Chapter 4: Non-Traded Goods and Relative Prices

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1. Introduction

- We now augment the basic model by considering the presence of non-tradable goods (N) in addition to tradable goods (T).
  - Relative price: $p_t = \frac{p_t^N}{p_t^T}$, which is the main adjustment mechanism to supply and demand shocks.
  - Real exchange rate $RER_t = \frac{1}{p_t}$. If $p_t \uparrow$ say $\left(p_t^N \uparrow\right)$ then $RER_t \downarrow$ appreciation.
- Supply side asymmetry:
  - Infinite supply elasticity of tradable goods
  - Small supply elasticity of non-tradable goods

Main adjustment mechanism

- During a boom consumption of both tradable and non-tradable goods is high.
- Since non-tradables must be produced at home – whereas tradable goods can be imported – more resources will be needed in the non-tradable goods sector.
- To entice this shift in resources, the relative price of non-tradable goods must be high.
- The good times will thus be characterized by high consumption, trade and current account deficits, relative low production of tradables, relative high production of non-tradables, and an appreciated real exchange rate.

2. Basic model with non-tradable goods

- Consumer's problem

$$\underset{\{c_t^T, c_t^N\}_{t=0}^{\infty}}{Max} \int_0^{\infty} u\left(c_t^T, c_t^N\right) e^{-\beta t} dt,$$

$$u_{c^T} > 0; u_{c^N} > 0; u_{c^T c^T} < 0; u_{c^T c^T} u_{c^N c^N} - u_{c^T c^N}^2 > 0$$

$$\text{subject to}: \dot{b}_t = r b_t + y_t^T + p_t y_t^N - c_t^T - p_t c_t^N$$

$$\text{or}: b_0 + \int_0^{\infty} \left(y_t^T + p_t y_t^N\right) e^{-rt} dt = \int_0^{\infty} \left(c_t^T + p_t c_t^N\right) e^{-rt} dt$$

for a given path of y_t^T, y_t^N, p_t, and r and a given b_0.

Optimal conditions

$$\underset{\{c_t^T, c_t^N, \lambda\}_{t=0}^{\infty}}{L} = \int_0^\infty u\left(c_t^T, c_t^N\right)e^{-\beta t}dt + \lambda\left[b_0 + \int_0^\infty \left(y_t^T + p_t y_t^N\right)e^{-rt}dt - \int_0^\infty \left(c_t^T + p_t c_t^N\right)e^{-rt}dt\right]$$

$$u_{c^T}\left(c_t^T, c_t^N\right)e^{-\beta t} = \lambda e^{-rt}$$

$$u_{c^N}\left(c_t^T, c_t^N\right)e^{-\beta t} = \lambda p_t e^{-rt}$$

$$b_0 + \int_0^\infty \left(y_t^T + p_t y_t^N\right)e^{-rt}dt = \int_0^\infty \left(c_t^T + p_t c_t^N\right)e^{-rt}dt$$

combining the FONC for c_t^T and c_t^N we get the intra-temporal rule:

$$\frac{u_{c^N}\left(c_t^T, c_t^N\right)}{u_{c^T}\left(c_t^T, c_t^N\right)} = p_t$$

Optimal conditions (cont.)

$$\text{If we assume that } \beta = r \text{ the FONC for } c_t^T \text{ and } c_t^N \text{ simplify to:}$$

$$u_{c^T}\left(c_t^T, c_t^N\right) = \lambda$$

$$u_{c^N}\left(c_t^T, c_t^N\right) = \lambda p_t$$

- The first condition says that the marginal utility from consuming tradable goods will be constant over time. However, this does not necessarily translate into a constant consumption path over time as non-tradable consumption can vary.

- The second condition shows that the marginal utility from consuming non-tradable goods will vary with changes in p_t.

How does a change in p_t affect c^T and c^N?

$$\frac{dc^N}{dp} = \lambda \frac{u_{c^T c^T}}{u_{c^T c^T} u_{c^N c^N} - u_{c^T c^N}^2} < 0$$

$$\frac{dc^T}{dp} = -\lambda \frac{u_{c^T c^N}}{u_{c^T c^T} u_{c^N c^N} - u_{c^T c^N}^2} \begin{matrix} \leq \\ 0 \\ \geq \end{matrix}$$

$$\text{if } u_{c^T c^N} = 0, T \text{ and } N \text{ independent, } \frac{dc^T}{dp} = 0$$

$$\text{if } u_{c^T c^N} < 0, T \text{ and } N \text{ substitutes, } \frac{dc^T}{dp} > 0$$

$$\text{if } u_{c^T c^N} > 0, T \text{ and } N \text{ complements, } \frac{dc^T}{dp} < 0$$

How do changes in $\dot{p}_t$ affect $\dot{c}_t^T$ and $\dot{c}_t^N$?

$$-\frac{u_{c^T c^T}}{u_{c^T}}\dot{c}_t^T - \frac{u_{c^T c^N}}{u_{c^T}}\dot{c}_t^N = r - \beta$$

$$-\frac{u_{c^T c^N}}{u_{c^N}}\dot{c}_t^T - \frac{u_{c^N c^N}}{u_{c^N}}\dot{c}_t^N = r - \frac{\dot{p}_t}{p_t} - \beta$$

to see more clearly the role of the domestic real interest rate $\left(r - \frac{\dot{p}_t}{p_t}\right)$ consider the case of separable utility $\left(u_{c^T, c^N} = 0\right)$. The above simplify to:

$$-\frac{u_{c^T c^T}}{u_{c^T}}\dot{c}_t^T = r - \beta$$

$$-\frac{u_{c^N c^N}}{u_{c^N}}\dot{c}_t^N = r - \frac{\dot{p}_t}{p_t} - \beta$$

Equilibrium Conditions

- Non-tradable goods market:

$$c_t^N = y_t^N$$

- Tradable goods / NFA market:

$$\dot{b}_t = rb_t + y_t^T - c_t^T$$

- Intertemporal budget constraint:

$$b_0 + \int_0^\infty y_t^T e^{-rt} dt = \int_0^\infty c_t^T e^{-rt} dt$$

Perfect Foresight Equilibrium

- Substituting the non-tradable goods market equilibrium in the FONC:

$$u_{c^T}\left(c_t^T, y_t^N\right) = \lambda$$

$$u_{c^N}\left(c_t^T, y_t^N\right) = \lambda p_t$$

These two conditions, together with the intertemporal budget constraint fully determine the perfect foresight paths of c_t^T and p_t and the unique value of λ.

The path of y_t^N will determine the time profile of c_t^T, while the intertemporal budget constraint will determine the level.

How do c_t^T and p_t move with changes in y_t^N ?

- Differentiating the FONC for tradable goods

$$\frac{dc_t^T}{dy_t^N} = \frac{-u_{c^T c^N}\left(c_t^T, y_t^N\right)}{u_{c^T c^T}\left(c_t^T, y_t^N\right)} \begin{cases} = 0, & \text{if } u_{c^T c^N} = 0, \\ < 0, & \text{if } u_{c^T c^N} < 0, \\ > 0, & \text{if } u_{c^T c^N} > 0. \end{cases}$$

$$\text{Given that the path of } p_t \text{ is given by: } p_t = \frac{u_{c^N}\left(c_t^T, y_t^N\right)}{u_{c^T}\left(c_t^T, y_t^N\right)}$$

$$\frac{dp_t}{dy_t^N} = \frac{1}{u_{c^T} u_{c^T c^T}} \left(\underbrace{u_{c^N c^N} u_{c^T c^T} - u_{c^T c^N}^2}_{+} \right) < 0$$

Non Tradable Goods and Trade Balance

- So relative to the basic model, we identified a new channel that affects an economy’s desire to run trade imbalances.

  - This channel is related to the effects that change in the endowment of non-tradable goods have on the desire to consume more tradable goods.

  - Could fluctuations in the supply of non-tradable goods provide a possible explanation for the countercyclicality of the trade balance shown by the data?

  No under the most plausible parameterization of preferences, good times will be associated with trade surpluses and bad times with trade deficits, so we still need investment.

3. External Deficits and the Real Exchange Rate

- What is the relationship between <u>external imbalances</u> (i.e., trade and current account imbalances) and the <u>real exchange rate</u>?

$$L = \int_0^\infty \left[\log\left(c_t^T\right) + \log\left(c_t^N\right)\right] e^{-\beta t} dt + \lambda \left[b_0 + \int_0^\infty \left(y_t^T + p_t y_t^N\right) e^{-rt} dt - \int_0^\infty \left(c_t^T + p_t c_t^N\right) e^{-rt} dt \right]$$

$$\frac{1}{c_t^T} = \lambda$$

$$\frac{1}{c_t^N} = \lambda p_t$$

- Combining these optimality conditions we get the relative demand of tradable to non-tradable goods

$$\frac{c_t^N}{c_t^T} = \frac{1}{p_t}$$

3.1 Initial Equilibrium

- The economy's equilibrium continues to be given by:

$$c_t^N = y_t^N, \qquad \dot{b}_t = rb_t + y_t^T - c_t^T, \qquad b_0 + \int_0^\infty y_t^T e^{-rt} dt = \int_0^\infty c_t^T e^{-rt} dt$$

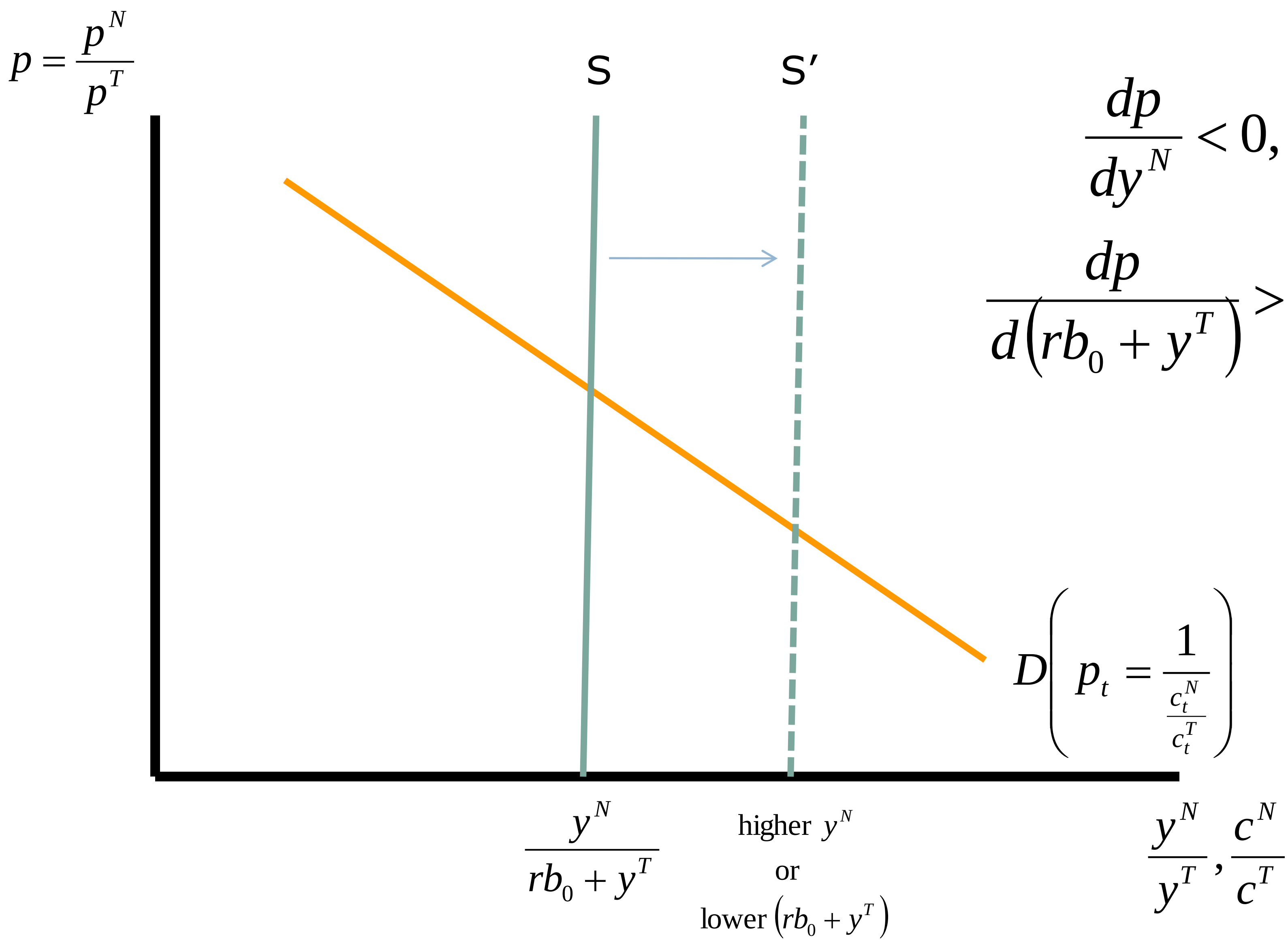
Suppose $y_t^T = y^T$ and $y_t^N = y^N$. Then, from the optimality condition for c_t^T, it is constant over time at a level given by:

$$c_t^T = rb_0 + y^T$$

Meanwhile, the relative price is:

$$p_t = \frac{rb_0 + y^T}{y^N}$$

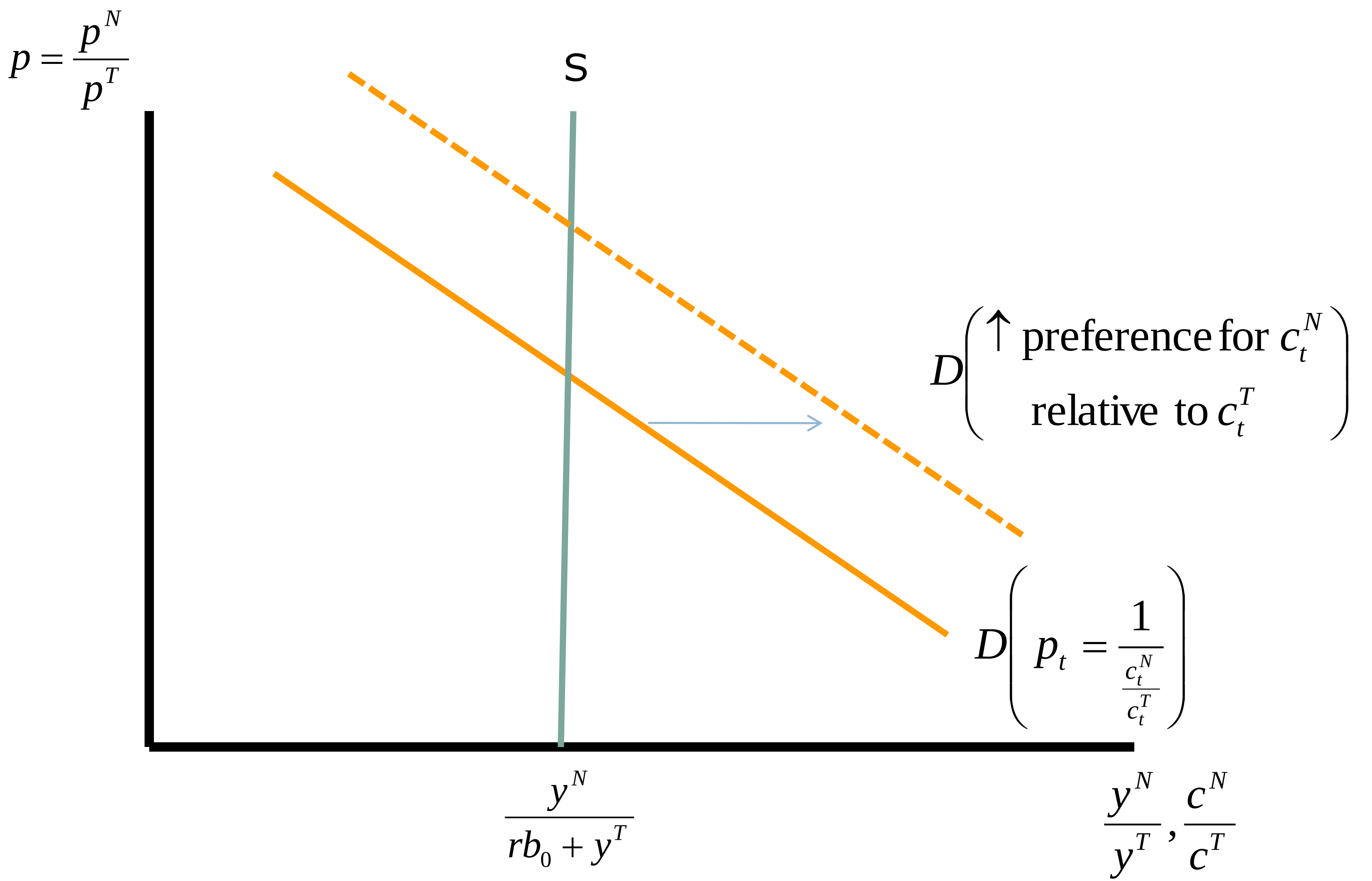
Determination of relative price of non-tradable goods



$$\frac{dp}{dy^N} < 0,$$

$$\frac{dp}{d\left(rb_0 + y^T\right)} > 0.$$

Determination of relative price of non-tradable goods



3.2 Comparative Statics

- The supply curve shifts if $\frac{y_t^N}{rb_t + y_t^T}$ changes for a given p_t.

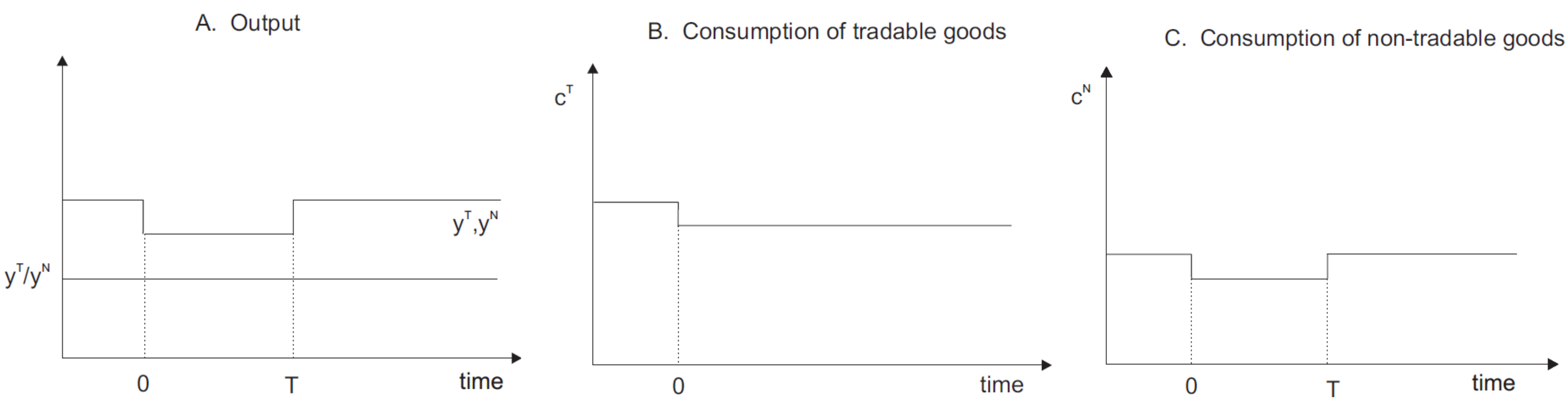
An increase in y_t^N, and/or a decrease in $rb_t + y_t^T$, will shift the supply curve to the right, lowering the equilibrium relative price $p_t = \frac{p_t^N}{p_t^T}$.

- The demand curve shifts if preferences change inducing a change in $\frac{c_t^N}{c_t^T}$ for a given p_t.

A higher preference for c_t^N relative to c_t^T, will shift the demand curve to the right, increasing the equilibrium relative price $p_t = \frac{p_t^N}{p_t^T}$.

3.3 Temporary fall in supply

- To understand the relationship between external imbalances and the real exchange rate consider the following temporary shock : at $t = 0$ there is an unanticipated and temporary (equiproportional) fall in the endowment of both goods (i.e., both y^T and y^N fall but the ratio $\frac{y^T}{y^N}$ remains unchanged)



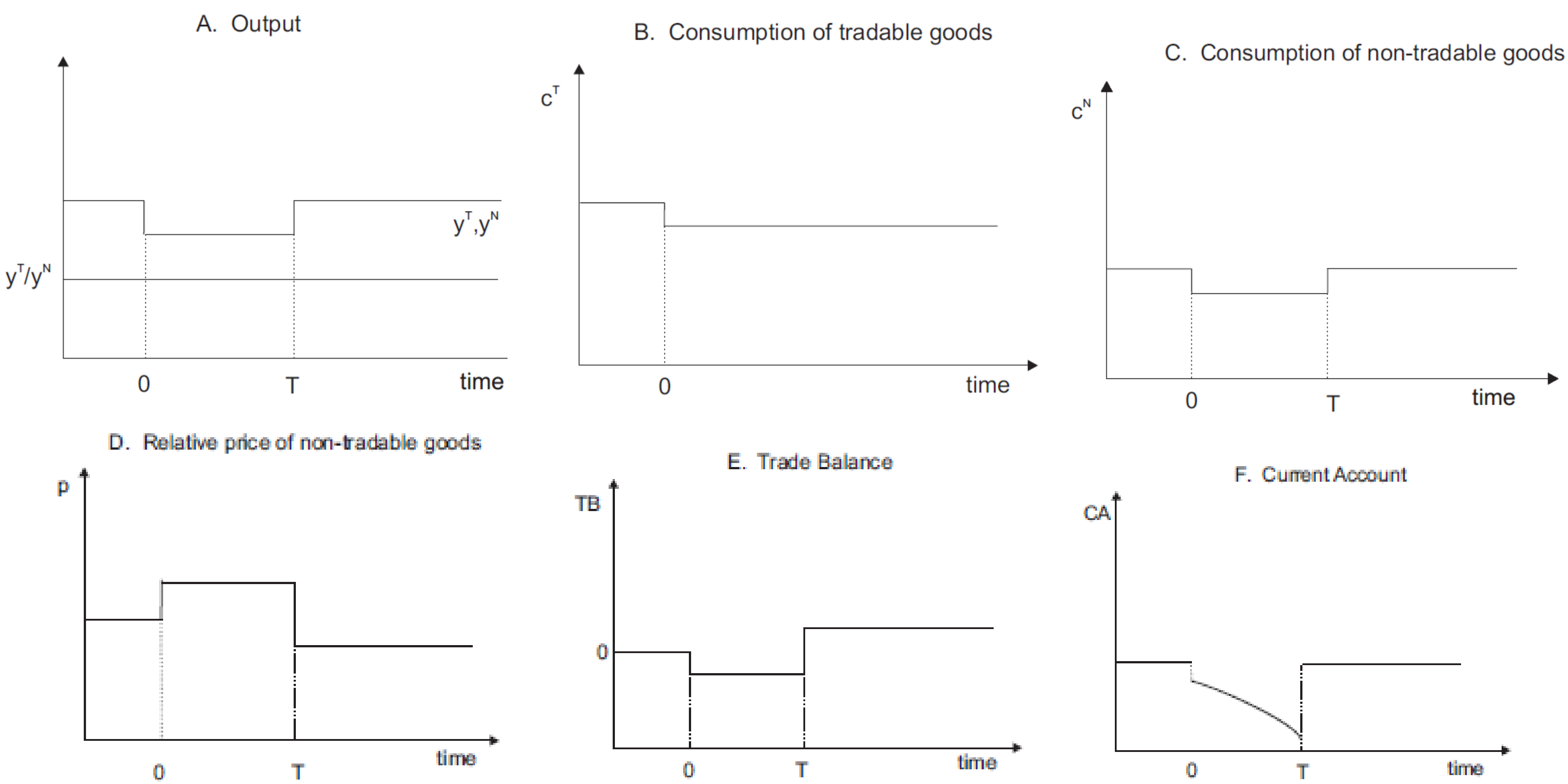
$$\frac{1}{c_t^T} = \lambda$$

$$b_0 + \int_0^\infty y_t^T e^{-rt} dt = \int_0^\infty c_t^T e^{-rt} dt$$

$$\frac{1}{c_t^N} = \lambda p_t$$

$$c_t^N = y_t^N$$

3.3 Temporary fall in supply (cont.)



$$p_t = \frac{c_t^T}{c_t^N}$$

$$TB_t = y_t^T - c_t^T$$

$$\dot{b}_t = rb_t + y_t^T - c_t^T$$

Trade Deficits and Real Appreciations

- Corollary: in the context of this paradigm, trade deficits go hand in hand with a real appreciation.
- Here trade deficits and real appreciation are simply an equilibrium response to a common shock; there is no causality whatsoever (wait until sticky prices are introduced to talk about causality).
- The same association between trade imbalances and the real exchange rate would emerge in response to a temporary demand shock that increases the demand for both tradable and non-tradable goods.

Excess demand for tradable goods can be met by importing goods (trade deficit), the excess demand for non-tradable goods must be chocked off by an increase in the relative price of non-tradable goods (real appreciation).

4. Fiscal Policy, Trade Imbalances and the Real Exchange Rate

- Will a fiscal contraction lead to a real depreciation?

- Will a fiscal expansion cause a trade deficit?

4.1 Government Spending with Lump Sum Taxation

$$W = \int_0^\infty \left[\log\left(c_t^T\right) + \log\left(c_t^N\right)\right] e^{-\beta t} dt$$

$$\text{subject to}: \dot{b}_t = r b_t + y_t^T + p_t y_t^N - c_t^T - p_t c_t^N - \tau_t$$

$$\text{or}: b_0 + \int_0^\infty \left(y_t^T + p_t y_t^N - \tau_t\right) e^{-rt} dt = \int_0^\infty \left(c_t^T + p_t c_t^N\right) e^{-rt} dt$$

First order conditions still given by:

$$\frac{1}{c_t^T} = \lambda$$

$$\frac{1}{c_t^N} = \lambda p_t$$

Government and Equilibrium Conditions

- Government balance:

$$\tau_t = g_t^T + p_t g_t^N$$

- Non-tradable goods market:

$$c_t^N + g_t^N = y_t^N$$

- Tradable goods / NFA market:

$$\dot{b}_t = rb_t + y_t^T - c_t^T - g_t^T$$

- Intertemporal budget constraint:

$$b_0 + \int_0^\infty y_t^T e^{-rt} dt = \int_0^\infty \left(c_t^T + g_t^T\right) e^{-rt} dt$$

Perfect Foresight Equilibrium

Along a PFEP c_t^T is constant at a level

$$c_t^T = r\left[b_0 + \int_0^\infty \left(y_t^T - g_t^T\right)e^{-rt}dt\right]$$

While the path for c_t^N is given by

$$c_t^N = y_t^N - g_t^N$$

and from the FONC the relative price p_t is given by

$$p_t = \frac{c_t^T}{c_t^N} = \frac{r\left[b_0 + \int_0^\infty \left(y_t^T - g_t^T\right)e^{-rt}dt\right]}{y_t^N - g_t^N}$$

Perfect Foresight Equilibrium (cont.)

This equation makes clear that the path for p_t is a function of the NPV of g^T and not on the particular time path. In contrast, the path of g_t^N will directly affect p_t (i.e., periods of high g_t^N are associated with a high p_t)

Given exogenous paths of g_t^T and g_t^N and the path of p_t given above, the government's flow constraint determines the level of lump-sum taxes

$$\tau_t = g_t^T + p_t g_t^N$$

Comparative Statics

Suppose that $y_t^T = y^T, y_t^N = y^N, g_t^T = g^T, g_t^N = g^N$ and $b_0 = 0.$

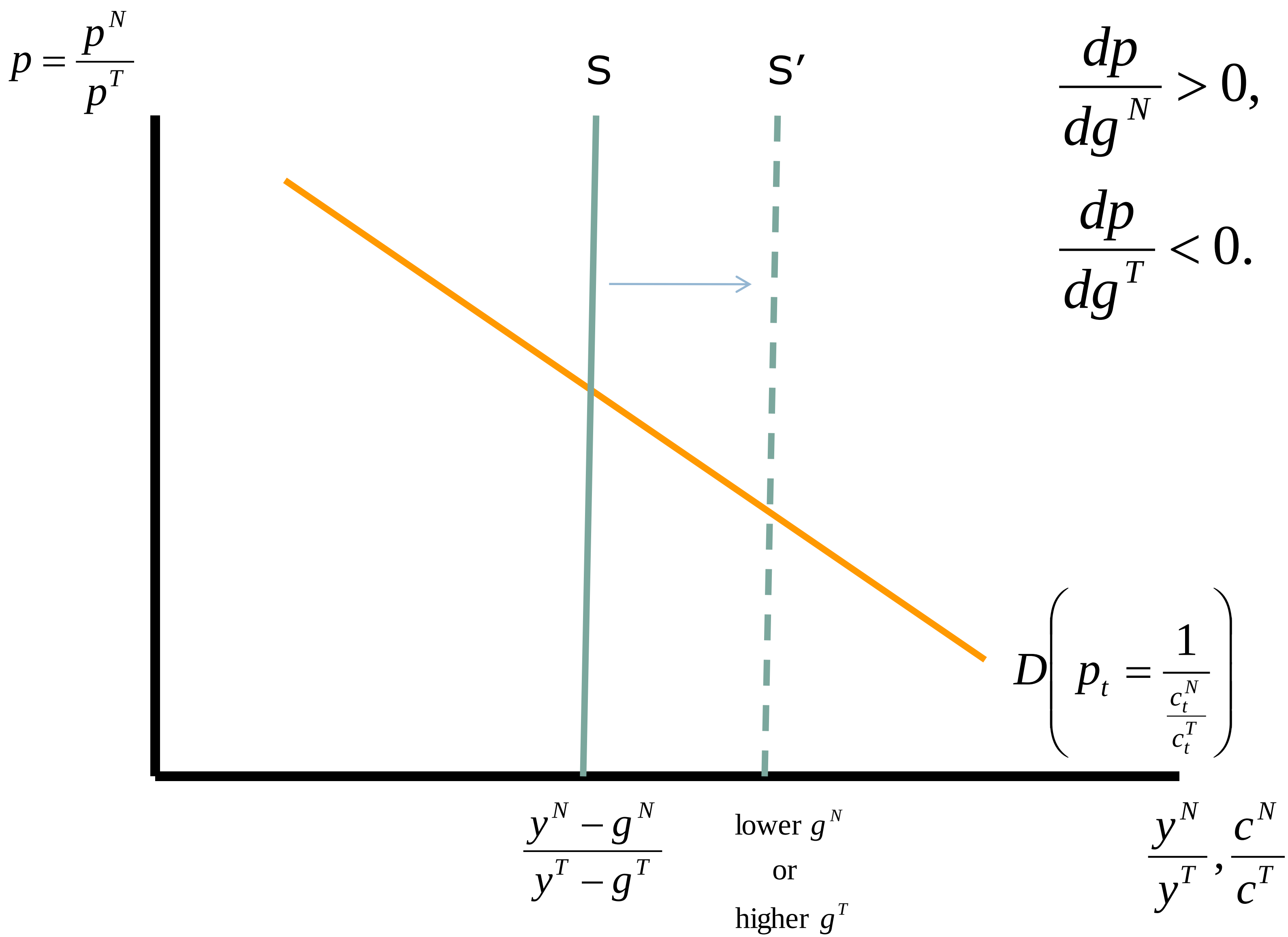
$$c^T = y^T - g^T$$

$$c^N = y^N - g^N$$

$$p = \frac{c^T}{c^N} = \frac{y^T - g^T}{y^N - g^N}$$

$$\tau = g^T + \frac{y^T - g^T}{y^N - g^N} g^N$$

Comparative Statics (cont.)



$$\frac{dp}{dg^N} > 0,$$

$$\frac{dp}{dg^T} < 0.$$

Effect of changes in total government expenditure: $\frac{dp}{dg}$

Suppose that the government sets an overall level of spending equal to g and spends in fixed proportions; namely :

$$g^T = \alpha g$$

$$pg^N = (1-\alpha)g$$

$$p = \frac{c^T}{c^N} = \frac{y^T - g^T}{y^N - g^N} = \frac{y^T - \alpha g}{y^N - (1-\alpha)\frac{g}{p}} = \frac{y^T + (1-2\alpha)g}{y^N}$$

$$\frac{dp}{dg} = \frac{(1-2\alpha)}{y^N}$$

Effect of changes in total government expenditure: $\frac{dp}{dg}$

$$\frac{dp}{dg} = \frac{(1-2\alpha)}{y^N}\begin{cases} = 0 & \text{if} \quad \alpha = \frac{1}{2}, \\ < 0 & \text{if} \quad \alpha > \frac{1}{2}, \\ > 0 & \text{if} \quad \alpha < \frac{1}{2}. \end{cases}$$

- What matters is the composition of government spending *relative* to that of the private sector $\left(p_t c_t^N = c_t^T\right)$, which spends half of its income on tradables and half on non-tradables.
- As $\left[\frac{dc^T}{dg} = \frac{d\left(pc^N\right)}{dg}\right] < 0$, if the government spends a higher fraction of these resources on non-tradables $\left(\alpha < \frac{1}{2}\right)$, then there will be an excess demand for non-tradable goods at the initial price, which will require a rise to clear the market.

Empirical Evidence of $\dfrac{dp}{dg}$

Table 1. Effects of government spending on real exchange rate

Country	Point estimation*	Sample and frequency	Estimation method	Source
8 European countries	-2.1 to -3.5	Annual 1979-1989	Panel	Froot and Rogoff (1991)
Japan	Not significant	Quarterly 1975.I-1990.III	Cointegration analysis	Rogoff (1992)
Chile	-0.8	*Calibration*	*Calibration*	Arrau (1992)
Chile	-3.1	Quarterly 1982.I-1993.IV	Cointegration analysis	Arellano and Larrain (1996)
12 Latin American countries	-0.3	Annual 1962-1984	Panel data, fixed effects	Edwards (1989)
9 Asian countries	Not significant	Annual 1970-1991	Error correction regressions, estimated with nonlinear least squares	Chinn (1997)
14 OECD countries	-2 to -5	Annual 1970-1985	SUR	De Gregorio and Wolf (1994)

* Per cent response of Real Exchange Rate to a permanent 1 per cent increase of the ratio of government spending to GDP.

Fiscal Expansions and Trade Deficits

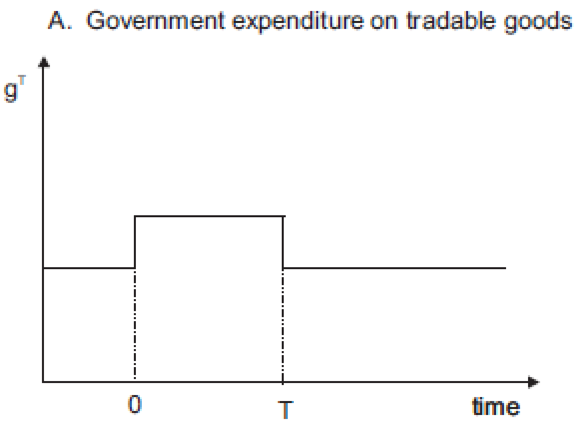
"Twin Deficits" hypothesis : Do increases in government spending lead to trade deficits?

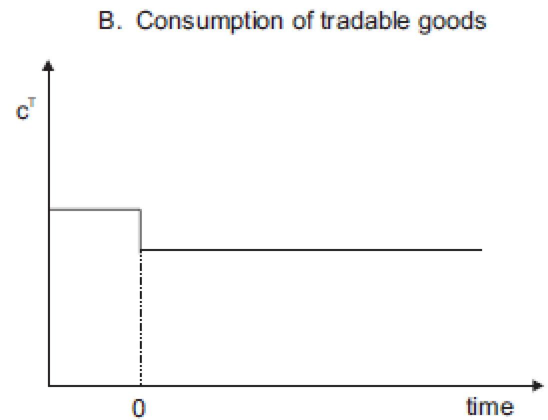
$$\text{Two cases}\begin{cases}\text{(1) temporary increase in } g^T \\ \text{(2) temporary increase in } g^N\end{cases}$$

In a perfect foresight stationary equilibrium :

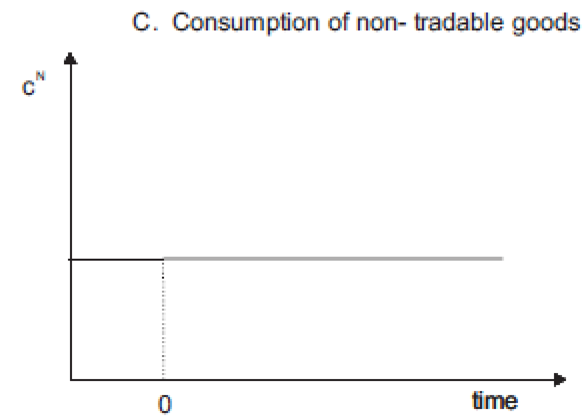
$$c^T = y^T - g^T, \qquad c^N = y^N - g^N, \qquad p = \frac{y^T - g^T}{y^N - g^N}$$

Twin deficits temporary increase in g^T

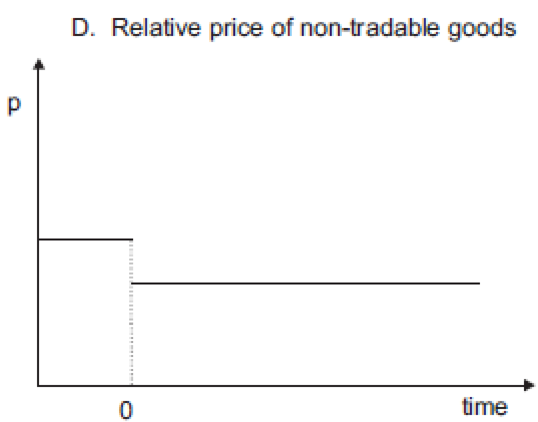




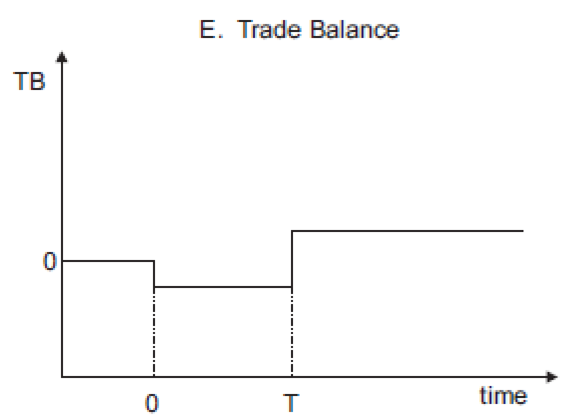
$$\frac{1}{c_t^T}=\lambda \quad , \quad c_t^T = r\left[b_0+\int_0^\infty \left(y_t^T-g_t^T\right)e^{-rt}dt\right]$$



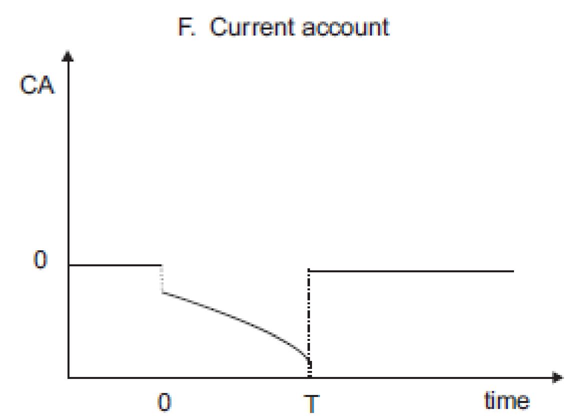
$$\frac{1}{c_t^N}=\lambda p_t \quad , \quad c_t^N = y_t^N - g_t^N$$



$$p_t=\frac{c_t^T}{c_t^N}=\frac{r\left[b_0+\int_0^\infty \left(y_t^T-g_t^T\right)e^{-rt}dt\right]}{y_t^N-g_t^N}$$



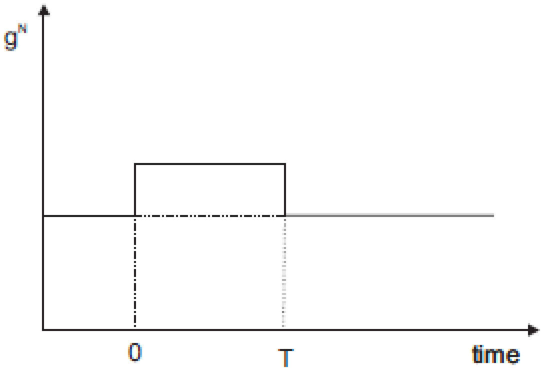
$$TB_t = y_t^T - c_t^T - g_t^T$$



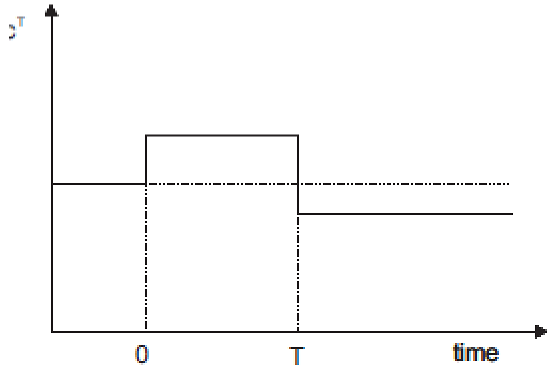
$$\dot{b}_t = rb_t + y_t^T - c_t^T - g_t^T$$

Twin deficits temporary increase in g^N

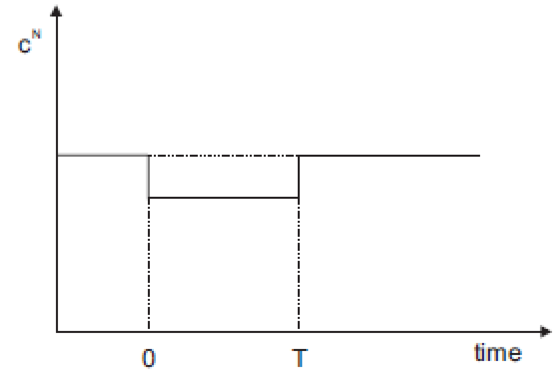
A. Expenditure on non-tradable goods



C. Consumption of tradable goods



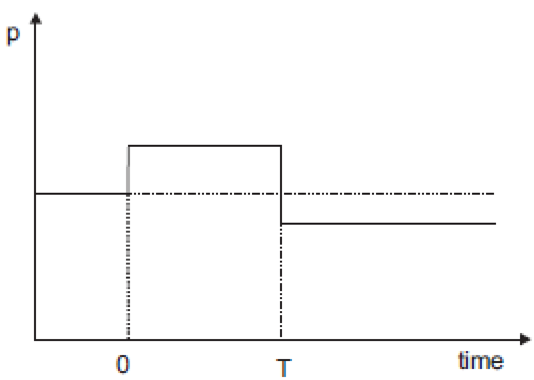
B. Consumption of non-tradable goods



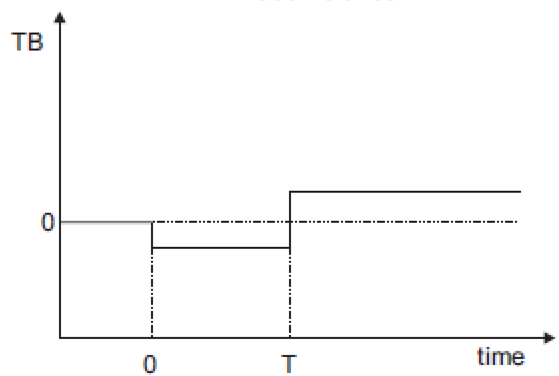
$$u_{c^T}\left(c_t^T, y^N - g_t^N\right) = \lambda \quad , \quad c_t^T = r\left[b_0 + \int_0^\infty \left(y_t^T - g_t^T\right)e^{-rt}dt\right]$$

$$u_{c^N}\left(c_t^T, y^N - g_t^N\right) = \lambda p_t \quad , \quad c_t^N = y_t^N - g_t^N$$

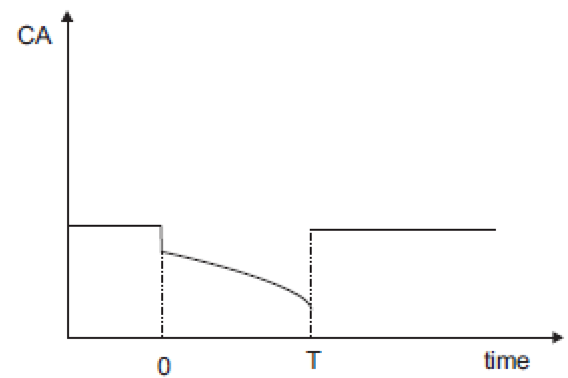
D. Relative price of non-tradable goods



E. Trade Balance



F. Current account



$$p_t = \frac{u_{c^N}\left(c_t^T, y^N - g_t^N\right)}{u_{c^T}\left(c_t^T, y^N - g_t^N\right)}$$

$$TB_t = y_t^T - c_t^T - g_t^T$$

$$\dot{b}_t = rb_t + y_t^T - c_t^T - g_t^T$$

4. Fiscal Policy, Trade Imbalances and the Real Exchange Rate

- Will a fiscal contraction lead to a real depreciation?

  - it could, under some circumstances

- Will a fiscal expansion cause a trade deficit?
  - with lump sum taxation:
    - ✓ yes, if the increase is in tradable goods
    - ✓ yes, if the increase is in non-tradable goods and tradable and non-tradable goods are Edgeworth substitutes.
  - with distortionary taxation:
    - ✓ yes, if the fiscal expansion is engineered via a temporary reduction in tax rates.