The effect of the nominal exchange rate on prices: a 2-sector dynamic model with slow capital adjustment and money-in-the-utility

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Model objectives

- **basic assumptions:**
  - two sectors (traded = manufacturing, nontraded = services), $p_t = e p_T^*$
  - two factors of production (capital and labor)
  - slow adjustments (from intertemporal behavior): nominal -- consumption expenditures and income (MIU); real -- K accumulation ($q$)

- **its behavior:** effects of shocks (nominal, real), nominal paths
  - prices, wages, rental rates
  - capital and labor employment in the two sectors
  - consumption, investment, trade balance
  - impact effect plus persistence -- an endogenous propagation mechanism: excess demand (spending) creates *some* of its excess supply (income)
  - both rigidities are needed for both the impact effect and the persistence

- *highlights that open economy real exchange rate developments have deep 2-sector, 2-factor determinants*
Potential applications

• demand effect of a fiscal (income) shock: income $\uparrow$ $\Rightarrow$ expenditure $\uparrow$ $\Rightarrow$ NT-T relative price $\uparrow$ $\Rightarrow$ income (w) $\uparrow$

• nominal appreciation: reproduces quite many of stylized ERBS facts (Reinhart-Végh 1995, Burnstein et al 2002) and the recent Hungarian experience, without sticky prices
  – (1-2) consumption boom, (3) slow disinflation, (4) trade deficits
  – NT prices and wages are major sources of inflation “misbehavior”
  – investment collapse, FDI outflow, T-NT asymmetry in investment

• the effect is like a fiscal expansion! $\Rightarrow$ *endogenously* slow adjustment of wages and NT prices $\Rightarrow$ failure of ERBSs?

• the impact of euro conversion rate on nominal and real variables -- the size and persistence of misalignment, its effect on sectors and factors of production

• B-S effect with slow investment, *temporary* demand effect
Theoretical interpretation of NATREX

- long run: all state variables are stable
- medium run: all state variables that adjust fast are “temporarily unchanged” (e.g., $H$ is along the $dH/dt=0$ location)
- realized behavior: all state variables adjust slowly
Model details

- 2 sectors: C-D prod., labor-augmenting exogenous growth in T (the long-run is then the “flexible Balassa-Samuelson model”); can transform all into effective variables
- 2 inputs: labor -- mobile across sectors, capital -- mobile across sectors but adjusts slowly between countries
- demand: intertemporal optimization of a C-D “aggregate” (T, NT consumption and real money -- H/P)
- a near-optimal policy function for nominal expenditure: $E = VH = (\delta + \pi)\gamma/(1-\gamma)H$ (neglects changes in $\pi$) -- have a continuous, full optimization version with qualitatively identical results (Benczur-Konya)
- consumer income: only w (K is foreign, capitalists eat only T)
- all markets clear except for
  - Tobin-q for capital ($r \neq r^*$), money accumulation ($E \neq Y$, $TB \neq 0$)
Numerical solution (winsolve is enough!)

- **dynamics:**
  \[ \dot{K}_t = \dot{K}_T + \lambda V \frac{\dot{H}}{e} * \dot{K}_T^{\beta} \left( \frac{1-\alpha}{1-\beta} - \frac{\alpha}{\beta} \right) \]
  \[ r = (1-\beta)e^{\dot{K}_T^{-\beta}} \]
  \[ \dot{K}_{t+1} = \frac{\dot{K}_{t+2}}{2 + r^*} + \frac{\dot{K}_t(1+r^*)}{2 + r^*} + \frac{c(r/e - r^*)}{2 + r^*} \]
  \[ \dot{H}_{t+1} = \dot{H}_t + \frac{e}{1+g} \beta k_T^{1-\beta} - \frac{V \dot{H}_t}{1+g}. \]

- **linearize laws of motion, can keep the per period equations**

- **calibration:**
  - \( \alpha=0.8, \beta=0.5 \) (NT is more labor-intensive); \( \lambda=2/3 \) weight of NT
  - \( r^*=0.005 \) (5\% per year since 1 year = 10 periods), \( g=0.001 \) (1\%)
  - \( c=3000 \) -- half-life of an innovation in \( K \) is appr. 2 years; \( V=0.1 \) -- half-life of a money shock is appr. 1 year
  - \( H_0, K_0 \) is 80-90-100\% of steady state values
Intuition of model mechanics

- nominal appreciation (disinflation, strong EMU rate) increases the value of money in T
- this leads to excess spending, just like a fiscal stimulus
- higher consumption of NT and T, higher NT production, lower T production, trade deficit (H flows out)
- NT prices increase because the short-term transformation curve is nonlinear
- *propagation*: higher NT prices increase domestic income ("transfer effect")! Concretely: if NT is more labor-intensive, then wages increase
- the price of capital (r and q) falls, which hurts investment
- asymmetry: w↑, r↓; NT↑, T↓, reallocations between sectors
Results

• equilibrium growth paths, with different $K_0$: (1-2)
  $K<K^* \Rightarrow r>r^* \Rightarrow p_{NT}<p_{NT}^*$ (inverse Stolper-Samuelson)
  $\Rightarrow$ convergence means excess inflation (even w/o TFP growth) -- if the NT sector is more labor-intensive

• nominal growth paths: from equilibrium $H_0(K_0)$, $e=1$ and 0.9 (3-7) -- appr. 1% misalignment for around 2 years, but an important effect on $r$, $w$ and $K$!

• the difference of the two nominal paths (i.e., the nominal impulse response of an appreciation): $K$, $p$, $K_{NT}$, $K_T$, $L_T$, $L_{NT}$, $k_T$ ($\sim k_{NT}$), $r/e$, $w/e$, $C$, $Y$, $TB$, “real” GDP (8-16)

• sensitivity to the adjustment speed ($c$, $V$), initial values, fiscal expansion ($dH>0$ extra income)
Discussion, future research

• general intuition: the nominal exchange rate influences T prices, while some assets are fixed in local currency => change in demand => GE change in prices and income
• money, wealth or portfolio-rebalancing interpretations -- similar, but different impact and persistence
• role of approximations (E=VH, near-q theory): full optimization version in continuous time, the same intuition works ($\partial E_0/\partial H_0>0$, so an appreciation creates excess demand)
• the role of sectoral intensities, capital ownership?
• the role of unit substitutability
  – CES in consumption: high substitutability decreases the impact and the persistence, low subst. increases ($w$ can even increase more than 1:1!)
  – CES in production: just the opposite (low subst. magnifies the effect)
Discussion, future research cont.

• slow reallocation between sectors:
  – sectoral q
  – Dixit-Stiglitz competition with temporary profits and gradual entry
    (“sticky entry”) => endogenous T passthrough as well?

• the role of economic development (distance from steady state, the weight of rK)

• price or inflation inertia? success of ERBSs -- can we trace them to differences in the strength of model effects?

• “sticky price” models: firms will not adjust to 100% exchange rate passthrough, so adjustment is even slower

• calibration on Hungarian data, or static/dynamics estimation? non-homotheticity of T-NT demand?