Unemployment in a Small Open Economy Model with Heterogeneous Job Separations

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Very preliminary. Please do not cite.

Background and motivation

- **Balassa-Samuelson effect**
  - Developed countries tend to experience real exchange rate appreciation
- **Mechanism**
  - Productivity in the tradeables sector improves → wage increases → Nontradeables price increases → Domestic price level increases → Real exchange rate appreciation
    - **Perfect labour mobility** and the **sectoral equalisation of wages** are the assumptions underpinning this result

Background and motivation

- **Empirical invalidity of a basic B-S model**
  - Basic B-S model tends to overvalue the response of relative price to changes in the productivity
- **Some recent studies**
  - Sheng and Xu (2011JIMF) show that a change in the price of nontradeables depends on the relative market matching efficiency between the two sectors
  - Hamano (2014JJIE) shows that theoretical B-S effect is amplified when extensive margins are taken into account
  - Cardi and Restout (2015JIE) remove the assumption of frictionless intersectoral labour mobility to improve the predictive ability

What we do

- **We develop a modified B-S model with the following characteristics**
  - There is one pool of job seekers
    - Unemployed search across all sectors (e.g. Gomes, 2015EJ); a sectoral unemployment rate is a redundant concept
  - Separation rates differ across industries
    - Separation rates by industry differ widely (e.g. Davis and Haltiwanger, 1992QJE)
    - Accordingly, there is a compensating wage differential (‘wage gap’) between the sectors
- **We examine the B-S effect and unemployment effect of productivity growth**

Model setup

- **Small open economy**
  - Price of tradeables is exogenous
- **Two sectors**
  - Tradeables and nontradeables
- **Specific factor framework**
  - Capital is specific to each sector
  - Capital accumulation captures productivity improvement
- **Search matching unemployment**
  - One pool of job seekers and heterogeneous job separations

Main results

◆Theoretical propositions

- P1: Wages are higher in the sector with higher separations
  - **Compensating wage differentials**
- P2: Labour moves across sectors so that the marginal contribution of labour over wage cost is equalized
  - This occurs due to **positive bargaining power of producers**
- P3: The real exchange rate appreciates (depreciates) with improvements in technological progress in the tradeables (nontradeables) sector
  - **The B-S effect can be muted** but the primary effect (the basic B-S effect) always dominates the secondary effect

Main results

◆ Simulation results of the B-S effect

- In the homogeneous case ($s_T = s_N$), the B-S effect is determined only by the relative productivity effect (Eq.97)
  - **Basic B-S model** is nested as a special case
- In the heterogeneous case ($s_T > s_N$), the relative labour effect offsets nearly 38% of the relative productivity effect (Eq.100)
  - Heterogeneous job separations explain **overvaluation in the basic B-S framework**

Main results

◆Simulation results for (un)employment

- There is the range of the substitutability in consumption between tradeables and nontradeables in which labour demand in both sectors increases with productivity growth in the tradeables sector (Fig.4)
- Unemployment decreases with productivity growth in the tradeables sector regardless of the substitutability (Fig.4)
- The wage gap increases with productivity in the tradeables sector (Fig.5)
- There is no value of the substitutability for which both sectors expand employment (Fig.6)

Search and matching

◆Labour stock evolution

- $\dot{L}_i = \frac{m_I}{V_I} V_i - s_I L_i, \quad i \in I, \ I = N, T \cdots (1)$
  - Assume that separation rates (s_I) differ across sectors
- $V_I = \int_{i \in I} V_i \, di$

◆Economy-wide vacancies

- $V = V_N + V_T$

Search and matching

◆Inverse Beveridge ratio

- $\theta_I = \frac{V_I}{U}$
- $\theta = \theta_N + \theta_T = \frac{V_N + V_T}{U} = \frac{V}{U}$

◆Matching function

- $M(U,V) = AU^{\alpha}V^{1-\alpha}, \alpha \in (0,1)$

◆Number of matches

- $m_I = \frac{V_I}{V} M(U,V)$
- $M(U,V) = m_N + m_T$

Vacancy posting

- **Firm's optimization problem**
  - $\max_{V_i} \int_0^\infty \pi_i(t) e^{-rt}\, dt \quad \text{s.t. } (1)$
  - $\pi_i = p_i F_i(k_i, L_i) - w_i L_i - \gamma V_i$
- **FOCs & transversality condition**
  - $\Lambda_i m_I = \gamma V_I$
  - $\dot{L}_i = \frac{m_I}{V_I} V_i - s_I L_i$
  - $\Lambda_i = \frac{p_i F'_{iL} - w_i}{r+s_I} + \frac{1}{r+s_I} \dot{\Lambda}_i$
  - $\lim_{t\to\infty} e^{-rt} \Lambda_i L_i = 0$

Equilibrium

- **Steady state condition**
  - $m_I = s_I L_I$
    - Number of entrants to, and exits from, each sector is offsetting
  - $\dot{U} = 0$, $\dot{L}_I = 0$ and $\dot{m}_I = 0$
- **Labour market equilibrium**
  - $\bar{L} = L_N + L_T + U$
    - That is, there is presence of unemployment

Wage determination

◆Discounted return on being unemployed

- $E_U = \frac{1}{1+r}\left\{z + \left(\frac{m_N}{U}E_N + \frac{m_T}{U}E_T\right) + \left(1 - \frac{m_N+m_T}{U}\right)E_U\right\}$

◆Discounted return on being employed

- $E_i = \frac{1}{1+r}\{w_i + s_I E_U + (1 - s_I)E_i\}$

◆Nash bargaining over wages

- $\max_{w_i} S_i = (E_i - E_U)^{\beta} \Lambda_i^{1-\beta}$
- $w_I = z + \frac{\beta\gamma}{1-\beta}\left\{\frac{\theta^{\alpha}(r+s_I)}{A} + \theta\right\} \cdots (46)$

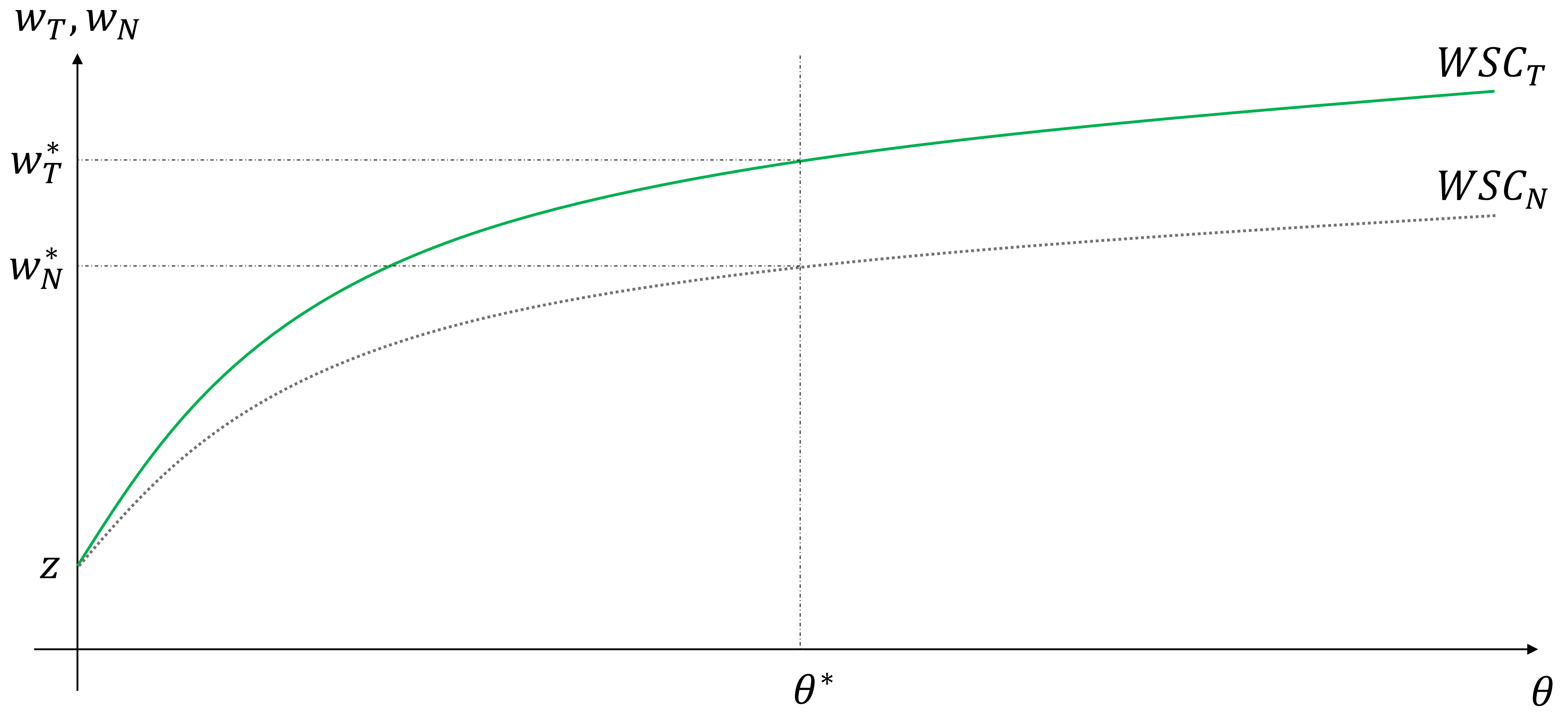
Compensating wage differentials (from Eq. 46)

◆ **Proposition 1: Wages are higher in the sector that has higher separations.**

- **Proof.** $\widetilde{W} = w_T - w_N = \frac{\beta\gamma}{1-\beta}\left\{\frac{\theta^{\alpha}(s_T - s_N)}{A}\right\}$. ■

- Firms in the sector with higher separation rate have to pay higher wages to attract workers
- If either the transaction cost of hiring workers (γ) or the worker's bargaining power (β) were zero, wages are equalised

Lower panel of Figure 3. Wage setting curves (See Eq. 46)



Note: $s_T > s_N$ is assumed

The price of nontradeables

◆Consumer's CES preference

- $C = \left[\psi^{\frac{1}{\rho}} c_N^{1-\frac{1}{\rho}} + (1-\psi)^{\frac{1}{\rho}} c_T^{1-\frac{1}{\rho}}\right]^{\frac{1}{1-\frac{1}{\rho}}}, \ \psi \in (0,1), \ \rho > 0$
  - As ρ approaches infinity (zero) then tradeables and nontradeables are perfect substitutes (complements)

◆Demand for nontradeables

- $\bar{L} c_N = \frac{Y}{P}$
  - Ignore international borrowing and lending, i.e., assume balanced trade

The price of nontradeables

- **National income**
  - $Y = pF_N + F_T$
    - Unemployment benefits, zU, are a transfer of income to the unemployed
- **Price of nontradeables (Real Exchange Rate, RER)**
  - $p = \left(\frac{\Psi F_T}{F_N}\right)^{\frac{1}{\rho}}$
    - p is determined by *domestic* demand and supply

Equilibrium

◆**Equilibrium conditions for L_N, L_T, p and θ**

□$A\theta^{1-\alpha}(\bar{L} - L_N - L_T) = s_N L_N + s_T L_T$

□$p = \left(\frac{\Psi F_T}{F_N}\right)^{\frac{1}{\rho}}$

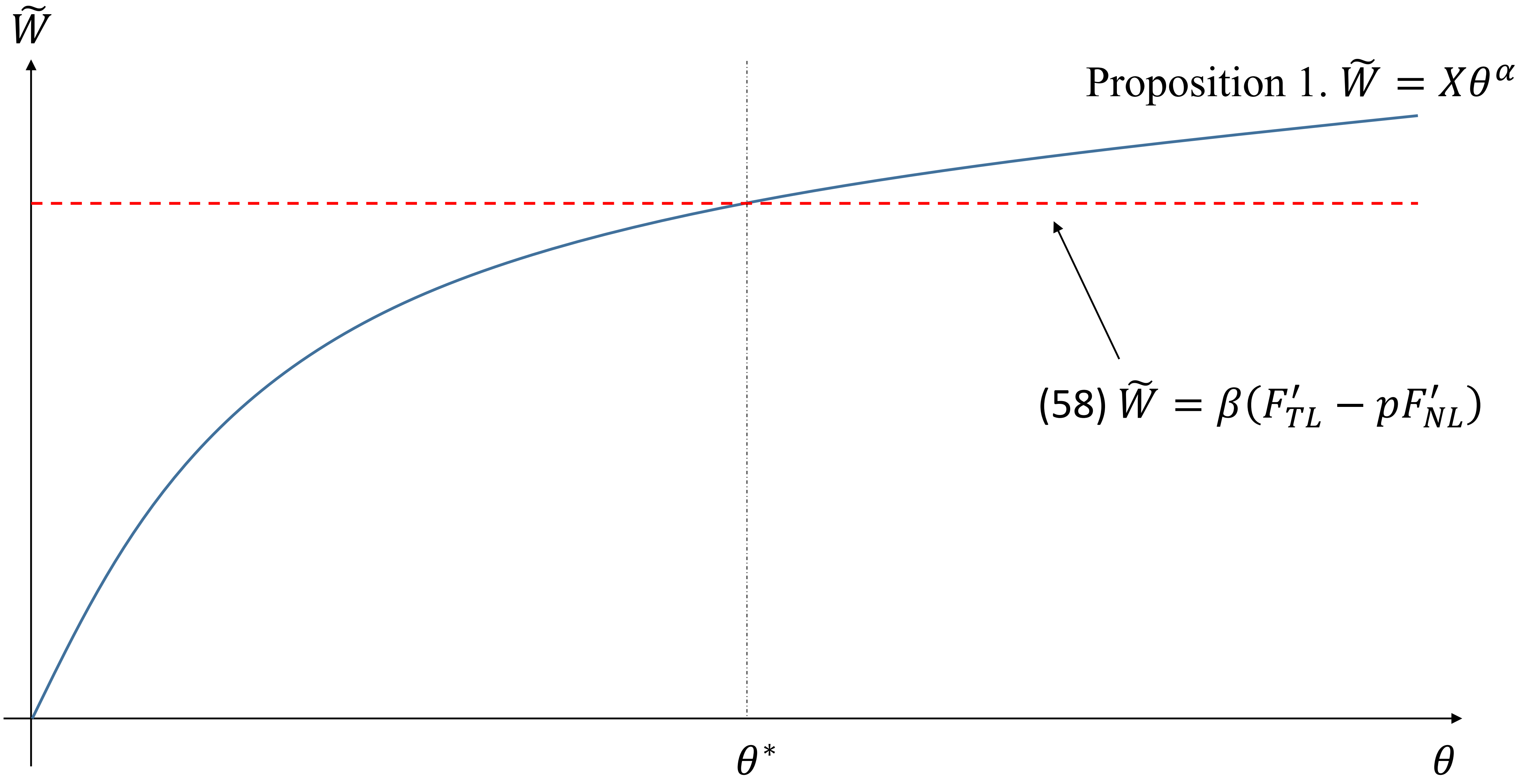
□$pF'_{NL} = \frac{\gamma\theta^{\alpha}(r+s_N)}{(1-\beta)A} + z + \frac{\beta\gamma\theta}{1-\beta}$

□$F'_{TL} = \frac{\gamma\theta^{\alpha}(r+s_T)}{(1-\beta)A} + z + \frac{\beta\gamma\theta}{1-\beta}$

◆**From last two conditions**

□$F'_{TL} - pF'_{NL} = \widetilde{W}/\beta \cdots (58)$

Upper panel of Figure 3. Wage setting curves ($s_T > s_N$ is assumed)



Labour allocation (from Eq. 58)

- **<u>Proposition 2</u>: Labour moves across sectors so that the marginal contribution of labour over wage cost is equalised.**
  - **Proof**. Using (58), the steady-steady state condition can be rewritten as: $pF'_{NL} - \frac{w_N}{\beta} = F'_{TL} - \frac{w_T}{\beta}$. ■
- When $\beta = 1$, we get the labour allocation condition familiar in the Ricardo-Viner model
- When $\beta = 0$, that $w_N = w_T = z$, the value of the marginal product is equalised across sectors

Unemployment and the Balassa-Samuelson effect

◆Equilibrium dynamics

- $R_N dL_N + R_T dL_T - d\theta = 0$
- $F'_{NL} dp + pF''_{NL} dL_N - Q_N d\theta = -pF''_{NLk} dk_N$
- $F''_{TL} dL_T - Q_T d\theta = -F''_{TLk} dk_T$
- $$\frac{dp}{p} = \underbrace{\eta^{-1}\left(\varepsilon_{Tk}\frac{dk_T}{k_T} - \varepsilon_{Nk}\frac{dk_N}{k_N}\right)}_{\text{(i)} Relative\ Productivity\ Effect} + \underbrace{\eta^{-1}\left(\varepsilon_{TL}\frac{dL_T}{L_T} - \varepsilon_{NL}\frac{dL_N}{L_N}\right)}_{\text{(ii)} Relative\ Labour\ Effect}$$

(i) → **Primary (basic) B-S effect**

(ii) → **Secondary effect from labour allocation**

Real exchange rate (from Eqs. 80 & 89)

- ◆**Proposition 3: The real exchange rate, *p*, appreciates (depreciates) with improvements in technological progress in the tradeables (nontradeables) sector.**
  - ➢**Proof**. (80) and (89) take positive and negative signs, respectively. ■
- □Relative labour effect does not overcome basic B-S effect, i.e. relative productivity effect

Simulating the Balassa-Samuelson effect

◆Production function

□$F_I = \nu_I^{-1} k_I L_I^{\nu_I} \rightarrow \varepsilon_{IL} = \frac{F'_{IL} L_I}{F_I} = \nu_I, \varepsilon_{Ik} = \frac{F'_{Ik} k_I}{F_I} = 1$

◆Baseline parameter values

s_N	0.025	ρ	0.5	ν_N	0.66	r	0.003	k_N	1
s_T	0.025	α	0.5	ν_T	0.66	$\bar{L}$	1	k_T	1
ψ	0.5	A	1	β	0.5	z	0.71	γ	2.5

Figure 1. Determination of L_T and L_N in the homogeneous case ($s_N = s_T$)

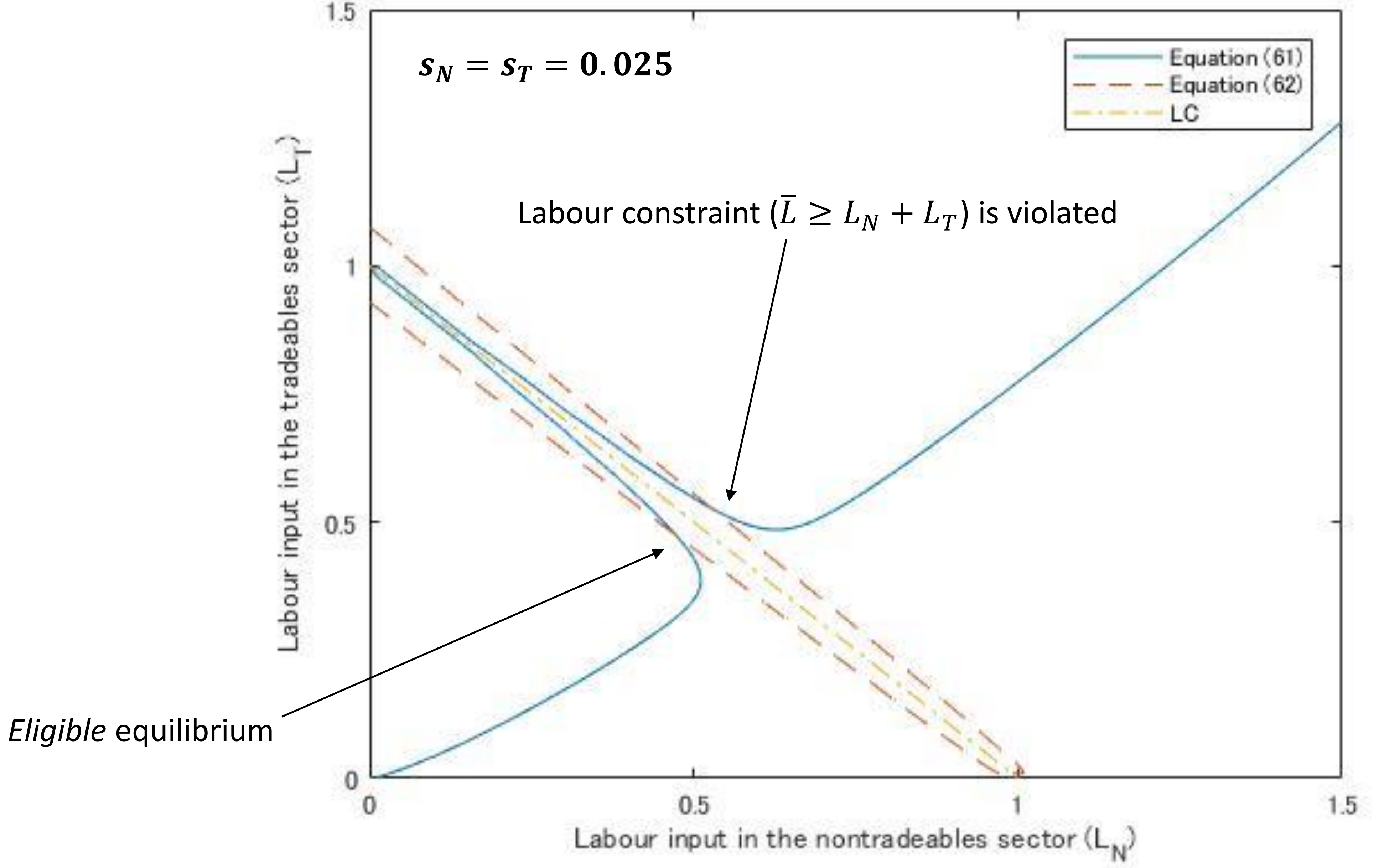
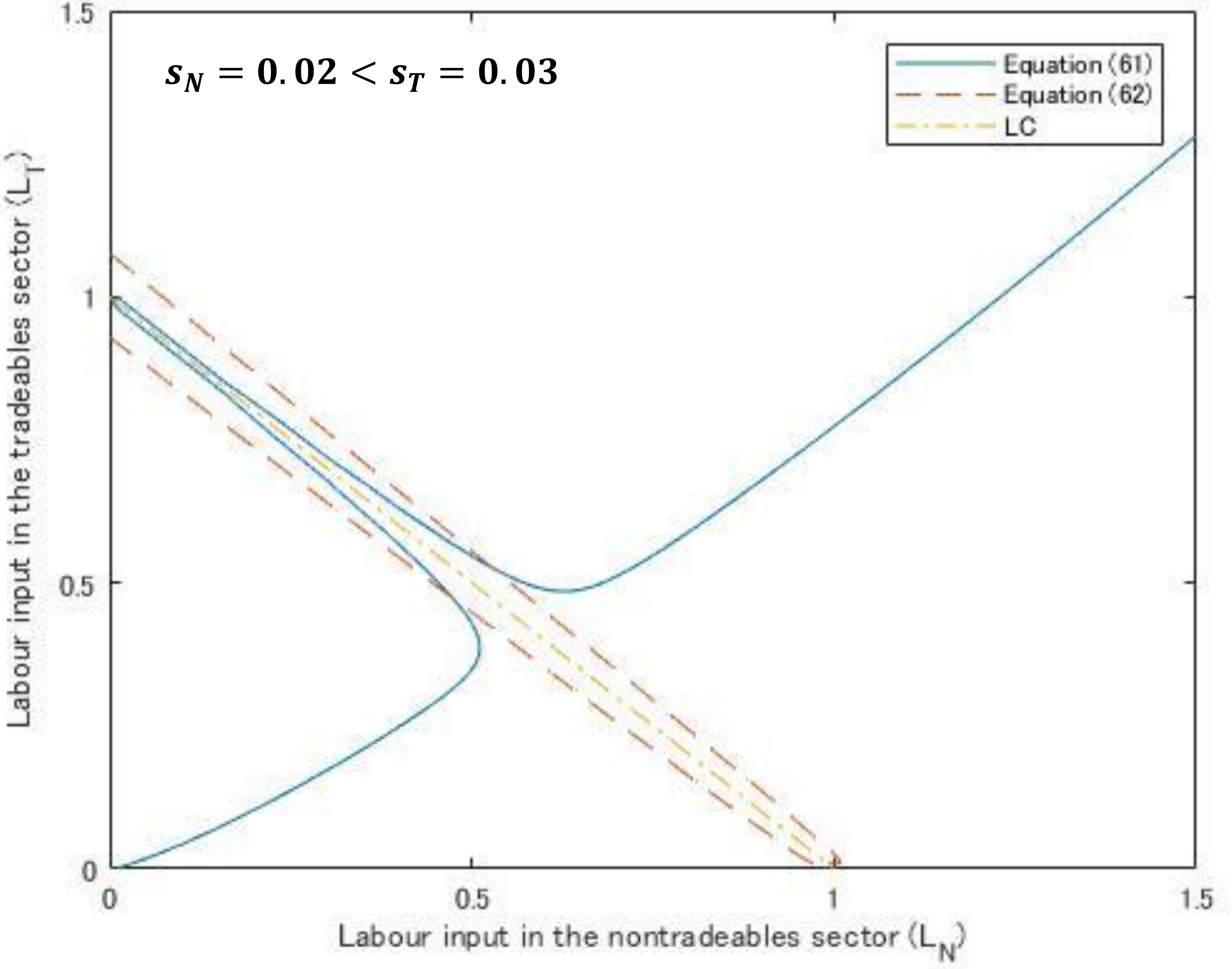


Figure 2. Determination of L_T and L_N in the heterogeneous case ($s_N < s_T$)



The B-S effect in homogeneous & heterogeneous cases

- **B-S effects**

  [Homo] $\frac{dp}{p} = \eta^{-1}\left(\frac{dk_T}{k_T} - \frac{dk_N}{k_N}\right)$

  [Hetero] $\frac{dp}{p} = \eta^{-1}\left(\frac{dk_T}{k_T} - \frac{dk_N}{k_N}\right) + \eta^{-1}\left(\nu_T \frac{dL_T}{L_T} - \nu_N \frac{dL_N}{L_N}\right)$

- **Productivity growth in Sector T ($dk_T/k_T = 0.1$)**

  - $\left.\frac{dp}{p}\right|_{Homo} = 0.2$
  - $\left.\frac{dp}{p}\right|_{Hetero} = 0.1986 - 0.0763 = 0.1223 < \left.\frac{dp}{p}\right|_{Homo}$
    - The relative labour effect offsets nearly 38 per cent of the relative productivity effect

Wage, labour demand and unemployment (heterogeneous case)

- **Wage gap ($\widetilde{W} = w_T - w_N$) increases**
  - $d\widetilde{W}/\widetilde{W} = 0.1226 > 0$
- **Labour demand in respective sectors**
  - $dL_T/L_T = -0.0229 < 0$
  - $dL_N/L_N = 0.0347 > 0$
- **Unemployment decreases**
  - $dU/U = -0.1089 < 0$
    - The rise in the nontradeables labour input exceeds the lower tradeables labour demand
- **Substitutability matters → See Figures 4 and 5**

Figure 4. Response of labour demand and unemployment to productivity growth in the tradeables sector

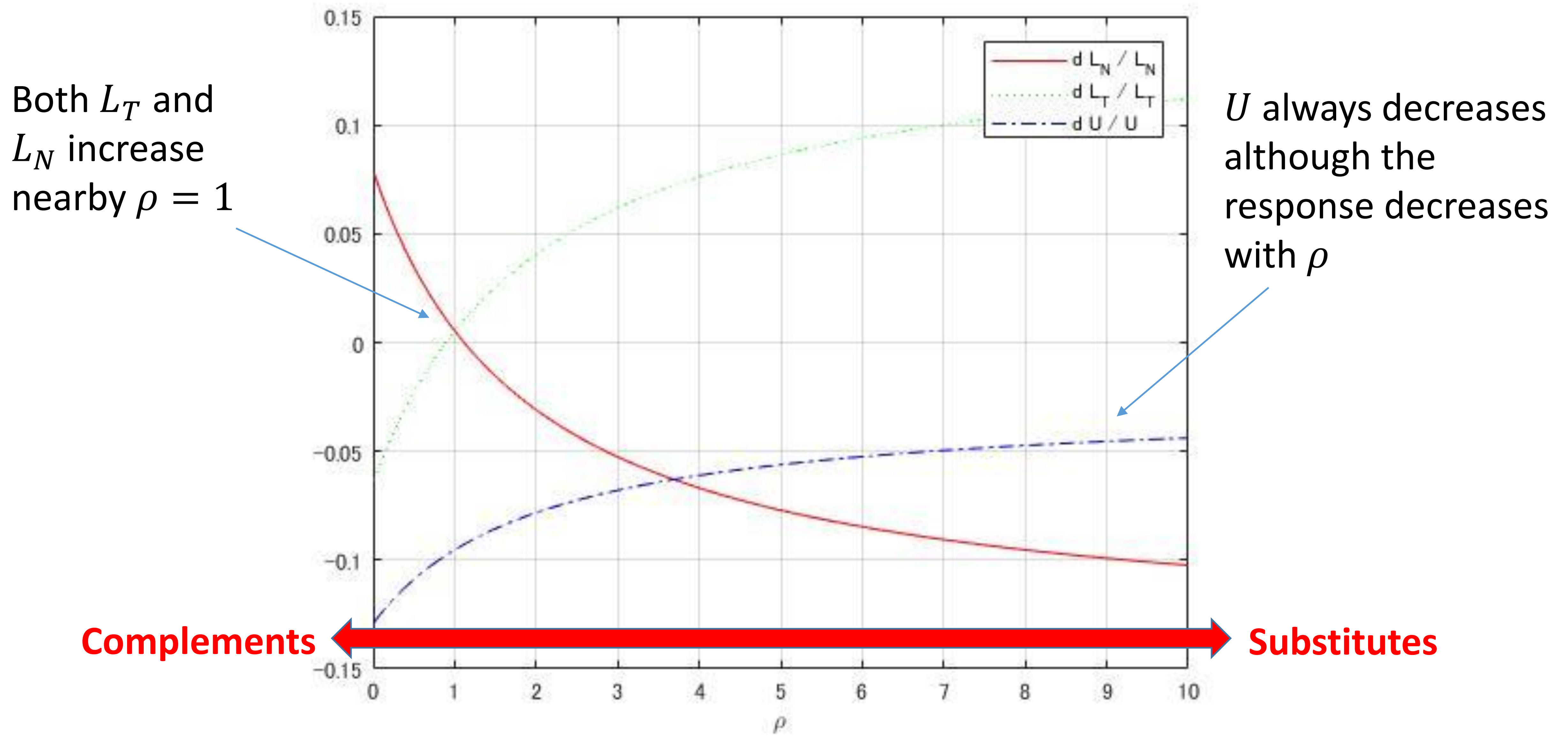


Figure 5. Response of the wage gap to productivity growth in the tradeables sector for alternative degrees of substitutability

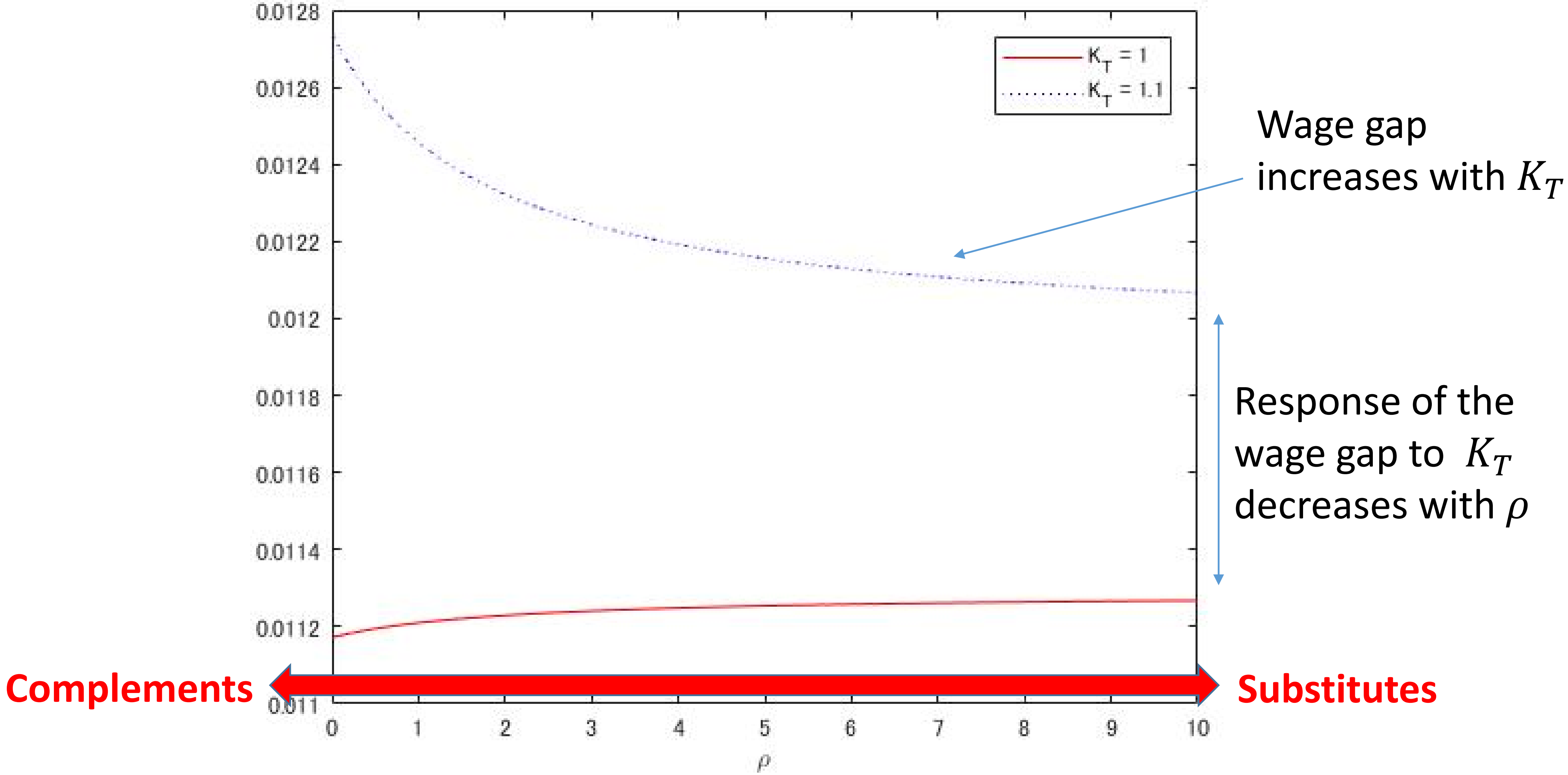
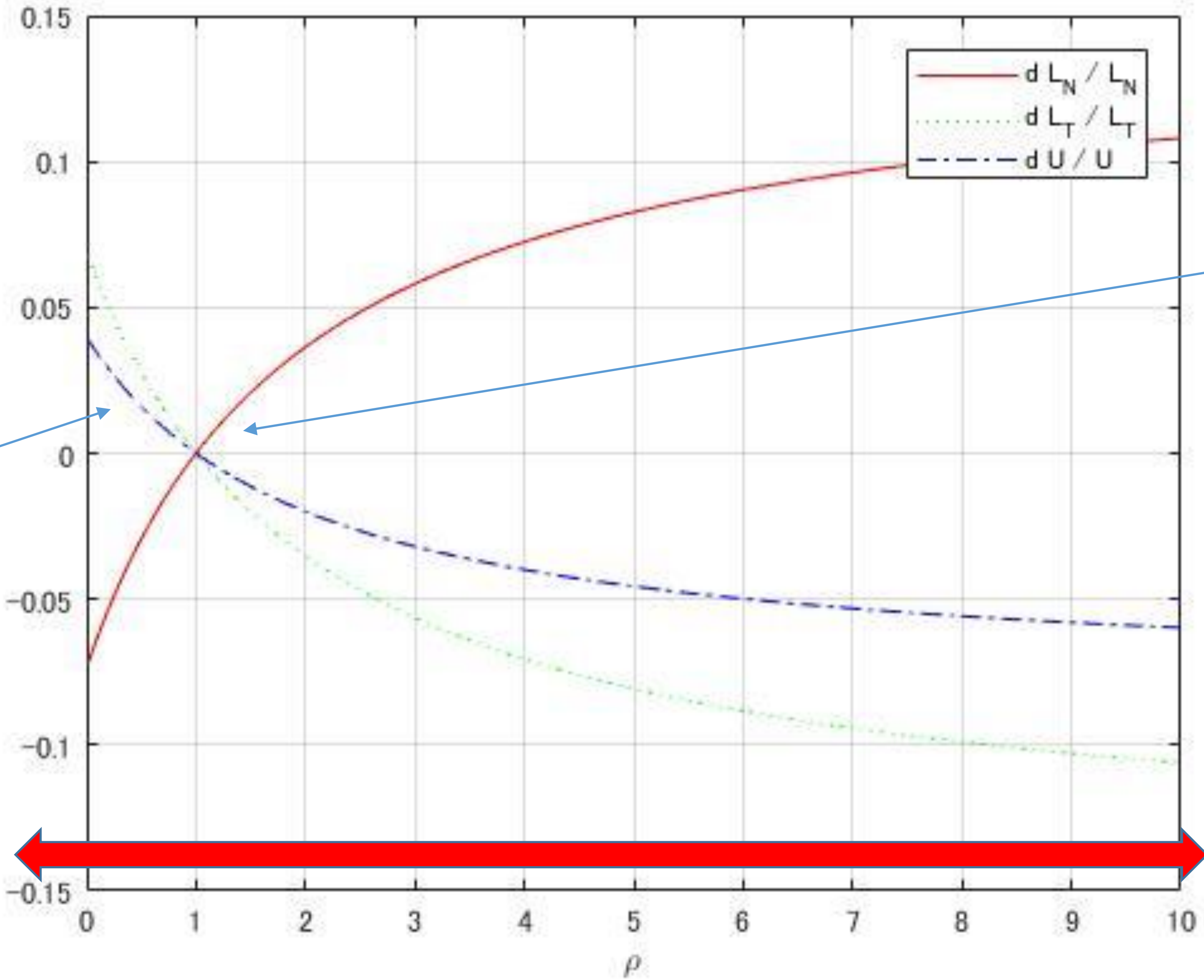


Figure 6. Response of labour demand and unemployment to productivity growth in the nontradeables sector ($dk_N/k_N = 0.1$)



No value of ρ for which both sectors expand employment

U increases when $\rho < 1$

Complements ⟷ **Substitutes**

Conclusion

- **We explain overvaluation of the B-S effect with heterogeneous job separations**
  - In the heterogeneous case ($s_T > s_N$), the relative labour effect offsets nearly 38 per cent of the relative productivity effect (Eq.100)
- **Substitutability significantly matters for the dynamics of (un)employment**
  - Rising productivity and capital growth in the nontradeables sector increases unemployment if tradeables and nontradeables are complements