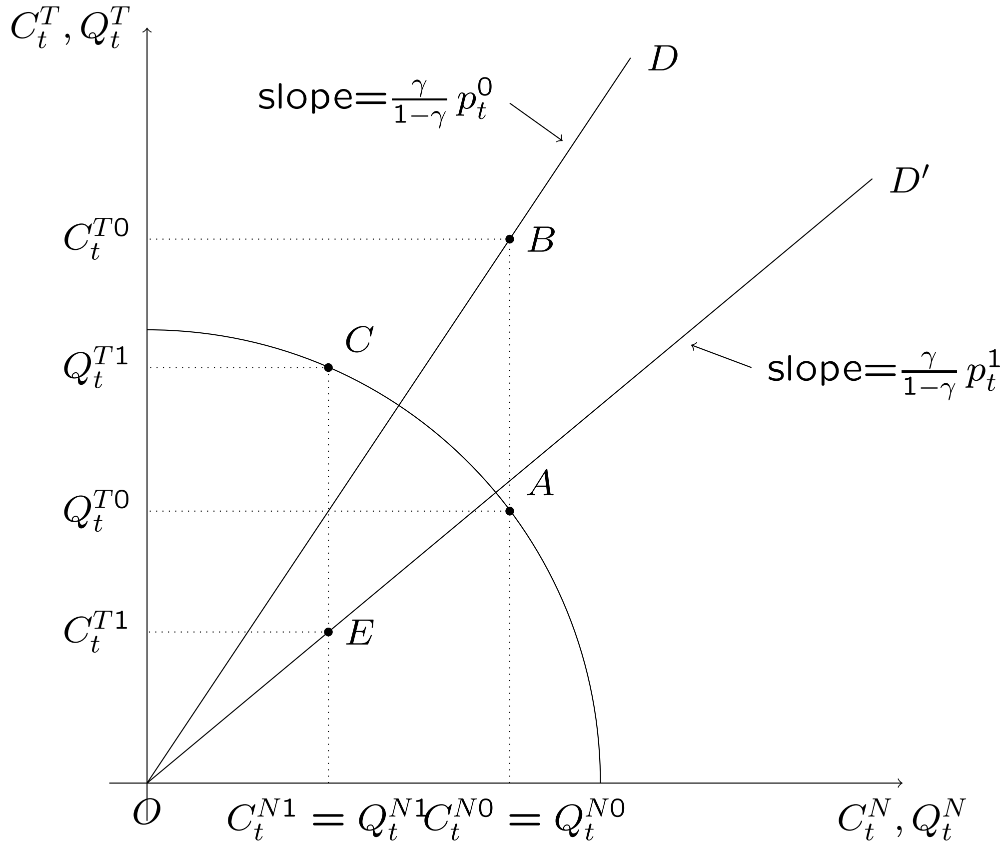
• The economy is initially producing at point A and consuming at point B. The trade balance, given by the distance between A and B, is negative.

• The fall in p_t causes a change in the production mix to a point like C, where the PPF is flatter than at point A. The economy produces less nontradables and more tradables.

• The fall in p_t also causes a clockwise rotation of the income expansion path from $\overline{OD}$ to $\overline{OD'}$.

• The new consumption basket is point E, and the new trade balance is the vertical distance between points C and E.

Partial Equilibrium: Adjustment to a Real Exchange Rate Depreciation



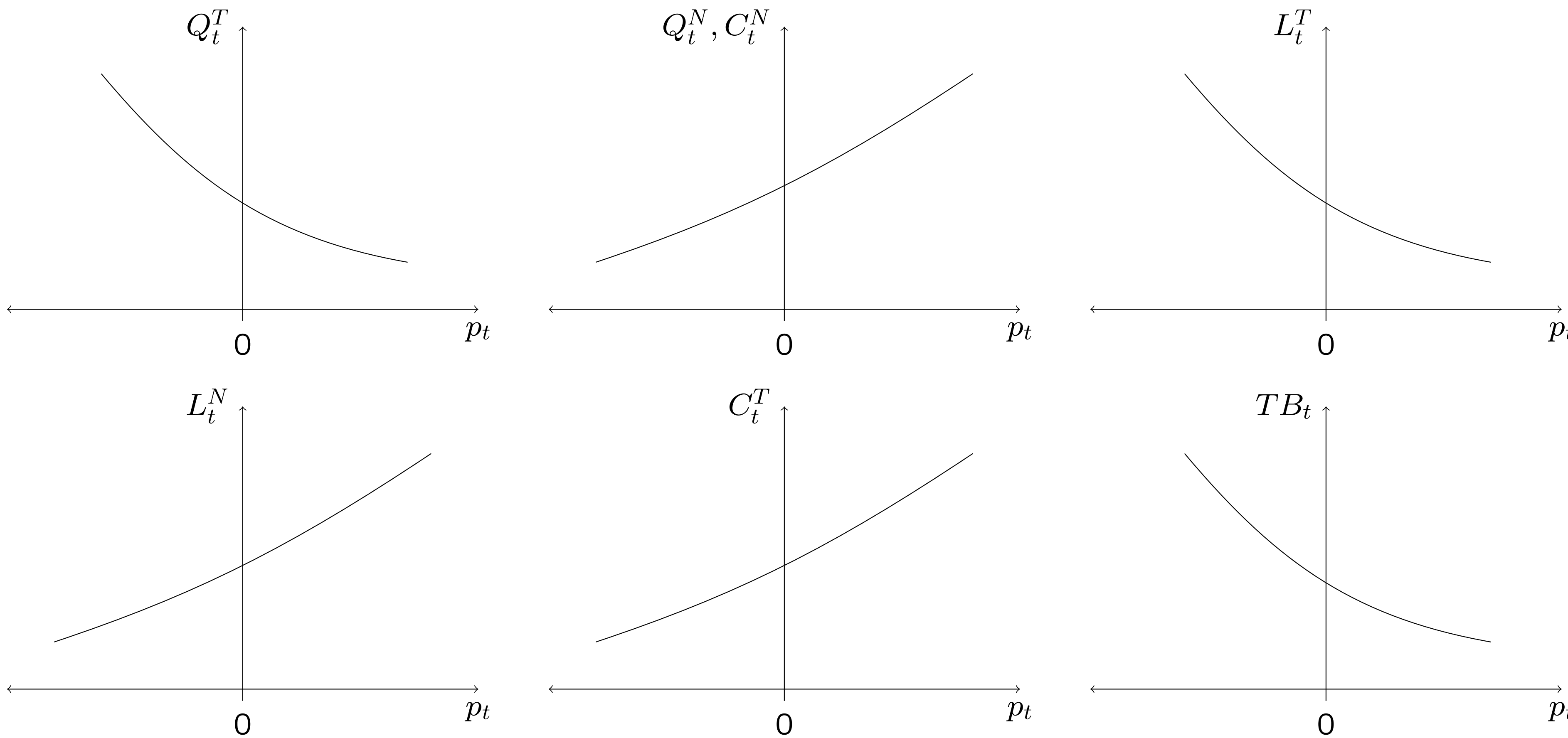
The figure displays the adjustment to a fall in the relative price of nontradables from p_t^0 to $p_t^1 < p_t^0$. Initially, production is at point A and consumption is at point B. After the real depreciation production shifts to point C and consumption to point E. Thus, production of tradables expands, production of nontradables contracts, and consumption of both tradables and nontradables contract. The new trade balance, given by the vertical distance between C and E, improves.

Summarizing

In response to the fall in p_t the economy produces more tradables ($Q_t^{T1} > Q_t^{T0}$) and less nontradables ($Q_t^{N1} < Q_t^{N0}$), and consumes less tradables as well as nontradables ($C_t^{T1} < C_t^{T0}$ and $C_t^{N1} < C_t^{N0}$), and the trade balance improves.

These relationships are illustrated in the next figure.

Partial equilibrium: Endogenous Variables as Functions of the Relative Price of Nontradables



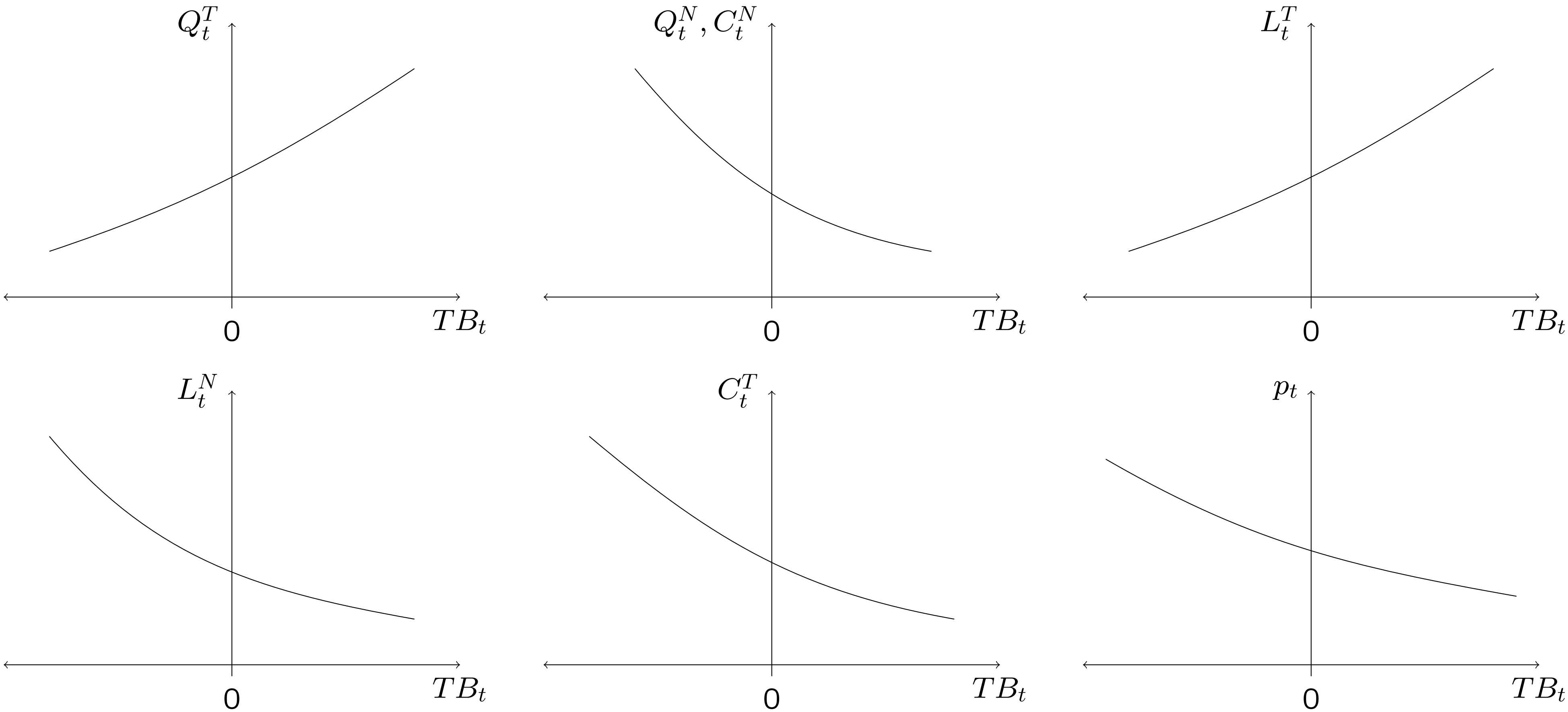
The figure displays the equilibrium values of seven endogenous variables of the TNT model for different given values of the relative price of nontradables.

The analysis we have conducted is called partial equilibrium because it characterizes the behavior of endogenous variables of the model (Q_t^T, Q_t^N, C_t^T, C_t^N, L_t^T, L_t^N, and TB_t) taking as exogenous the value of one endogenous variable of the model, p_t.

We could have picked any other variable instead of p_t and treated it as exogenous. For example, consider the trade balance, TB_t. From the bottom-right panel of the previous figure, we see that it is inversely related to p_t. We can now easily relate any other endogenous variable with TB_t. Take tradable consumption, C_t^T. From the bottom-middle panel of the previous figure, we see that C_t^T is positively related with p_t. Since p_t is inversely related with TB_t, we have that C_t^T is inversely related to TB_t. A similar logic applies to the other variables.

The next figure plots all endogenous variables of the TNT model as functions of the trade balance, which is also endogenous, but is taken as exogenous in this partial equilibrium analysis.

Partial equilibrium: Endogenous Variables as Functions of the Trade Balance



The figure displays the equilibrium values of the endogenous variables of the model for different given values of the trade balance.

General Equilibrium

The partial equilibrium analysis leaves two equations out of the analysis.

- The Euler equation

and

- The intertemporal resource constraint

The Euler Equation in Equilibrium

Recall that the Euler equation is given by $C_2^T = \beta(1+r^*)C_1^T$. Using the result derived in the partial equilibrium analysis that there is a one-to-one relationship between C_t^T and TB_t (see the previous figure), we can write $C_t^T = C^T(TB_t)$. So the Euler equation becomes

$$C^T(TB_2) = \beta(1+r^*)C^T(TB_1)$$

This relationship is plotted in slide 75 as the locus $\overline{EE}$.

The Resource Constraint in Equilibrium

The resource constraints of the economy in periods 1 and 2 are

$$C_1^T + B_1 = Q_1^T \quad \text{and} \quad C_2^T = Q_2^T + (1+r^*)B_1$$

Combining them to get rid of B_1 yields

$$C_1^T + \frac{C_2^T}{1+r^*} = Q_1^T + \frac{Q_2^T}{1+r^*}$$

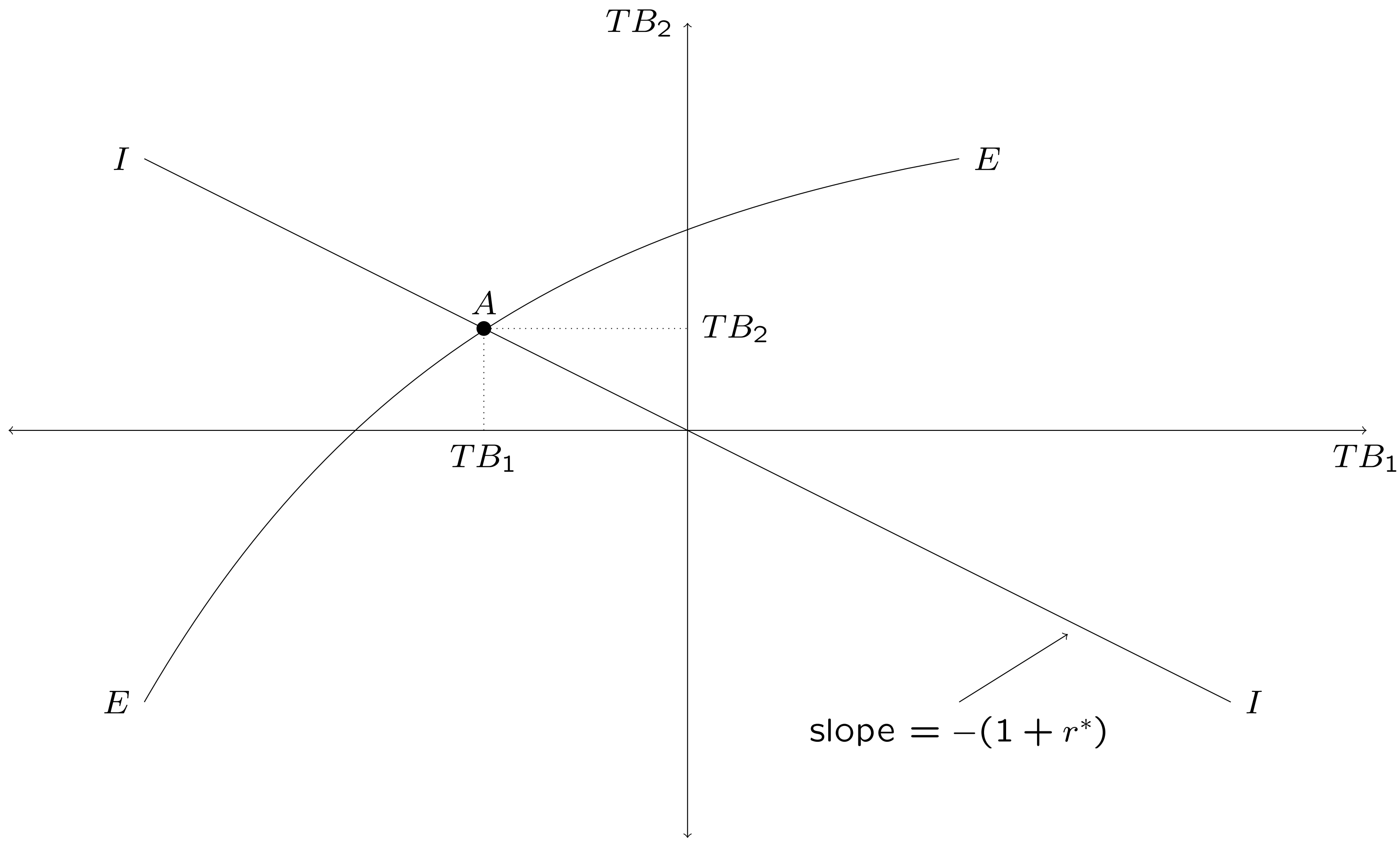
Recalling that $TB_t = Q_t^T - C_t^T$, we can write

$$TB_2 = -(1+r^*)TB_1$$

This equilibrium resource constraint is plotted in the next figure as the locus $\overline{II}$. Intuitively, if the country runs a trade surplus in period 1, it can save these resources in a bank for one period, allowing it to spend the proceeds next period.

The equilibrium takes place at point A, where the loci $\overline{EE}$ and $\overline{II}$ intersect.

General Equilibrium Determination of the Trade Balance



The locus $\overline{EE}$ depicts the pairs of current and future trade balances TB_1 and TB_2 that are consistent with the household's Euler equation in equilibrium. The locus $\overline{II}$ depicts the pairs (TB_1, TB_2) that satisfy the economy's intertemporal resource constraint in equilibrium. The equilibrium is at point A, where the economy runs a trade balance deficit in period 1 ($TB_1 < 0$) and a surplus in period 2 ($TB_2 > 0$).

Sudden Stops and Sectoral Reallocations

Suppose that the world interest rate increases from r^n to $r^s > r^n$.

The effect of this shock is illustrated in the next figure.

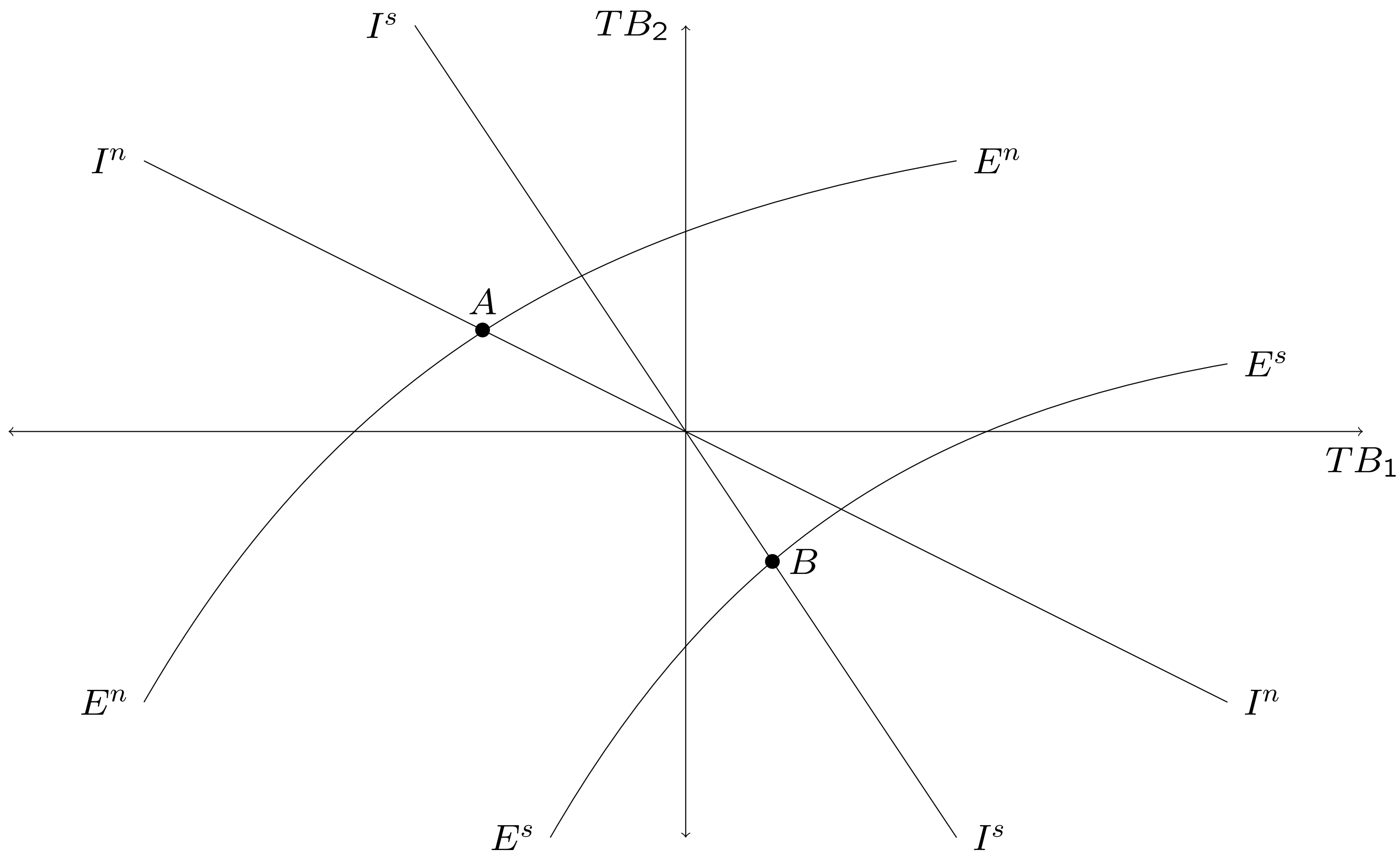
The equilibrium before the sudden stop (normal times) is at point A, where the economy runs a trade balance deficit in period 1 and a surplus in period 2.

The increase in the interest rate pushes $\overline{EE}$ locus down and to the right from $\overline{E^nE^n}$ to $\overline{E^sE^s}$ and causes a clockwise rotation in the locus $\overline{II}$ from $\overline{I^nI^n}$ to $\overline{I^sI^s}$. This is shown in the next figure.

The new equilibrium is at point B. In period 1 the trade balance experiences a reversal from a deficit to a surplus.

The analysis of partial equilibrium then tells us (see the figure in slide 70) that output and employment increase in the traded sector and fall in the nontraded sector.

A Sudden Stop in the TNT Model with Production



The figure depicts the adjustment of the trade balance to an increase in the interest rate from r^n to $r^s > r^n$. The equilibrium before the sudden stop is at point A, where $\overline{I^n I^n}$ intersects $\overline{E^n E^n}$. At point A, the country runs a trade deficit in period 1. In response to the increase in the interest rate to r^s, the equilibrium moves to point B, where the loci $\overline{I^s I^s}$ and $\overline{E^s E^s}$ intersect. At point B, the country runs a trade surplus in period 1. Thus, the sudden stop leads to a trade balance reversal.

Taking stock

- The effects of a sudden stop on the trade balance (improvement), the real exchange rate (depreciation), and the absorption of tradable goods (contraction), are the same as in the endowment economy.

- The new prediction stemming from the economy with sectoral production is that the sudden stop also causes a contraction in the absorption of nontradable goods and a reallocation of output and employment away from the nontraded sector and toward the traded sector.

- In the model the reallocation of workers across sectors happens instantaneously. In real life, however, it is not so easy for workers to move from one sector to another. Such a transition typically involves a period of involuntary unemployment during which the workers that lost their job in the nontraded sector search for a new job.

Let's Take Another Look at the Data

• The TNT model's prediction of a sectoral reallocation of production away from nontradable sectors and toward tradable sectors is borne out in the data.

The next figure plots GDP in the construction and the wholesale and retail trade sectors—two large and labor-intensive nontradable sectors—as shares of total GDP around the Argentine and Icelandic sudden stops.

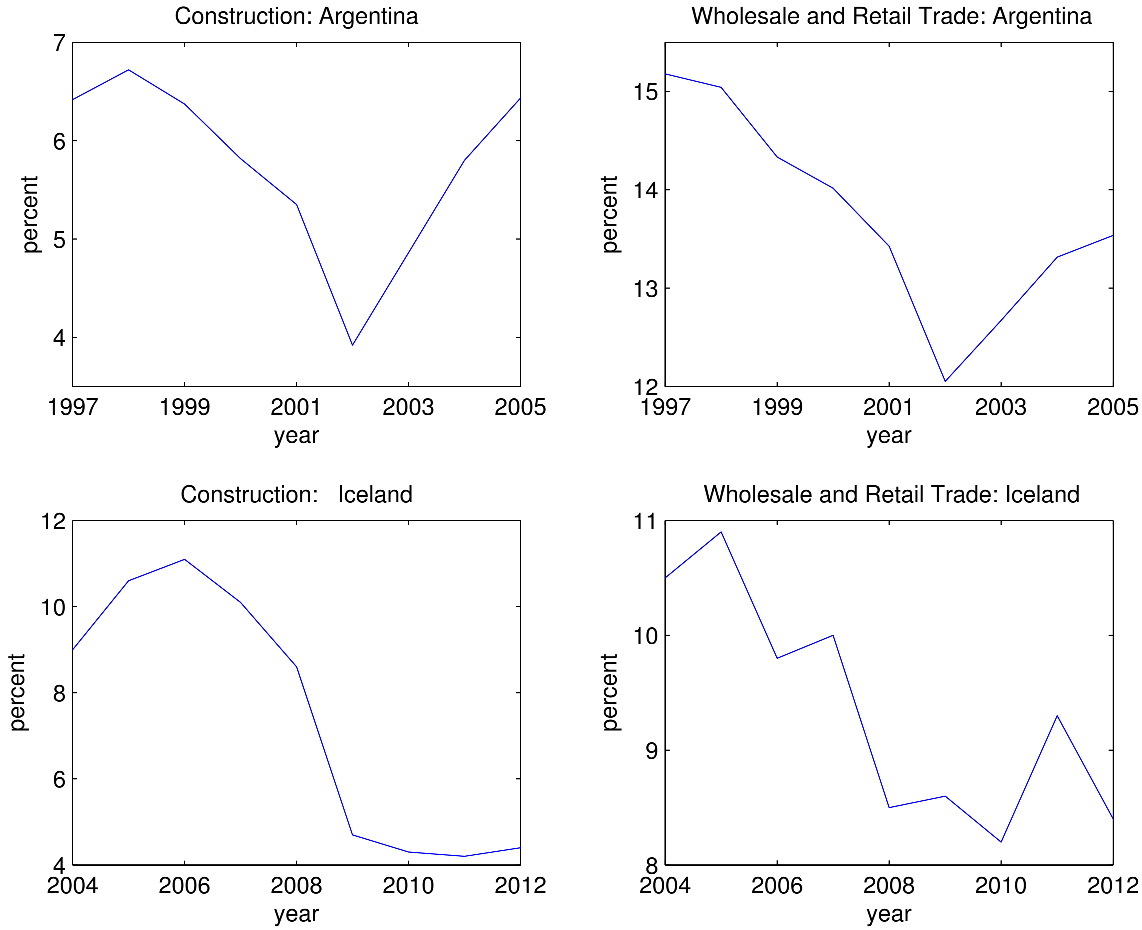
• Their combined share in GDP fell from an average of 20 percent to less than 16 percent during the Argentine sudden stop of 2001 and from an average of 20 percent to less than 15 percent during the Icelandic sudden stop of 2008.

Let's Take Another Look at the Data (ctd.)

• Recalling that in 2002 total GDP in Argentina fell by 12.5 percent, it follows that the crisis in the construction and the wholesale and retail trade sectors was enormous in absolute terms. A similar pattern is observed in the Icelandic sudden stop.

• Because of their labor intensity, these sectors contributed greatly to the surge in involuntary unemployment suffered by Argentina and Iceland in the aftermath of their sudden stops.

GDP Shares in Construction and Wholesale and Retail Trade During the Sudden Stops in Argentina 2001 and Iceland 2008



Construction and wholesale and retail trade are large, labor intensive, nontradable sectors. Their combined share in GDP fell from an average of 20 percent to less than 16 percent during the Argentine sudden stop of 2001 and from an average of 20 percent to less than 15 percent during the Icelandic sudden stop of 2008. This pattern of sectoral reallocation of production away from nontradable sectors conforms with the predictions of the TNT model.

Productivity Differentials and Real Exchange Rates: The Balassa-Samuelson Model

- The TNT model assumes no technological progress. For this reason, it is most useful for understanding short-run movements in the real exchange rate.

- We will now present a popular theory of the long-run determinants of the real exchange rate. It's known as the Balassa-Samuelson model.

- It predicts that persistent movements in the real exchange rate are due to differential cross-country changes in relative productivities in the traded and nontraded sectors.

The Production Technologies

Suppose that tradable and nontradable goods are produced with linear production functions,

$$Q^T = a_T L^T \quad \text{and} \quad Q^N = a_N L^N, \tag{17}$$

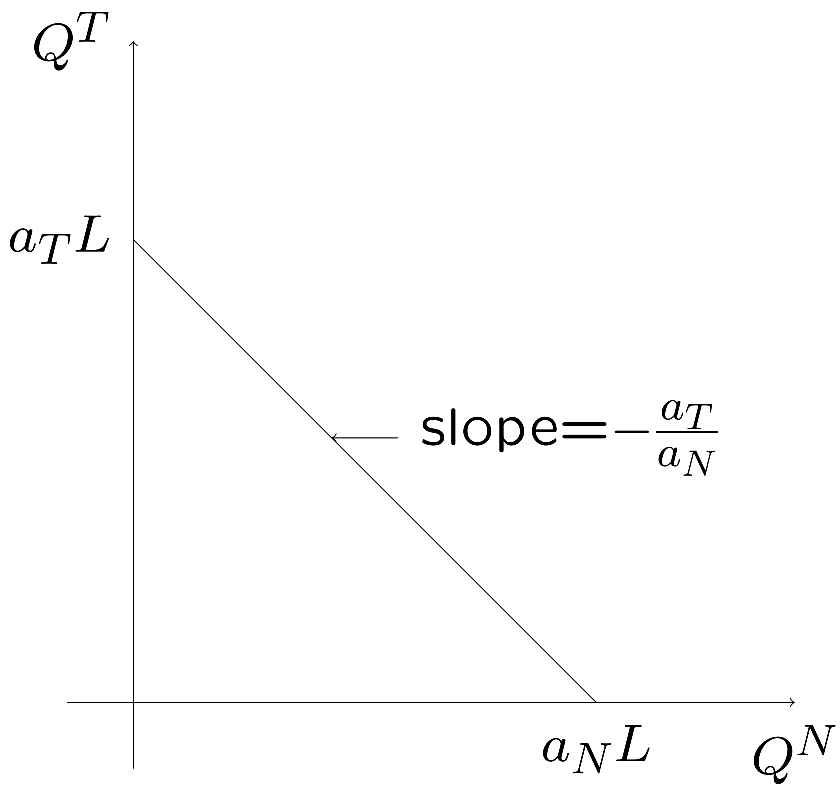
where a_T and a_N are positive parameters and denote labor productivity in the traded and nontraded sectors, and L^T and L^N denote labor input in the traded and nontraded sectors.

Total labor supply is constant and equal to L:

$$L^T + L^N = L.$$

These production functions give rise to a linear PPF as shown in the figure on the next slide

The PPF when Technology is Linear in Labor



Firms

Profits in the traded and nontraded sectors are given by

$$P^T Q^T - W L^T \quad \text{and} \quad P^N Q^N - W L^N.$$

Assume that perfect competition and absence of restrictions for firms to enter the market drive profits to zero in both sectors. So we have

$$P^T Q^T = W L^T \quad \text{and} \quad P^N Q^N = W L^N.$$

Using the production functions $Q^T = a_T L^T$ and $Q^N = a_N L^N$ to eliminate Q^T and Q^N, we get

$$P^T a_T = W \quad \text{and} \quad P^N a_N = W.$$

Now combine these two expressions to eliminate W

$$\frac{P^N}{P^T} = \frac{a_T}{a_N}. \tag{18}$$

In words, in equilibrium the relative price of nontraded goods, P^N/P^T, is equal to the ratio of labor productivity in the traded sector to that in the nontraded sector, a_T/a_N.

The Foreign Country

In the foreign country, the relative price of nontradables is determined in a similar fashion:

$$\frac{P^{N*}}{P^{T*}} = \frac{a_T^*}{a_N^*}. \tag{19}$$

The Equilibrium Real Exchange Rate

The price levels in the domestic and foreign countries are averages of the respective prices of tradables and nontradables:

$$P = \phi(P^T, P^N) \qquad \text{and} \qquad P^* = \phi^*(P^{T*}, P^{N*})$$

In turn, the real exchange rate, e, is the relative price of a basket of goods abroad in terms of domestic baskets of goods:

$$e = \frac{\mathcal{E}\phi^*(P^{T*}, P^{N*})}{\phi(P^T, P^N)}$$

Assume the LOOP holds for tradables, $P^T = \mathcal{E}P^{T*}$. Then,

$$e = \frac{\phi^*(1, P^{N*}/P^{T*})}{\phi(1, P^N/P^T)}$$

The Equilibrium Real Exchange Rate (ctd.)

Using $\frac{P^N}{P^T} = \frac{a_T}{a_N}$ and $\frac{P^{N*}}{P^{T*}} = \frac{a_T^*}{a_N^*}$ to eliminate $\frac{P^N}{P^T}$ and $\frac{P^{N*}}{P^{T*}}$ yields

$$e = \frac{\phi^*(1, a_T^*/a_N^*)}{\phi(1, a_T/a_N)} \tag{20}$$

This is the main result of the Balassa-Samuelson model: deviations from PPP ($e \neq 1$) are due to differences in relative productivities across countries.

If a_T/a_N grows faster than a_T^*/a_N^*, then the real exchange rate will appreciate over time ($e \downarrow$), i.e., the domestic country will become more expensive.

Why? Because in the domestic country nontradables are becoming relatively more costly to produce than in the foreign country, forcing the relative price of nontradables in the domestic country to grow at a faster rate than in the foreign country.

Empirical Validity of the Balassa-Samuelson Model

The Balassa-Samuelson model predicts that in the long run the relative price of nontradable goods in terms of tradable goods, P^N/P^T, is an increasing function of the relative productivities, a_T/a_N, see equation (18), which we repeat here

$$\frac{P^N}{P^T} = \frac{a_T}{a_N} \tag{R.18}$$

We will now ask if this prediction of the Balassa-Samuelson model is borne out in the data.

Empirical Validity of the Balassa-Samuelson Model (ctd.)

For this we need data on the level of (P^N/P^T) and (a_T/a_N). One problem, as in the analysis of absolute PPP, is that such level data is hard to come by because prices and labor productivity measurements are typically in the form of an index. Thus, we will test whether this prediction holds for rates of change.

If (18) holds, then it must be the case that

$$\%\Delta\left(\frac{P^N}{P^T}\right) = \%\Delta\left(\frac{a_T}{a_N}\right)$$

where $\%\Delta X$ denotes the percent change of the variable X over time.

Suppose we have this type of data for a number of different countries. Then, the Balassa Samuelson model predicts that if we plot observations of $\%\Delta\left(\frac{P^N}{P^T}\right)$ against $\%\Delta\left(\frac{a_T}{a_N}\right)$, then the observations should line up on the 45-degree line. This is a prediction we can test.

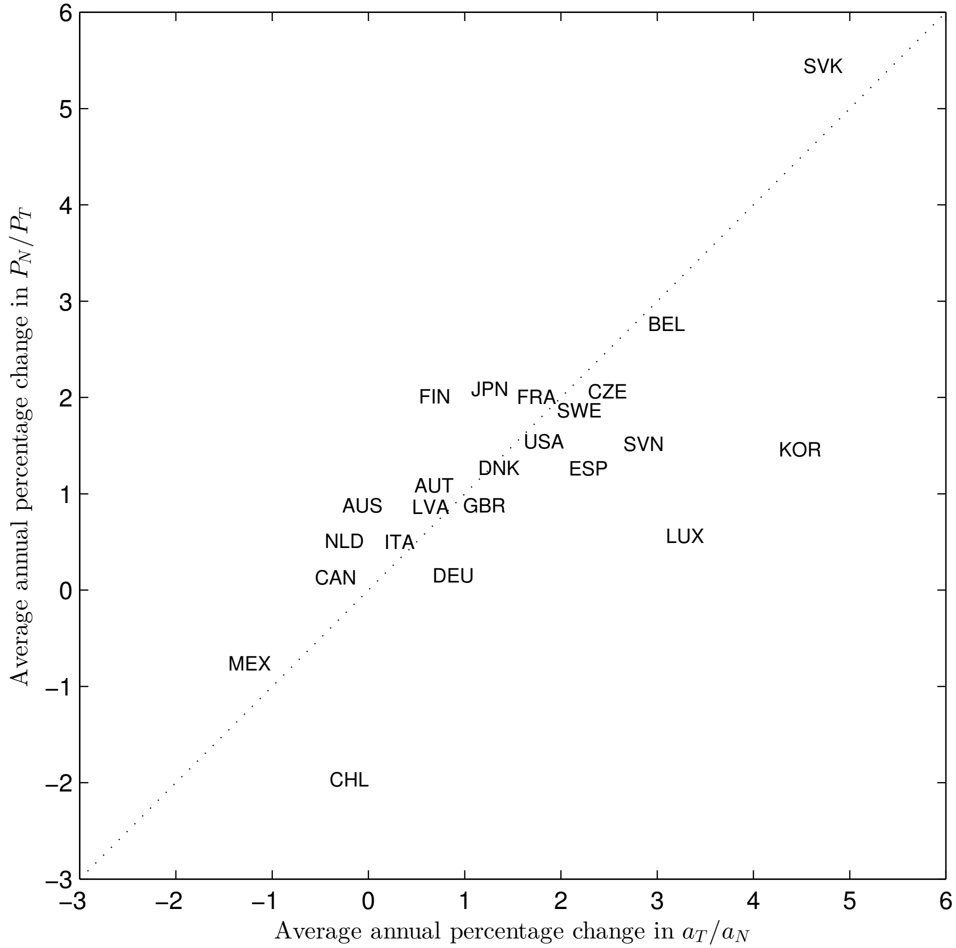
Empirical Validity of the Balassa-Samuelson Model (concluded)

The figure in the next slide plots the average annual percentage change in P^N/P^T against the average annual percentage change in a_T/a_N for 23 countries over the period 1996 to 2015.

The figure shows that in the long run there is a strong positive relationship between sectoral differences in productivity growth and sectoral differences in price growth.

This evidence provides empirical support to Balassa's and Samuelson's theory of the long-run determinants of deviations from purchasing power parity.

Relative Productivity Growth in the Traded and Nontraded Sectors and Changes in the Relative Price on Nontradables



The figure plots the average annual percentage change in the relative price of nontradables in terms of tradables, P^N/P^T, against the average annual percentage change in productivity in the traded sector relative to the nontraded sector, a_T/a_N, for 23 countries over the period 1996 to 2015. The strong positive relationship provides empirical support to the Balassa-Samuelson model.

Summing Up

This chapter studies the determination of the real exchange rate in the short and long runs.

• The TNT model is an open economy model with tradable and nontradable goods. It is a useful framework for understanding the determinants of the real exchange rate and sectoral reallocations of output and employment in the short run.

• The TNT model predicts that in response to an increase in the world interest rate, the real exchange rate depreciates, the relative price of nontradable goods falls, output and employment in the nontradable sector contract, and output and employment in the tradable sector expand.

• The TNT model predicts that in response to positive shocks to the tradable endowment or improvements in the terms of trade the real exchange rate appreciates and the relative price of nontradables increases. These effects are stronger when the shocks are expected to be persistent.

Summing Up (continued)

- A sudden stop is a macroeconomic crisis that occurs when foreign lenders abruptly stop extending credit to a debtor nation. It manifests itself by a steep increase in the country interest rate.

- The main observed effects of a sudden stop are a current account reversal from a large deficit to near balance or even surplus, a sharp depreciation of the real exchange rate, and a reallocation of production and employment from the nontradable sector to the tradable sector.

- The TNT model explains well the macroeconomic consequences of observed sudden stops.

Summing Up (concluded)

• The Balassa-Samuelson model is a theory that explains long run movements in real exchange rates. It explains deviations from PPP as stemming from international differences in relative sectoral productivity growth.

• The Balassa-Samuelson model predicts that for a given country if productivity grows faster in the traded sector than in the nontraded sector, then the relative price of nontradables in terms of tradables grows over time. This prediction is borne out in the data. Across countries, long-run averages of the growth rate of relative productivities in the tradable and nontradable sectors are positively correlated with long-run averages of the growth rate of the relative price of nontradables in terms of tradables.

• The Balassa-Samuelson model predicts that if in the domestic country productivity in the traded sector relative to productivity in the nontraded sector grows faster than in the foreign country, then the domestic country becomes more expensive, that is, its real exchange rate appreciates.