# The TNT Model

International Macroeconomics
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**Introduction:** Why does the real exchange rate move over time? What are the underlying economic forces driving its fluctuations? To address these questions, this chapter introduces the *TNT model*, which explicitly distinguishes between tradable and nontradable goods. By modeling consumption and production choices involving both types of goods, the TNT model uncovers how shifts in preferences, endowments, and interest rates shape the relative price of nontradables and thus the real exchange rate.

## 1. The TNT Model

The TNT model features two types of goods: tradables and nontradables. Tradable goods can be freely exchanged in international markets, while nontradables must be consumed domestically. This structure introduces an additional relative price into the model—the price of nontradables in terms of tradables, denoted $p_t \equiv \frac{P_t^N}{P_t^T}$, which plays a central role in the determination of the real exchange rate.

### 1.1. Households

Consider a two-period economy populated by identical households. Preferences are represented by a time-separable utility function:

$$U = \ln C_1 + \beta \ln C_2,$$

where $C_1$ and $C_2$ denote consumption in periods 1 and 2, respectively, and $\beta \in (0, 1)$ is the subjective discount factor.

Each period's consumption is a Cobb-Douglas aggregate of tradable and nontradable goods:

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

where $\gamma \in (0, 1)$ captures the relative weight of tradables in utility.

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The household receives endowments $Q_t^T$ and $Q_t^N$ in tradable and nontradable goods in each period $t = 1, 2$. It can borrow or lend in period 1 using a bond $B_1$ denominated in tradable goods, which pays the gross interest rate $1 + r_1$ in period 2. There is no initial wealth: $B_0 = 0$.

The budget constraint in period 1 is:

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

and in period 2:

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

Dividing both constraints by the price of tradables in each period and letting $p_t \equiv \frac{P_t^N}{P_t^T}$ denote the relative price of nontradables, we obtain:

$$C_1^T + p_1 C_1^N + B_1 = Q_1^T + p_1 Q_1^N,$$
$$C_2^T + p_2 C_2^N = Q_2^T + p_2 Q_2^N + (1 + r_1) B_1.$$

Eliminating $B_1$, we derive the intertemporal budget constraint:

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

The household chooses $\{C_1^T, C_1^N, C_2^T, C_2^N\}$ to maximize:

$$\ln\left[(C_1^T)^\gamma (C_1^N)^{1-\gamma}\right] + \beta \ln\left[(C_2^T)^\gamma (C_2^N)^{1-\gamma}\right],$$

subject to the intertemporal budget constraint above.

We define the Lagrangian:

$$\mathcal{L} = \ln(C_1^T)^\gamma (C_1^N)^{1-\gamma} + \beta \ln(C_2^T)^\gamma (C_2^N)^{1-\gamma} - \lambda \left[C_1^T + p_1 C_1^N + \frac{C_2^T + p_2 C_2^N}{1 + r_1} - RHS\right],$$

where $RHS$ denotes the right-hand side of the intertemporal budget constraint.

Taking first-order conditions with respect to $C_1^T, C_1^N, C_2^T, C_2^N$:

$$
\begin{aligned}
\frac{\partial \mathcal{L}}{\partial C_1^T} &= \frac{\gamma}{C_1^T} - \lambda = 0 \Rightarrow \lambda = \frac{\gamma}{C_1^T}, \\
\frac{\partial \mathcal{L}}{\partial C_1^N} &= \frac{1-\gamma}{C_1^N} - \lambda p_1 = 0 \Rightarrow \frac{1-\gamma}{C_1^N} = \frac{\gamma p_1}{C_1^T}, \\
\frac{\partial \mathcal{L}}{\partial C_2^T} &= \frac{\beta\gamma}{C_2^T} - \lambda \frac{1}{1+r_1} = 0 \Rightarrow \frac{\beta\gamma}{C_2^T} = \frac{\gamma}{C_1^T} \cdot \frac{1}{1+r_1}, \\
\frac{\partial \mathcal{L}}{\partial C_2^N} &= \frac{\beta(1-\gamma)}{C_2^N} - \lambda \frac{p_2}{1+r_1} = 0.
\end{aligned}
$$

From these conditions, we derive two key optimality conditions:

1. **Euler equation for tradables:**

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

2. **Intratemporal allocation between tradables and nontradables:**

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

The first condition is the standard Euler equation: a higher interest rate raises the opportunity cost of current consumption, incentivizing intertemporal substitution. The second condition determines the demand for nontradables: as their relative price $p_t$ increases, households substitute toward tradables, lowering $C_t^N$ relative to $C_t^T$.

## 1.2. Equilibrium

In equilibrium, the market for nontradable goods must clear in each period. That is, consumption must equal endowment:

$$C_t^N = Q_t^N \quad \text{for } t = 1, 2.$$

Since the economy is open and features free capital mobility, the domestic interest rate must equal the world interest rate:

$$r_1 = r^*.$$

Using the market-clearing condition to substitute for $C_1^N$ and $C_2^N$ in the intertemporal budget constraint, the non-tradable terms cancel out and we obtain:

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

Combining this with the Euler equation for tradables,

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

we solve for equilibrium consumption of tradables in period 1:

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

This expression shows that consumption of tradables is increasing in both present and expected future endowments of tradables, and decreasing in the interest rate. We summarize this dependency as:

$$C_1^T = C^T(r^{*-}, Q_1^{T+}, Q_2^{T+})$$

The trade balance in period 1 is defined as:

$$TB_1 = Q_1^T - C_1^T = TB(r^{*+}, Q_1^{T+}, Q_2^{T-}).$$

Since the initial asset position is zero ($B_0 = 0$), the current account in period 1 equals the trade balance:

$$CA_1 = TB_1 = CA(r^{*+}, Q_1^{T+}, Q_2^{T-}).$$

Now using the intratemporal optimality condition:

$$C_1^N = \frac{1-\gamma}{\gamma}\frac{C_1^T}{p_1}$$

and imposing the market-clearing condition $C_1^N = Q_1^N$, we obtain the equilibrium condition for the relative price of nontradables:

$$\begin{aligned} Q_1^N &= \frac{1-\gamma}{\gamma}\frac{C_1^T}{p_1}, \\ \Rightarrow p_1 &= \frac{1-\gamma}{\gamma}\cdot\frac{C_1^T}{Q_1^N} \end{aligned}$$

Since all variables on the right-hand side are exogenous, equation (9.13) determines the equilibrium relative price of nontradables in period 1.

## 1.3. Adjustment to Interest Rate and Endowment Shocks

### Interest Rate Shock

Suppose the world interest rate increases from $r^*$ to $r^{*'} > r^*$. The Euler equation implies that households will postpone consumption, reducing $C_1^T$. From the demand schedule for nontradables,

$$C_1^N = \frac{1-\gamma}{\gamma}\frac{C_1^T}{p_1},$$

the fall in $C_1^T$ causes a downward shift in the demand for nontradables. At the initial relative price $p_1^e$, there is now excess supply of nontradables. Sellers reduce prices until market clearing is restored at a new lower equilibrium price $p_1^{e'} < p_1^e$.

In summary, a higher interest rate reduces the equilibrium relative price of nontradables by decreasing total consumption demand.

#### Increase in Tradable Endowments

Suppose now that either $Q_1^T$, $Q_2^T$, or both increase. This produces a positive wealth effect, raising consumption $C_1^T$. Higher tradable consumption shifts the demand for nontradables upward, increasing $C_1^N$. Given the fixed supply $Q_1^N$, the price $p_1$ must rise to restore equilibrium. The qualitative effect is the same regardless of the timing of the endowment shock, but the magnitude may differ depending on whether the effect is current or anticipated income.

#### Increase in Nontradable Endowment

An increase in the period-1 nontradable endowment, $Q_1^N$, shifts the supply schedule up. At the initial price $p_1^e$, there is now excess supply. Sellers reduce prices to clear the market, leading to:

$$Q_1^{N+} \Rightarrow p_1^{e'} < p_1^e.$$

Collecting the results, the equilibrium relative price of nontradables in period 1[1] is:

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

## 2. From the Relative Price of Nontradables to the Real Exchange Rate

There is a close relationship between the relative price of nontradables, $p_t$, and the real exchange rate, $e_t$. Recall that the real exchange rate measures the relative price of a

[1] Why doesn't the equilibrium price $p_1$ depend on the future nontradable endowment $Q_2^N$? One might expect that an increase in $Q_2^N$ would generate a positive wealth effect, raising demand in period 1 and pushing up $p_1$. However, this is exactly offset by a substitution effect: higher $Q_2^N$ lowers $p_2$, incentivizing more consumption in period 2 and less in period 1. With log utility and Cobb-Douglas preferences, these two effects cancel out precisely, rendering $p_1$ independent of $Q_2^N$.

basket of goods abroad in terms of baskets of goods at home:

$$e_t = \frac{E_t P_t^*}{P_t},$$

where $E_t$ is the nominal exchange rate (domestic currency per unit of foreign currency), $P_t^*$ is the price of the foreign consumption basket (in foreign currency), and $P_t$ is the price of the domestic consumption basket (in domestic currency).

In our model, the consumption basket includes both tradable and nontradable goods. Therefore, we assume:

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

where $\varphi(\cdot,\cdot)$ and $\varphi^*(\cdot,\cdot)$ are increasing, homogeneous-of-degree-one functions (e.g., Cobb-Douglas).

Substituting into the expression for the real exchange rate, we get:

$$e_t = \frac{E_t \varphi^*(P_t^{T*}, P_t^{N*})}{\varphi(P_t^T, P_t^N)}$$

Using the homogeneity property of $\varphi$, we can rewrite:

$$e_t = \frac{E_t P_t^{T*} \cdot \varphi^*\left(1, \frac{P_t^{N*}}{P_t^{T*}}\right)}{P_t^T \cdot \varphi\left(1, \frac{P_t^N}{P_t^T}\right)}.$$

Assuming the law of one price (LOOP) holds for tradables, $E_t P_t^{T*} = P_t^T$, so:

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

where:

$$p_t \equiv \frac{P_t^N}{P_t^T}, \qquad p_t^* \equiv \frac{P_t^{N*}}{P_t^{T*}}.$$

This expression shows that the real exchange rate depends inversely on the domestic relative price of nontradables:

- If $p_t$ increases (nontradables become more expensive relative to tradables at home), then $e_t$ falls — the home country becomes more expensive in real terms.
- If $p_t^*$ increases (foreign nontradables become more expensive), then $e_t$ rises — the foreign country becomes more expensive in real terms.

Therefore, holding $p_t^*$ constant, the real exchange rate is a decreasing function of $p_t$. In small open economy models, where $p_t^*$ is treated as given, it is common to refer to the domestic relative price of nontradables, $p_t$, as the real exchange rate.

Since we already characterized $p_1$ as a function of fundamentals, we can now write the real exchange rate in period 1 as:

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

That is, the real exchange rate in period 1:

- **Depreciates** when the world interest rate $r^*$ increases,
- **Appreciates** when current or future tradable endowments ($Q_1^T$, $Q_2^T$) increase,
- **Depreciates** when the current nontradable endowment $Q_1^N$ increases.

# 3. The Terms of Trade and the Real Exchange Rate

Suppose that the tradable consumption good, $C_t^T$, corresponds to an imported good (e.g., food), while the tradable endowment, $Q_t^T$, corresponds to an exported good (e.g., oil). In this case, the value of the tradable endowment in terms of the imported consumption good is given by:

$$\mathrm{TOT}_t Q_t^T, \quad \text{where} \quad \mathrm{TOT}_t = \frac{P_t^X}{P_t^M},$$

with $P_t^X$ being the price of the exported good and $P_t^M$ the price of the imported good.

A positive terms-of-trade shock (an increase in $\mathrm{TOT}_t$) has a similar effect to a positive endowment shock in tradables. Thus, the predictions of the TNT model remain valid, but $Q_t^T$ must now be replaced by $\mathrm{TOT}_t Q_t^T$ in the expressions for equilibrium.

The equilibrium demand for tradable consumption becomes:

$$C_1^T = C^T(r^*_{-}, \mathrm{TOT}_1 Q_1^T{}_{+}, \mathrm{TOT}_2 Q_2^T{}_{+}),$$

and the demand for nontradables is now given by:

$$C_1^N = \frac{1-\gamma}{\gamma} \cdot \frac{C^T(r^*, \mathrm{TOT}_1 Q_1^T, \mathrm{TOT}_2 Q_2^T)}{p_1}.$$

Imposing the market-clearing condition $C_1^N = Q_1^N$ and solving for the equilibrium relative price of nontradables (in terms of the imported good), $p_1 = \frac{P_1^N}{P_1^M}$, we obtain:

$$p_1 = \frac{1-\gamma}{\gamma} \cdot \frac{C^T(r^*, \mathrm{TOT}_1 Q_1^T, \mathrm{TOT}_2 Q_2^T)}{Q_1^N}.$$

Hence, the equilibrium relative price of nontradables satisfies:

$$p_1 = p(r^{*-}, \mathrm{TOT}_1 Q_1^{T+}, \mathrm{TOT}_2 Q_2^{T+}, Q_1^{N-}).$$

The consumer price level $P_1$ is now an aggregate of import, export, and nontradable prices:

$$P_1 = \varphi(P_1^M, P_1^X, P_1^N),$$

while the foreign price level is:

$$P_1^* = \varphi^*(P_1^{M*}, P_1^{X*}, P_1^{N*}).$$

The real exchange rate is given by:

$$e_1 = \frac{E_1 P_1^*}{P_1} = \frac{E_1 \varphi^*(P_1^{M*}, P_1^{X*}, P_1^{N*})}{\varphi(P_1^M, P_1^X, P_1^N)}.$$

Using the homogeneity of degree one of $\varphi$ and $\varphi^*$, we can rewrite:

$$e_1 = \frac{E_1 P_1^{M*}}{P_1^M} \cdot \frac{\varphi^*\left(1, \frac{P_1^{X*}}{P_1^{M*}}, \frac{P_1^{N*}}{P_1^{M*}}\right)}{\varphi\left(1, \frac{P_1^X}{P_1^M}, \frac{P_1^N}{P_1^M}\right)}.$$

Assuming the law of one price holds for tradable goods (importables and exportables), we have:

$$\frac{E_1 P_1^{M*}}{P_1^M} = 1, \quad \frac{P_1^{X*}}{P_1^{M*}} = \frac{P_1^X}{P_1^M},$$

so:

$$e_1 = \frac{\varphi^*(1, \mathrm{TOT}_1, p_1^*)}{\varphi(1, \mathrm{TOT}_1, p_1)}.$$

$$e_1 = \frac{\varphi^*(1, 1, p_1^*)}{\varphi(1, 1, p_1)}.$$

Therefore, the RER depends once again in $p_1^*$ and $p_1$[2]. Therefore, an improvement in the current or expected terms of trade ($\mathrm{TOT}_1$, $\mathrm{TOT}_2$) raises the relative price of nontradables and leads to a real appreciation. A higher price for the exported good (e.g., oil) increases national income. Households increase demand for both imported and nontradable goods. Given the fixed supply of nontradables, this increased demand drives up their relative price. Consequently, the country becomes more expensive relative to the rest of the world, i.e., the real exchange rate appreciates.

# 4. Endogenous Production in the TNT model

So far, we have studied a version of the TNT model in which the supplies of tradable and nontradable goods are fixed. While this assumption is useful for isolating the effects of shocks on the real exchange rate, it abstracts from the important role of production decisions. We now consider a richer environment where labor can be reallocated across sectors, and output in each sector is determined endogenously.

[2] Another assumption is that there should be no home bias. If there is no home bias—meaning consumers treat domestic and foreign goods equally—then any change in the relative price of exports to imports in one country will be offset by an opposite change in the other country. In other words, if a country's exports become more expensive relative to its imports, its trading partner will see its imports become cheaper relative to what it exports. The effects cancel out across countries.

## 4.1. Production Possibility Frontier (PPF)

Assume that tradable and nontradable goods are produced using labor. The production technologies are given by:

$$Q_t^T = F_T(L_t^T), \qquad Q_t^N = F_N(L_t^N),$$

where $L_t^T$ and $L_t^N$ denote the amount of labor allocated to the tradable and nontradable sectors in period $t = 1, 2$, respectively. The functions $F_T(\cdot)$ and $F_N(\cdot)$ are increasing and concave, that is:

$$F_T' > 0, \quad F_T'' < 0, \qquad F_N' > 0, \quad F_N'' < 0.$$

Total labor supply is fixed and denoted $L$, so labor allocations must satisfy:

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

To derive the production possibility frontier (PPF), we solve for the labor required in each sector:

$$L_t^T = F_T^{-1}(Q_t^T), \qquad L_t^N = F_N^{-1}(Q_t^N),$$

where $F_T^{-1}(\cdot)$ and $F_N^{-1}(\cdot)$ are the inverse functions of the respective production technologies. Substituting into the labor constraint:

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

This implicit equation characterizes the feasible combinations of $Q_t^T$ and $Q_t^N$ that the economy can produce. The PPF is strictly concave due to the diminishing marginal returns to labor. Intuitively, increasing output of one good requires sacrificing an increasing amount of the other.

The position of the economy along the PPF depends on the relative price of nontradables in terms of tradables. Consider a representative firm in the tradable sector. Its profit is:

$$\Pi_t^T = P_t^T F_T(L_t^T) - W_t L_t^T,$$

where $P_t^T$ is the price of tradables and $W_t$ is the wage rate. The firm maximizes profits by choosing $L_t^T$, yielding the first-order condition:

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

Similarly, the nontradable firm chooses $L_t^N$ to maximize:

$$\Pi_t^N = P_t^N F_N(L_t^N) - W_t L_t^N,$$

leading to:

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

Equating the two expressions (since wages are equalized across sectors in equilibrium), we obtain:

$$\frac{F_T'(L_t^T)}{F_N'(L_t^N)} = \frac{P_t^N}{P_t^T} \equiv p_t.$$

The left-hand side represents (minus) the slope of the PPF, while the right-hand side is the relative price of nontradables. Thus, the economy produces a bundle of tradables and nontradables such that the marginal rate of transformation equals the relative price. A depreciation of the real exchange rate (i.e., a rise in $p_t$) induces firms to produce relatively more tradables and fewer nontradables.

## 4.2. Household Optimization Problem

Households now derive income from both labor and firm profits. They work $L$ hours each period and receive a wage $W_t$. Since they own the firms, they also receive profits $\Pi_t^T + \Pi_t^N$. As in the endowment economy, they can save or borrow through a tradable bond $B_1$ that pays the interest rate $r_1$ in period 2. Preferences are given by:

$$U = \ln C_1 + \beta \ln C_2,$$

with consumption aggregators:

$$C_1 = (C_1^T)^\gamma (C_1^N)^{1-\gamma}, \qquad C_2 = (C_2^T)^\gamma (C_2^N)^{1-\gamma}.$$

The period-by-period budget constraints are:

$$P_1^T C_1^T + P_1^N C_1^N + P_1^T B_1 = W_1 L + \Pi_1^T + \Pi_1^N,$$

$$P_2^T C_2^T + P_2^N C_2^N = W_2 L + \Pi_2^T + \Pi_2^N + (1 + r_1) P_2^T B_1.$$

Dividing both equations by $P_1^T$ and $P_2^T$, respectively, and introducing $p_t \equiv P_t^N / P_t^T$, we rewrite the intertemporal budget constraint as:

$$C_1^T + p_1 C_1^N + \frac{C_2^T + p_2 C_2^N}{1 + r_1} = \frac{W_1 L + \Pi_1^T + \Pi_1^N}{P_1^T} + \frac{W_2 L + \Pi_2^T + \Pi_2^N}{(1 + r_1) P_2^T}.$$

Let this be the constraint for the household's problem. Define the Lagrangian:

$$\mathcal{L} = \ln C_1 + \beta \ln C_2 + \lambda \left[ \text{(intertemporal constraint)} \right].$$

Substituting the Cobb-Douglas consumption bundles into utility and deriving with respect to $C_1^T, C_1^N, C_2^T, C_2^N$, we recover the same first-order conditions as in the endowment economy:

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

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

These optimality conditions describe the household's intertemporal consumption smoothing and its intratemporal allocation between tradables and nontradables, both of which respond to changes in the real exchange rate.

## 4.3. Positive Productivity Shock in the Nontradable Sector

Suppose that the productivity in the nontradable sector increases. Formally, the production function for nontradables becomes more efficient:

$$Q_t^N = \widetilde{F}_N(L_t^N), \quad \text{with } \widetilde{F}'_N(L_t^N) > F'_N(L_t^N) \text{ for all } L_t^N.$$

This productivity shock rotates the PPF outward, allowing the economy to produce more nontradables with the same amount of labor. The marginal product of labor in the nontradable sector increases, raising the value of the marginal product:

$$P_t^N \widetilde{F}'_N(L_t^N) > W_t,$$

which implies that, at the initial allocation of labor, nontradable firms are making above-normal profits and thus have an incentive to hire more labor.

As nontradable firms demand more labor, the wage rate begins to rise. Tradable firms, facing a higher wage bill, reduce employment. The reallocation of labor continues until a new equilibrium is achieved where:

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

Since the denominator of the left-hand side has increased due to the shock, labor must shift toward the nontradable sector (i.e., $L_t^N$ increases and $L_t^T$ decreases) in order to restore equality. As a result:

- **Production of nontradables increases**, since more labor is allocated to that sector and it is now more productive.
- **Production of tradables falls**, as labor is drawn away from that sector.
- **The relative price of nontradables, $p_t$, declines**, since supply has expanded while demand (which depends on consumption smoothing and preferences) adjusts gradually.

From a real exchange rate perspective, this fall in $p_t$ represents a *real depreciation*. The domestic economy becomes cheaper relative to the rest of the world, even though it is now more productive in nontradables. This may seem counterintuitive, but reflects a supply-driven decline in prices.

## 4.4. Positive Productivity Shock in the Tradable Sector

Now suppose that the productivity of the tradable sector improves. That is, the production function becomes more efficient:

$$Q_t^T = \widetilde{F}_T(L_t^T), \quad \text{with } \widetilde{F}'_T(L_t^T) > F'_T(L_t^T) \text{ for all } L_t^T.$$

This shock expands the production possibility frontier outward in the tradables dimension, allowing the economy to produce more tradables with the same labor input. As a result, the value of the marginal product of labor in the tradable sector increases:

$$P_t^T \widetilde{F}_T'(L_t^T) > W_t.$$

At the pre-shock allocation, tradable firms now make excess profits and therefore have an incentive to hire more labor.

As tradable firms demand more labor, wages begin to rise. This reduces the profitability of firms in the nontradable sector, who respond by cutting back on employment. Labor is reallocated *toward* the tradable sector until equilibrium is restored and:

$$\frac{\widetilde{F}_T'(L_t^T)}{F_N'(L_t^N)} = \frac{P_t^N}{P_t^T} \equiv p_t.$$

Since the numerator of the left-hand side has increased due to the productivity shock, the new equilibrium requires a higher $L_t^T$ and lower $L_t^N$. Consequently:

- **Output of tradables increases**, driven by both higher productivity and more labor.
- **Output of nontradables decreases**, as labor is drawn out of that sector.
- **The relative price of nontradables, $p_t$, increases**, because their supply falls while demand adjusts more slowly.

From the perspective of the real exchange rate, the increase in $p_t$ implies a *real appreciation*: domestic goods become relatively more expensive compared to the rest of the world. While the economy becomes more productive, this leads to upward pressure on wages and prices, especially in the nontradable sector.