Balance-of-Payments Crises and Household Heterogeneity

Small Open Economy with Hand-to-Mouth Agents (TANK)

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EUI

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Motivation

Distinct characteristics of emerging market economies (EME):

- **higher volatility** relative to advanced economies
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  - ...and consumption $[var(C)/var(Y)]$

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$\Rightarrow$ Could the HtM-channel can explain (some) of this high volatiliy?

$\Rightarrow$ How does it work in BoP crises?

$\Rightarrow$ How does it interact with monetary policy?

Overview

Idea: higher average MPC due to HtM can provide amplification

- New Keynesian Cross mechanism [Bilbiie, 2017]
  - *direct* effects of shocks on aggregate demand (e.g. of interest rate changes through intertemporal substitution, Euler-eq.)
  - *indirect* GE effects on consumption through income can lead to multiplication – only with HtM households
  - HtM consume out of *current income* (high MPC), unlike consumption-smoothing optimizers who consume out of *lifetime income*

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- look at a sudden stop (incomplete markets)
  - A) real interest rates rise: $r \uparrow \Rightarrow$ depresses consumption (as in RANK)
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    - A vs B determines recession or expansion, and how the HtM-channel through the indirect effect operates (only in TANK)
- monetary policy and currency regime can matter a lot [Krugman, 2014]
  - with nominal rigidities it affects how the shock is distributed across $r \uparrow$ and $Q \uparrow$

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3. under free float the HtM-channel **mitigates** the fall in aggregate consumption (since incomes increase)
   - Ricardian and HtM consumption goes in opposite direction (instead of reinforcing, direct and indirect effects work against each other)
   - with high HtM share and nominal rigidities, HtM-channel can dominate the downward pressure from intertemporal substitution: aggregate consumption *rises* (only in TANK!)

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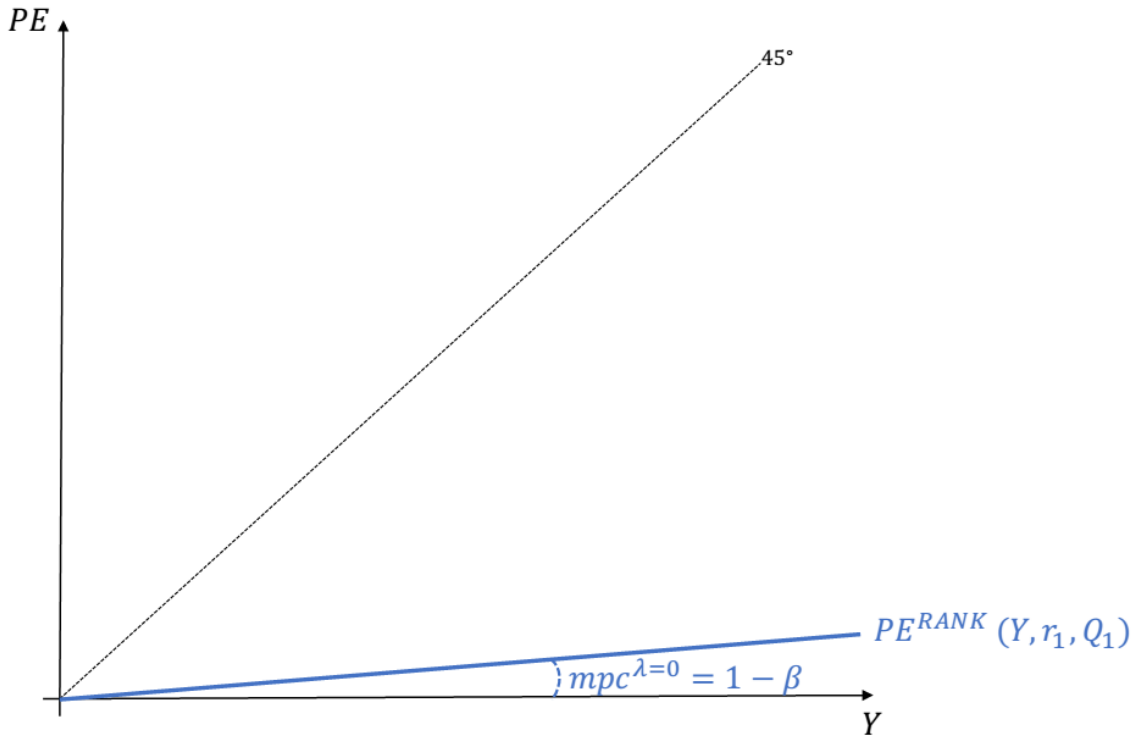
4. under FX-peg the HtM-channel **amplifies** the fall in aggregate consumption (since incomes also fall)

$\Rightarrow$ Accounting for the HtM-channel, a FX-peg is even more detrimental relative to a free float during BoP crises.

The New Keynesian Cross



$$c_t = \underbrace{[1-\beta]}_{mpc} y_t - \underbrace{\beta\sigma}_{\Omega_D} r_t + \underbrace{\beta}_{1-mpc} E_t c_{t+1}$$

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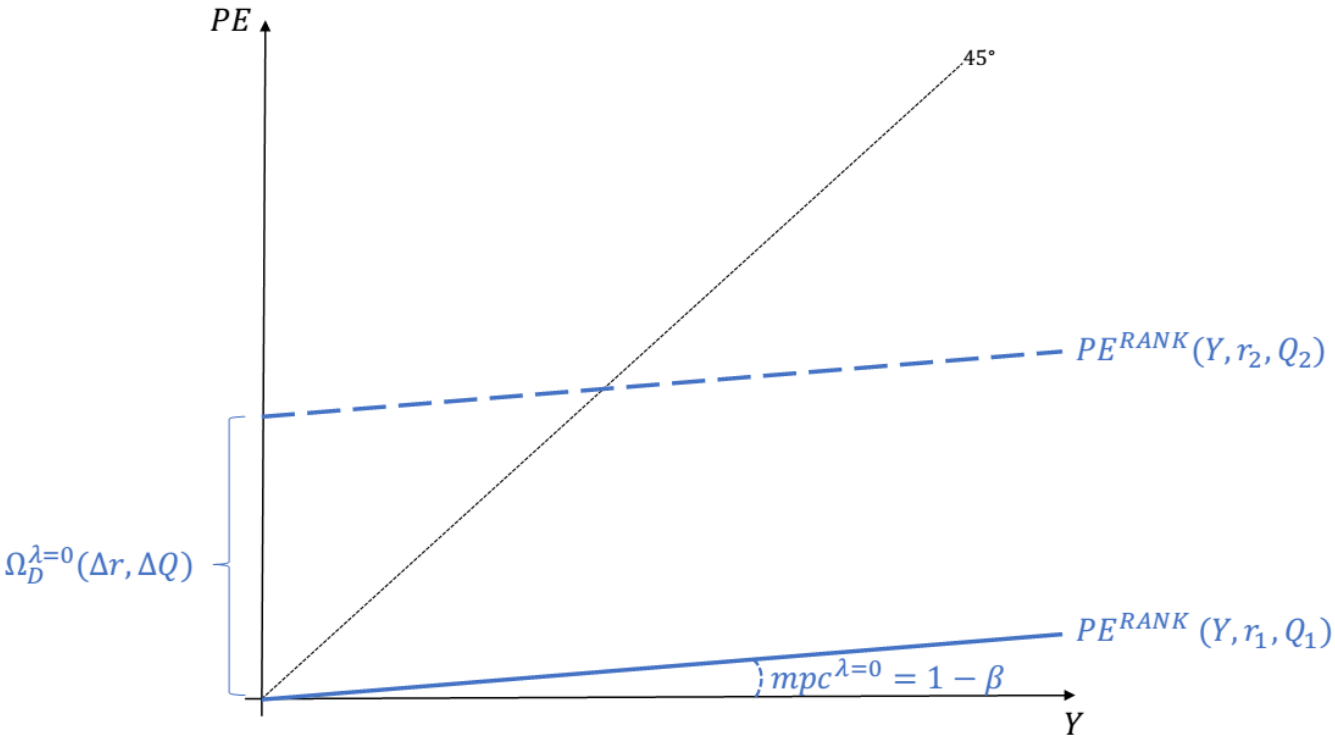

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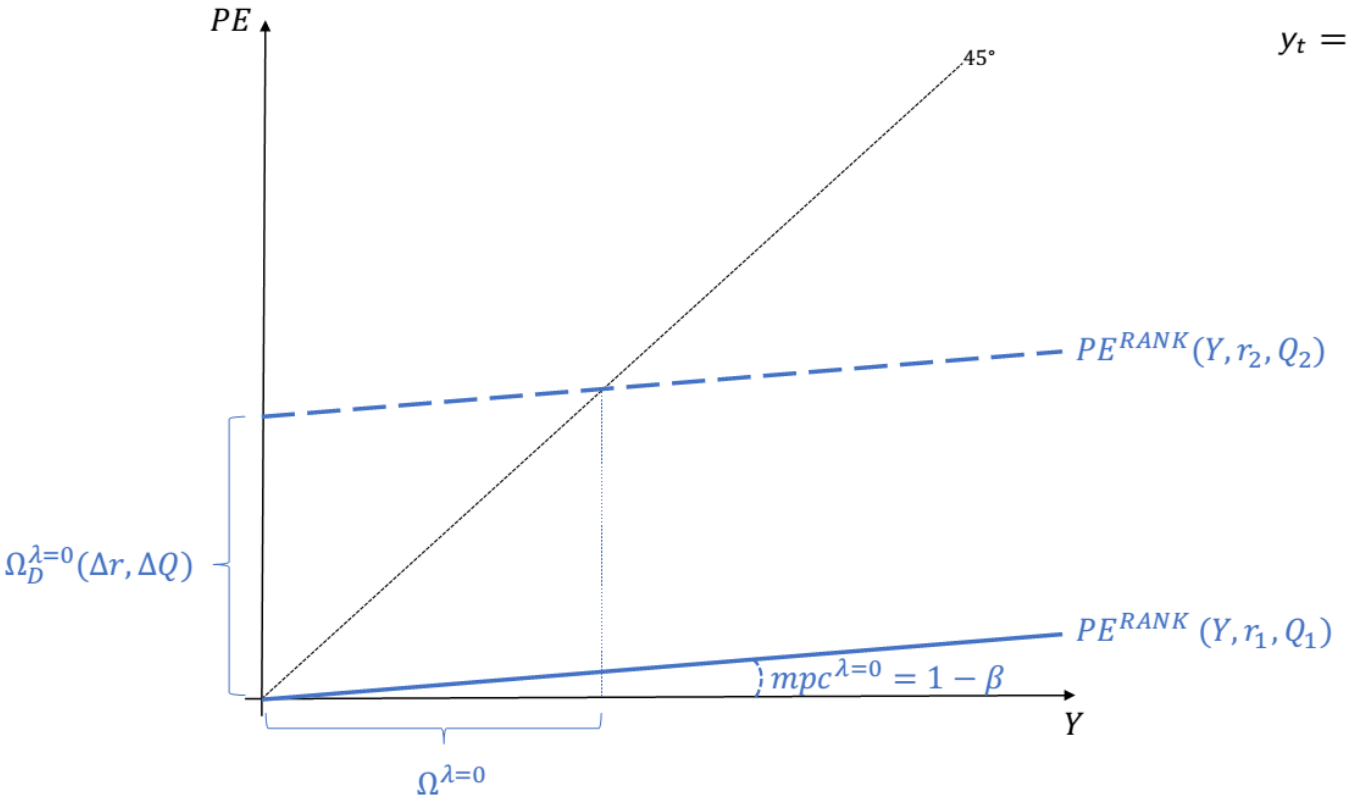

$$y_t = E_t y_{t+1} - \underbrace{\sigma}_{\Omega = \frac{\Omega_D}{1-mpc}} r_t$$

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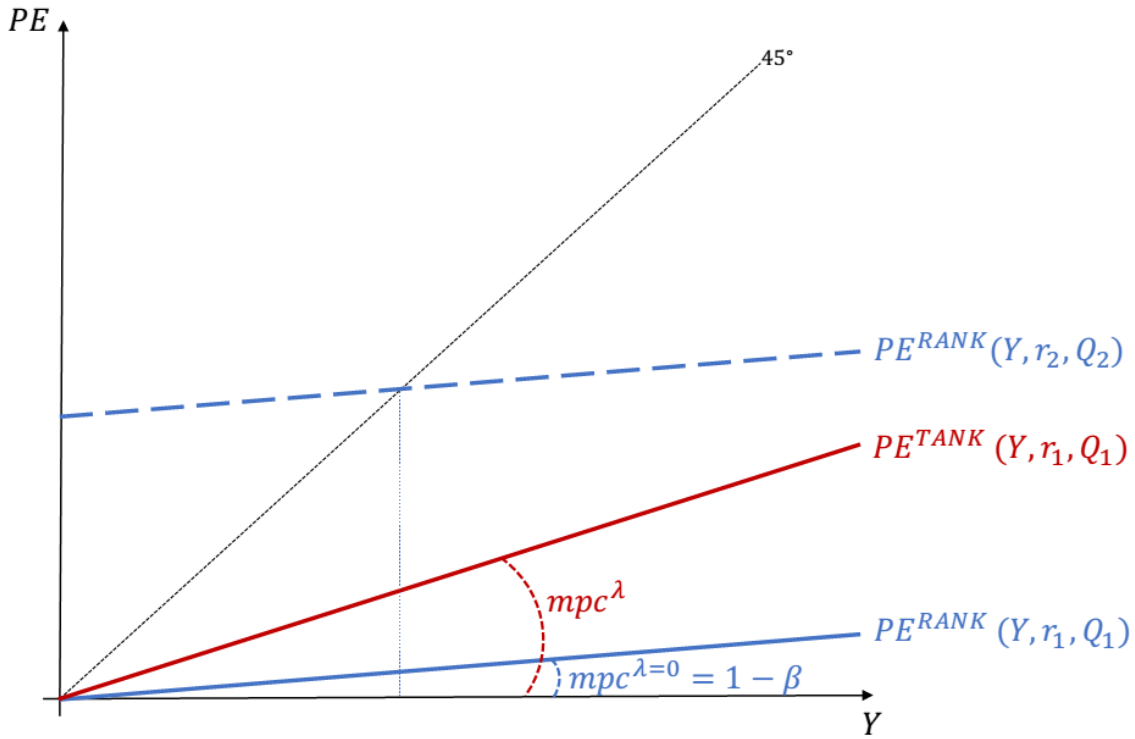

$$c_t = \underbrace{\left[1 - \beta(1 - \lambda\chi)\right]}_{mpc} y_t - \underbrace{(1 - \lambda)\beta\sigma}_{\Omega_D} r_t + \underbrace{\beta(1 - \lambda\chi)}_{1-mpc} E_t c_{t+1}$$

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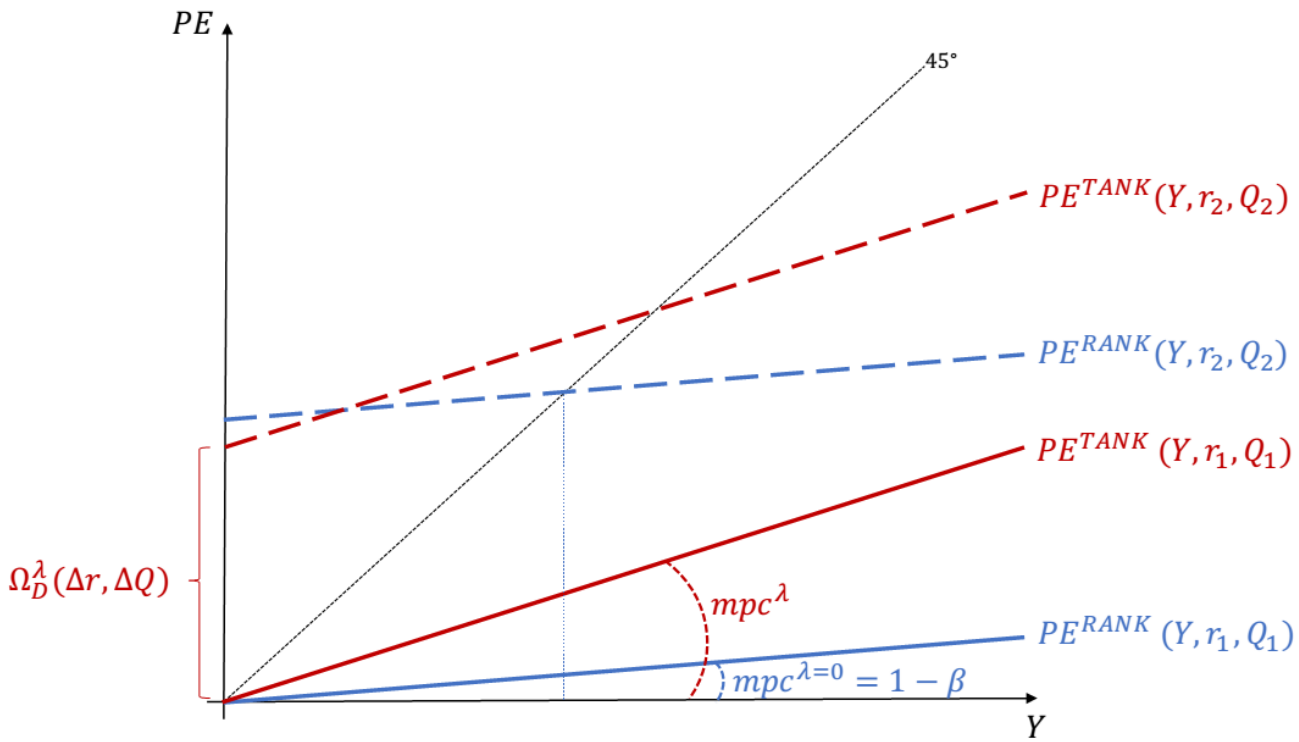

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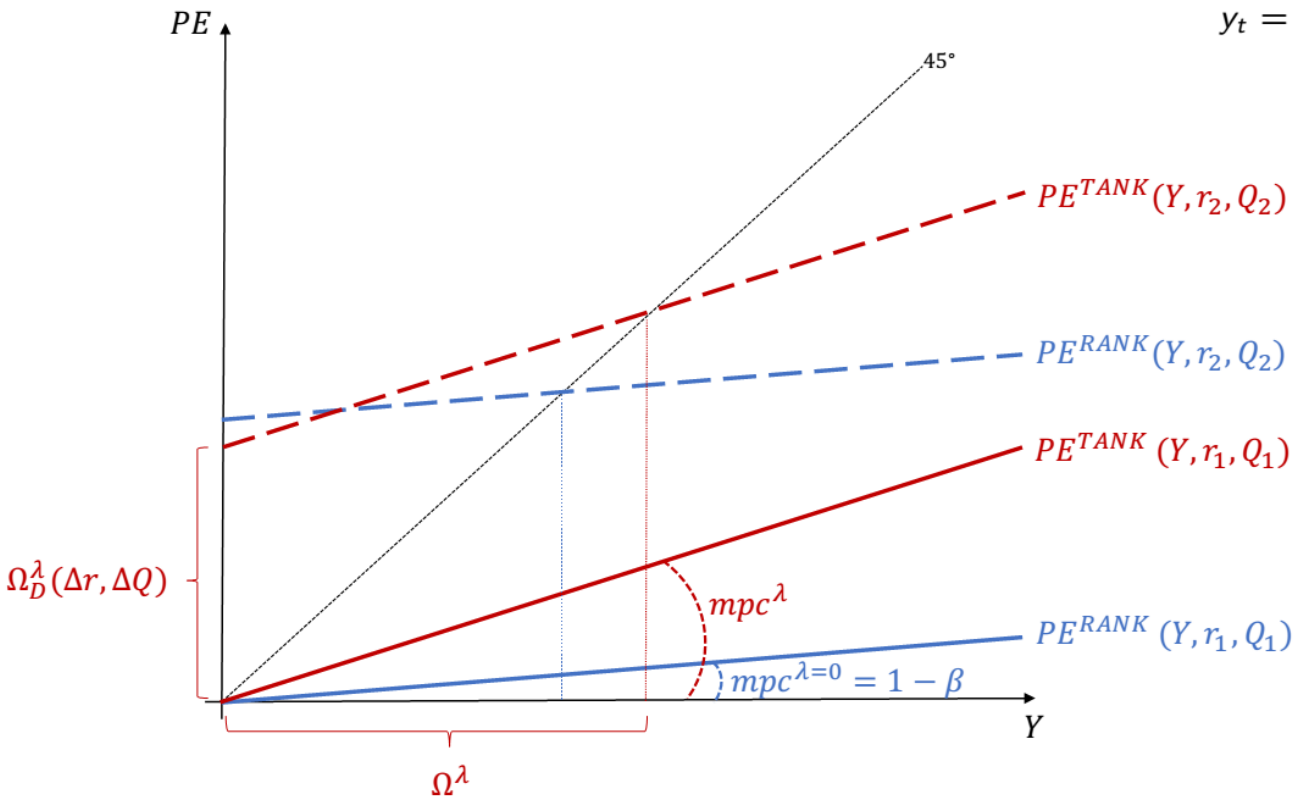

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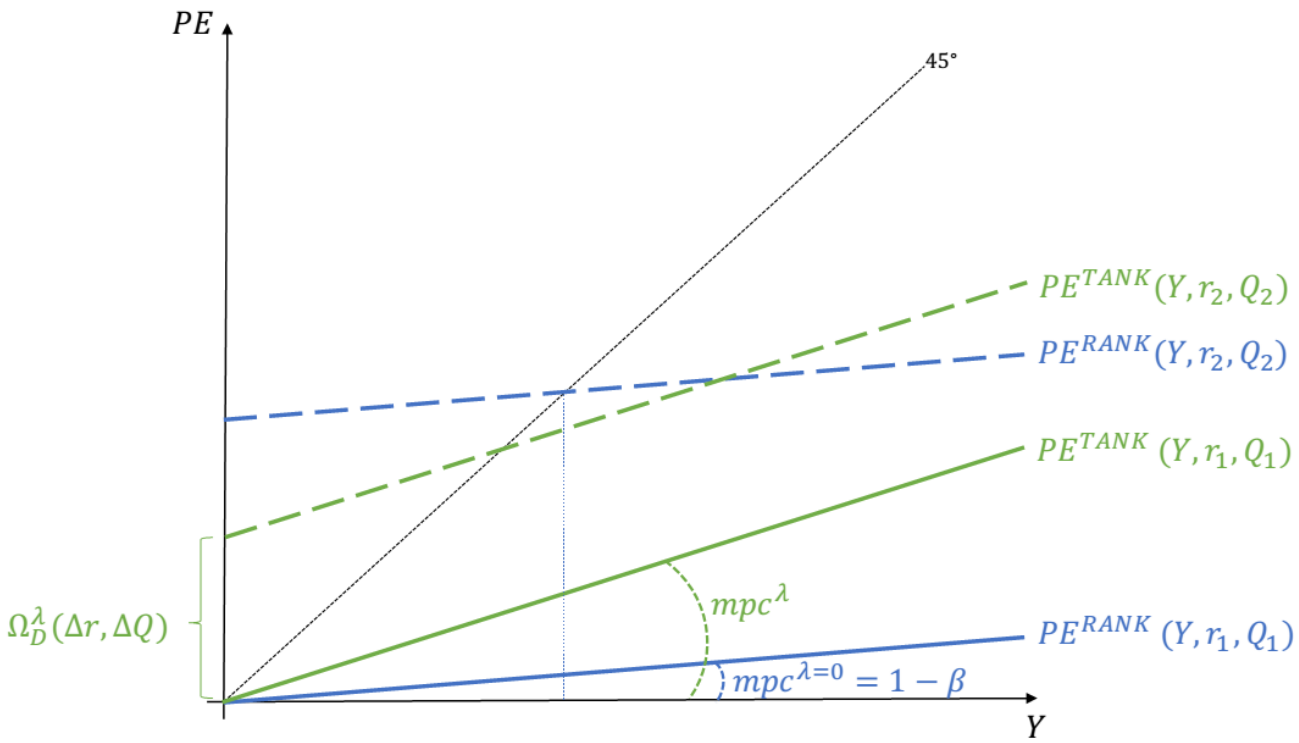

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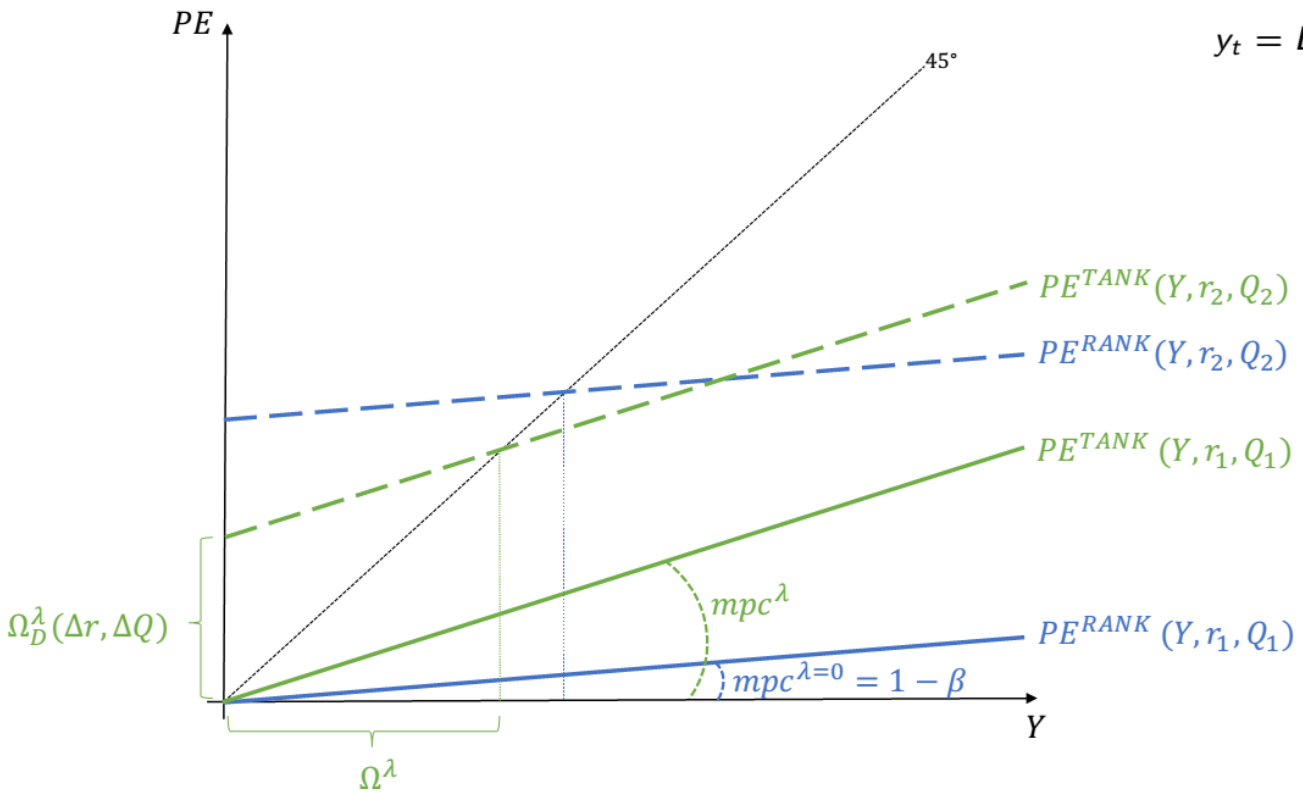

Literature

- emerging market financial crises
  - financial frictions on firm investment (collateral constraints, balance sheet effects, currency mismatch) [Mendoza, 2002], [Mendoza, 2010], [Aghion et al., 2001], [Céspedes et al., 2004]
  - reduced form **risk premium** [Benczúr and Kónya, 2015]
- **open economy New Keynesian** models (RANK)
  - complete markets [Galí and Monacelli, 2005]
  - **incomplete markets** [De Paoli, 2009]
- heterogeneous agents (mainly closed economy)
  - hand-to-mouth agents **(TANK)**: [Bilbiie, 2017]
  - uninsured idiosyncratic risk (HANK): [Kaplan et al., 2018], [Debortoli and Galí, 2018], [Bilbiie, 2018]

[Iyer, 2017] and [Boerma, 2014] consider an open economy TANK model, but with perfect international risk sharing ⇒ not suitable for sudden stops

$$\underbrace{c_t = E_t c_{t+1} - \sigma r_t}_{\text{RANK}} - \underbrace{\frac{\lambda(\chi-1)}{1-\lambda\chi}\sigma r_t}_{\text{TANK: HtM-channel (cyclical inequality)}} + \underbrace{(\delta-1)E_t c_{t+1}}_{\text{HANK: acycl. idiosyncr. risk}} + \underbrace{(\theta-1)\left(\delta E_t c_{t+1} - \sigma\frac{1-\lambda}{1-\lambda\chi}r_t\right)}_{\text{HANK: cyclical risk}}$$

Model ingredients

- small open economy (SOE) $\Rightarrow$ real exchange rate matters for aggregate demand
- two agents (TA): Ricardian and Hand-to-Mouth households $\Rightarrow$ AD-amplification through New Keynesian Cross (high aggregate MPC)
- nominal rigidities (NK) $\Rightarrow$ monetary policy and currency regimes matter
- incomplete international financial markets: Ricardians trade in a single bond
  - no idiosyncratic risk (avoiding a full-blown HANK)
  - **LCY debt** – or FX debt (currency mismatch)
  - debt-elastic risk-premium (ensuring stationarity)
  - balance-of-payments matters (sudden stop) – as opposed to perfect risk-sharing
- sudden stop as a shift in foreigner's asset supply (the premium function)
- balanced budget fiscal policy (for now)
  - potentially redistributing profits
  - no government expenditures
  - no government debt

Hand-to-Mouth households

λ fraction of households don't participate in financial markets:

$$\max_{\check{C}_t, \check{N}_t} \quad E_t \left\{ \frac{\check{C}_t^{1-\sigma}}{1-\sigma} - \frac{\check{N}_t^{1+\varphi}}{1+\varphi} \right\}$$

$$P_t \ \check{C}_t = W_t \ \check{N}_t + P_t \check{T}_t$$

- HtM labor supply:

$$w_t \equiv \frac{W_t}{P_t} = \check{C}_t^{\sigma} \ \check{N}_t^{\varphi}$$

Ricardian households

$1-\lambda$ fraction of households can trade in a risk-free international bond (LCY or FCY):

$$\max_{\widehat{C}_t,\widehat{N}_t,\widehat{B}_t,\widehat{B}_t^*} \quad E_t \sum_{t=0}^{\infty} \beta^t \left\{ \frac{\widehat{C}_t^{1-\sigma}}{1-\sigma} - \frac{\widehat{N}_t^{1+\varphi}}{1+\varphi} \right\}$$

$$P_t\ \widehat{C}_t + \frac{\widehat{B}_t}{1+i_t} + \frac{e_t\ \widehat{B}_t^*}{(1+i_t^*)\psi_t} \leq \widehat{B}_{t-1} + e_t\ \widehat{B}_{t-1}^* + W_t\ \widehat{N}_t + \frac{(1-\tau^D)P_t\Upsilon_t}{1-\lambda}$$

- FOCs:

$$w_t = \frac{W_t}{P_t} = \widehat{C}_t^{\sigma}\ \widehat{N}_t^{\varphi}$$

$$\frac{1}{1+i_t} = \beta\ E_t \left\{ \left[\frac{\widehat{C}_{t+1}}{\widehat{C}_t} \right]^{-\sigma} \frac{1}{\Pi_{t+1}} \right\}$$

$$\frac{1+i_t}{\mathrm{E_t}\ \Pi_{t+1}} = \frac{1+i_t^*}{\mathrm{E_t}\ \Pi_{t+1}^*}\ \psi_t\ \frac{\mathrm{E_t}\ Q_{t+1}}{Q_t}$$

International risk sharing

- incomplete markets $\Rightarrow$ imperfect risk sharing

$$\left[\frac{\mathrm{E_t}\ \widehat{C}_{t+1}}{\widehat{C}_t}\right]^{\sigma} = \left[\frac{\mathrm{E_t}\ C^*_{t+1}}{C^*_t}\right]^{\sigma}\ \psi_t\ \frac{\mathrm{E_t}\ Q_{t+1}}{Q_t}$$

- less tight link between consumption and the real exchange rate than under perfect risk sharing $\widehat{C}_t = C^*_t\, Q_t^{\frac{1}{\sigma}}$
- debt-elastic risk-premium ψ_t drives a further wedge (needed for stationarity, otherwise random walk, [Schmitt-Grohé and Uribe, 2003])
- market incompleteness is aggrevated by the presence of HtM ($\lambda \neq 0 \Rightarrow \widehat{C}_t \neq C_t$) who cannot participate in markets

Consumption baskets

- α is a measure of openness (import intensity), $1-\alpha$ is the home bias
- η elasticity of substitution between Home and Foreign produced (imported) goods

$$\check{C}_t = \left[(1-\alpha)^{\frac{1}{\eta}}(\check{C}_t^H)^{\frac{\eta-1}{\eta}} + \alpha^{\frac{1}{\eta}}(\check{C}_t^F)^{\frac{\eta-1}{\eta}}\right]^{\frac{\eta}{\eta-1}}$$

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Demand functions and CPI:

$$P_t = \left[(1-\alpha)(P_t^H)^{1-\eta} + \alpha(P_t^F)^{1-\eta}\right]^{\frac{1}{1-\eta}}$$

$$\check{C}_t^H = (1-\alpha)\left[\frac{P_t^H}{P_t}\right]^{-\eta}\check{C}_t \qquad \check{C}_t^F = \alpha\left[\frac{P_t^F}{P_t}\right]^{-\eta}\check{C}_t$$

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Consumption baskets – 2

- γ elasticity of substitution between imports from different countries $j \in [0,1]$
- ε elasticity of substitution between different good varieties $i \in [0,1]$ (monopolistic competition)b

Demand functions for HtM (similarly for Ricardians $\widehat{C}_t$, and for Home $j = H$):

$$\check{C}_t^F = \left[\int_0^1 (\check{C}_t^j)^{\frac{\gamma-1}{\gamma}} \, \mathrm{d}j\right]^{\frac{\gamma}{\gamma-1}}$$

$$\check{C}_t^j = \left[\frac{P_{t,j}}{P_t^F}\right]^{-\gamma} \check{C}_t^F$$

$$P_t^F = \left[\int_0^1 P_{t,j}^{1-\gamma} \, \mathrm{d}j\right]^{\frac{1}{1-\gamma}}$$

$$\check{C}_t^j = \left[\int_0^1 \check{C}_t^j(i)^{\frac{\varepsilon-1}{\varepsilon}} \, \mathrm{d}i\right]^{\frac{\varepsilon}{\varepsilon-1}}$$

$$\check{C}_t^j(i) = \left[\frac{P_{t,j}(i)}{P_{t,j}}\right]^{-\varepsilon} \check{C}_t^j$$

$$e_{t,j} P_t^j = P_{t,j} = \left[\int_0^1 P_{t,j}(i)^{1-\varepsilon} \, \mathrm{d}i\right]^{\frac{1}{1-\varepsilon}}$$

$$P_t^H = \left[\int_0^1 P_t^H(i)^{1-\varepsilon} \, \mathrm{d}i\right]^{\frac{1}{1-\varepsilon}}$$

Exchange rates

- *effective* nominal exchange rate is defined as $e_t = \left[\int_0^1 e_{t,j}^{1-\gamma}\ \mathrm{d}j\right]^{\frac{1}{1-\gamma}}$
- *bilateral* real exchange rate is $Q_{t,j} = \frac{e_{t,j}P_t^j}{P_t}$, while the *effective* real exchange rate is defined as $Q_t = \left[\int_0^1 Q_{t,j}^{1-\gamma}\mathrm{d}j\right]^{\frac{1}{1-\gamma}} \Rightarrow Q_t = P_t^F/P_t$
- the Law of One Price holds for imports (but due to home bias, $\alpha \neq 1$, Purchasing Power Parity in terms of the CPI P_t does not apply):

$$P_t^F = e_t P_t^*$$

- effective real exchange rate:

$$Q_t = \frac{e_t P_t^*}{P_t}$$

- CPI-PPI wedge due to openness ($\alpha \neq 0$)

$$\frac{P_t}{P_t^H} = \left[\frac{1-\alpha}{1-\alpha\, Q_t^{1-\eta}}\right]^{\frac{1}{1-\eta}} \equiv h(Q_t) \qquad (1)$$

Retailers

Perfectly competitive Retailers bundle together differentiated intermediate goods into final goods

$$\max_{Y_t(i)} \left\{ P_t^H Y_t - \int_0^1 P_t^H(i) Y_t(i) \, \mathrm{d}i \right\}$$

$$Y_t = \left[Y_t(i)^{\frac{\varepsilon - 1}{\varepsilon}} \mathrm{d}i \right]^{\frac{\varepsilon}{\varepsilon - 1}}$$

Demand function:

$$Y_t(i) = \left[\frac{P_t^H(i)}{P_t^H} \right]^{-\varepsilon} Y_t$$

Intermediate good firms

- monopolistically competitive
- Calvo rigidities (θ) in Home produced good prices

$$\max_{P_t^H(i)} \quad \sum_{k=0}^{\infty} \theta^k \underbrace{\frac{1}{\prod_{s=1}^{k}(1+i_{t+s})}}_{\equiv \Psi_{t,t+k}} \left[P_t^H(i)\, Y_{t+k}(i) - (1-\tau^w) W_{t+k} N_{t+k}(i) - P_{t+k}\, T^s_{t+k} \right]$$

$$Y_{t+k}(i) = \left[\frac{P_t^H(i)}{P^H_{t+k}} \right]^{-\varepsilon} Y_{t+k}$$

$$Y_t(i) = A_t N_t(i)$$

optimal price decision:

$$P_t^H(*) = \underbrace{\frac{\varepsilon(1-\tau^w)}{\varepsilon - 1}}_{\mathcal{M}} \; \mathrm{E_t} \; \frac{\sum_{k=0}^{\infty} \theta^k \Psi_{t,t+k}\; Y_{t+k}(i)\; MC_{t+k}(i)}{\sum_{k=0}^{\infty} \theta^k \Psi_{t,t+k}\; Y_{t+k}(i)}$$

Aggregate supply

- aggregate production function

$$Y_t \, \Xi_t = A_t \, N_t$$

- price dispersion

$$\Xi_t \; = \left(\Pi_t^H\right)^{\varepsilon} \, \theta \, \Xi_{t-1} + (1-\theta) \left[\frac{1-\theta\left(\Pi_t^H\right)^{\varepsilon-1}}{1-\theta} \right]^{\frac{\varepsilon}{\varepsilon-1}}$$

- firm profits: wage subsidy is financed by lump sum tax T_t^s *on firms!*

$$\begin{aligned} \Upsilon_t &= \frac{P_t^H}{P_t} Y_t - (1-\tau^w) w_t N_t - T_t^s = \\ &= \frac{Y_t}{h(Q_t)} - w_t N_t = \\ &= \frac{Y_t}{h(Q_t)} \left[1 - \; rMC_t \, \Xi_t \right] \end{aligned}$$

Market clearing and accounting

$$N_t = \lambda \check{N}_t + (1-\lambda)\widehat{N}_t$$
$$C_t = \lambda \check{C}_t + (1-\lambda)\widehat{C}_t$$
$$C_t^H = \lambda \check{C}_t^H + (1-\lambda)\widehat{C}_t^H$$
$$C_t^F = \lambda \check{C}_t^F + (1-\lambda)\widehat{C}_t^F$$

Goods market clearing (Aggregate Demand):

$$Y_t = C_t^H + C_{t,*}^H =$$
$$= \underbrace{(1-\alpha)\left[\frac{P_t^H}{P_t}\right]^{-\eta} C_t}_{C_t^H} + \underbrace{\alpha \int_0^1 \left[\frac{P_t^H}{e_{t,j}P_t^{F,j}}\right]^{-\gamma}\left[\frac{P_t^{F,j}}{P_t^j}\right]^{-\eta} C_{t,j}\,\mathrm{d}j}_{C_{t,*}^H} =$$
$$= (1-\alpha)\left[h(Q_t)\right]^{\eta} C_t + \alpha\left[h(Q_t)\right]^{\gamma} Q_t^{\gamma} Y_t^*$$

- in a closed economy ($\alpha = 0$) this collapses to be the resource constraint
- with openness this is an important descriptor of the economy's AD side as a function of REER

External balance

Balance of payments

LCY debt:

$$P_t C_t + \frac{B_t}{1+i_t} = B_{t-1} + W_t N_t + P_t \Upsilon_t$$

$$\frac{1}{P_t}\left[\frac{B_t}{1+i_t} - B_{t-1}\right] = \underbrace{\frac{P_t^H}{P_t} Y_t - C_t}_{NX_t}$$

$$\frac{b_t}{1+i_t} - \frac{b_{t-1}}{\Pi_t} = NX_t$$

FX debt:

$$P_t C_t + \frac{e_t B_t^*}{(1+i_t^*)\psi_t} = e_t B_{t-1}^* + W_t N_t + P_t \Upsilon_t$$

$$\frac{e_t}{P_t}\left[\frac{B_t^*}{(1+i_t^*)\psi_t} - B_{t-1}^*\right] = \underbrace{\frac{P_t^H}{P_t} Y_t - C_t}_{NX_t}$$

$$\frac{b_t^*}{(1+i_t^*)\psi_t} - b_{t-1}^* \frac{Q_t}{Q_{t-1}} = NX_t$$

- incomplete markets: NFA position b_{t-1} is an important state variable
- first-order valuation effects when $b \neq 0$ (monetary policy non-neutral with nominal LCY debt, even under flex prices)

Risk premium

- domestic households face a debt-elastic risk premium ψ_t (= asset supply of foreigners)
- no idiosyncratic risk (= flat asset demand of domestic households), but no perfect risk sharing either (incomplete int'l markets)
  - without the risk premium ($\delta > 0$) the model would not be stationary and the steady state NFA (= "asset distribution") would not be pinned down [Schmitt-Grohé and Uribe, 2003]
  - through debt-elastic ψ_t assets become an important state variable in the consumption-saving decision, anchoring the model
- sudden stop as a shock to ζ_t
- ζ is a parameter pinning down steady state NFA

$$\psi_t = e^{-\delta\left(\frac{B_t}{P_t^H Y_t} - \zeta_t\right)} =$$

$$= e^{-\delta\left(b_t \frac{h(Q_t)}{Y_t} - \zeta_t\right)}$$

$$\zeta_t = (1 - \rho_\zeta)\zeta + \rho_\zeta \zeta_{t-1} + \epsilon_t^\zeta$$

Government policies

Monetary policy:

$$\frac{1+i_t}{1+i} = \left(\frac{\Pi_t^H}{\Pi^H}\right)^{\phi^\pi} \left(\frac{Y_t}{\overline{Y}_t}\right)^{\phi^y} \left(\frac{e_t}{e_{t-1}}\right)^{\phi^e} v_t$$

- strict domestic inflation (or PPI) targeting: $\Pi_t^H = 1$
- exchange rate peg: $e_t/e_{t-1} = 1$
- strict inflation (CPI) targeting: $\Pi_t = 1$

Fiscal policy:

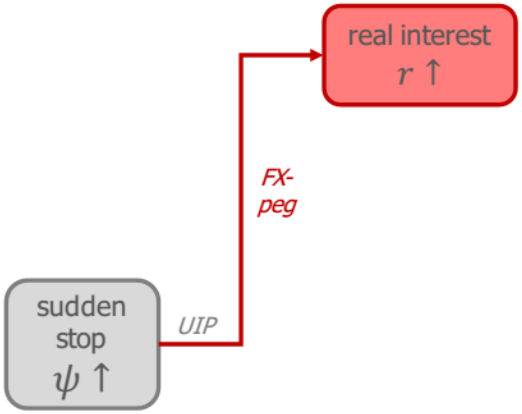
$$\check{T}_t = \frac{\tau^D}{\lambda}\Upsilon_t$$
$$T_t^s = \tau^w w_t N_t$$

Calibration

Parameters					
discount factor	β	0.99	HtM share	λ	0.3
risk aversion	σ	1	openness	α	0.5
inv. Frisch-elast.	φ	2	trade elast.	η	1.5
steady state NFA	ζ	0	trade elast.	γ	1.5
debt-elast. of prem	δ	0.1	monopolistic comp.	ε	6
dividend tax	τ^D	0	wage subsidy	τ^w	$1/\varepsilon$
Taylor-coeff.	ϕ^π	1.5	Calvo param	θ	0.9
Steady states					
markup	$\mathcal{M}$	1	output	Y	1
profit	Υ	0	foreign output	Y^*	1
REER	Q	1	real wages	w	1
HtM employment	$\check{N}$	1	HtM consumption	$\check{C}$	1
Ricardian employment	$\widehat{N}$	1	Ricardian consumption	$\widehat{C}$	1

Table: Parameters and selected steady state values

Transmission of a sudden stop – big picture



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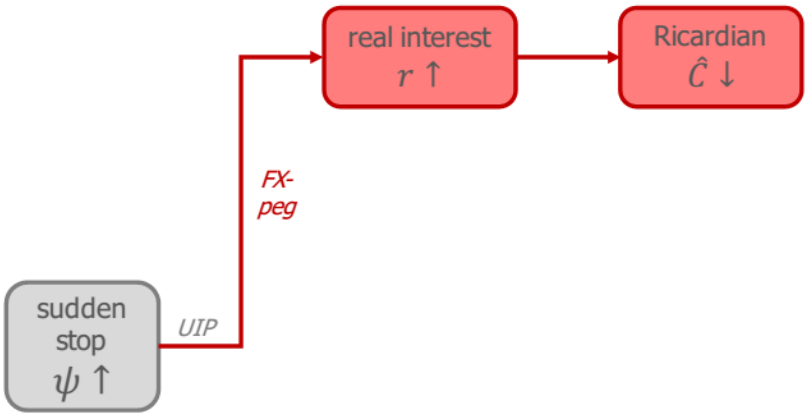

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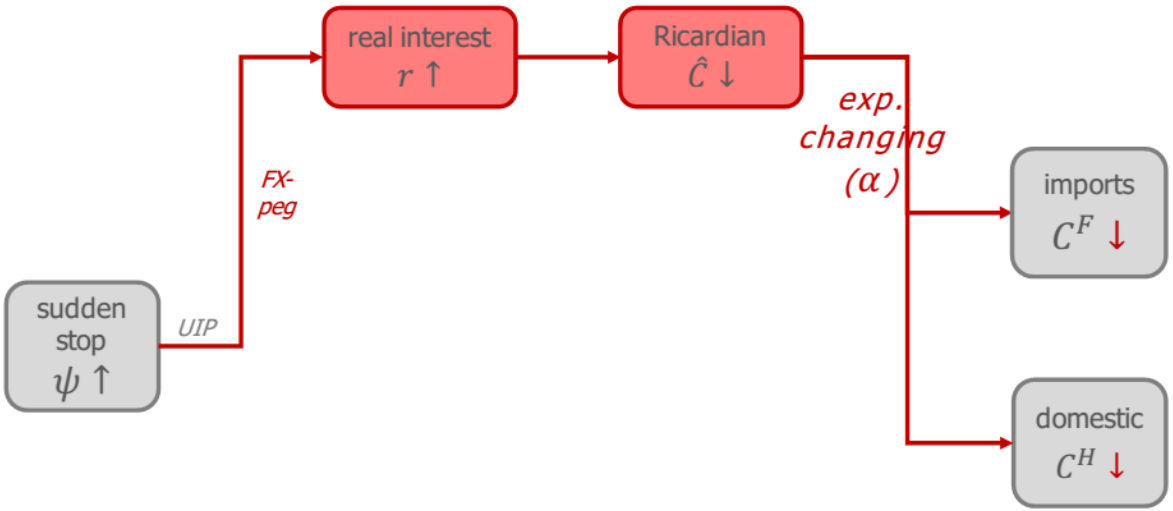

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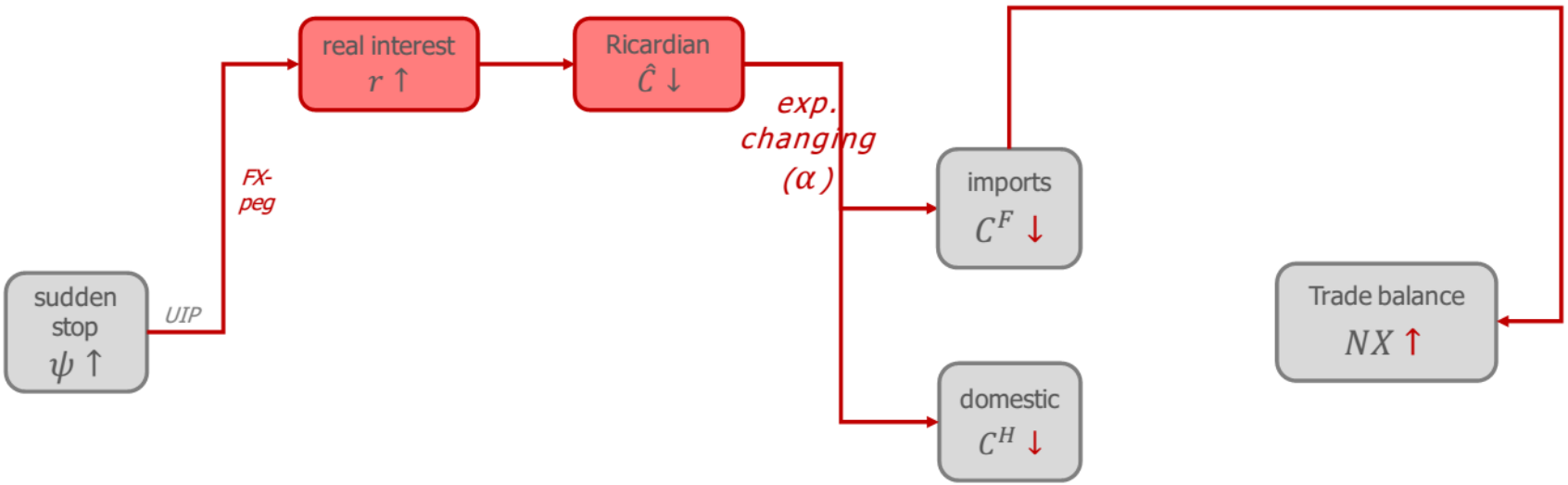
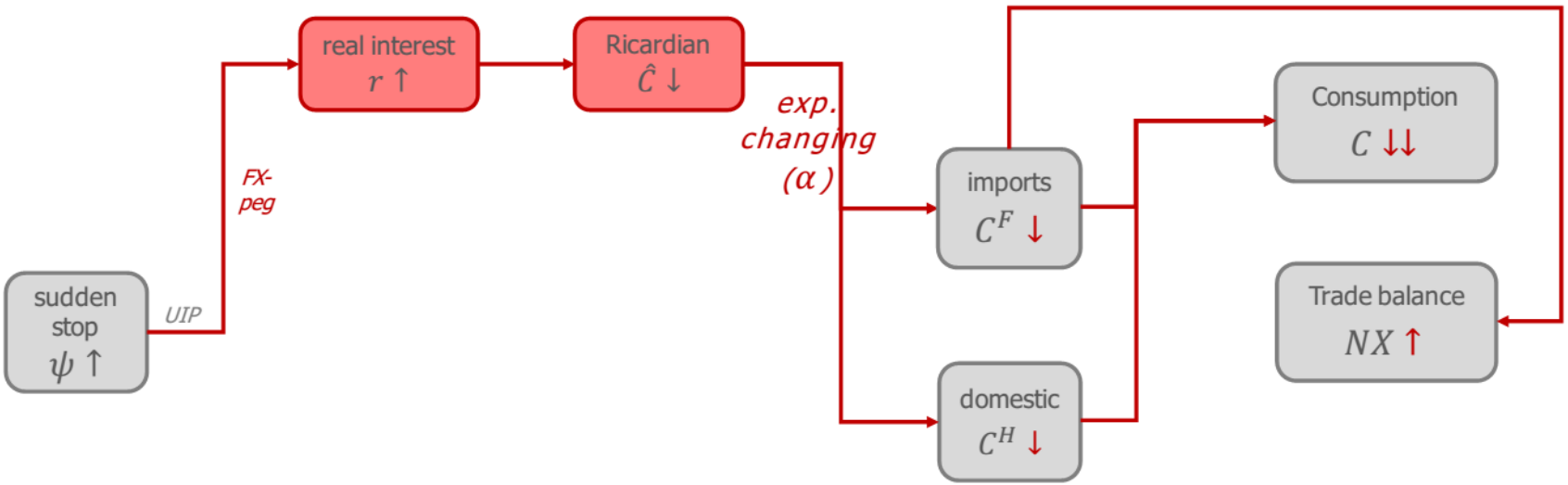
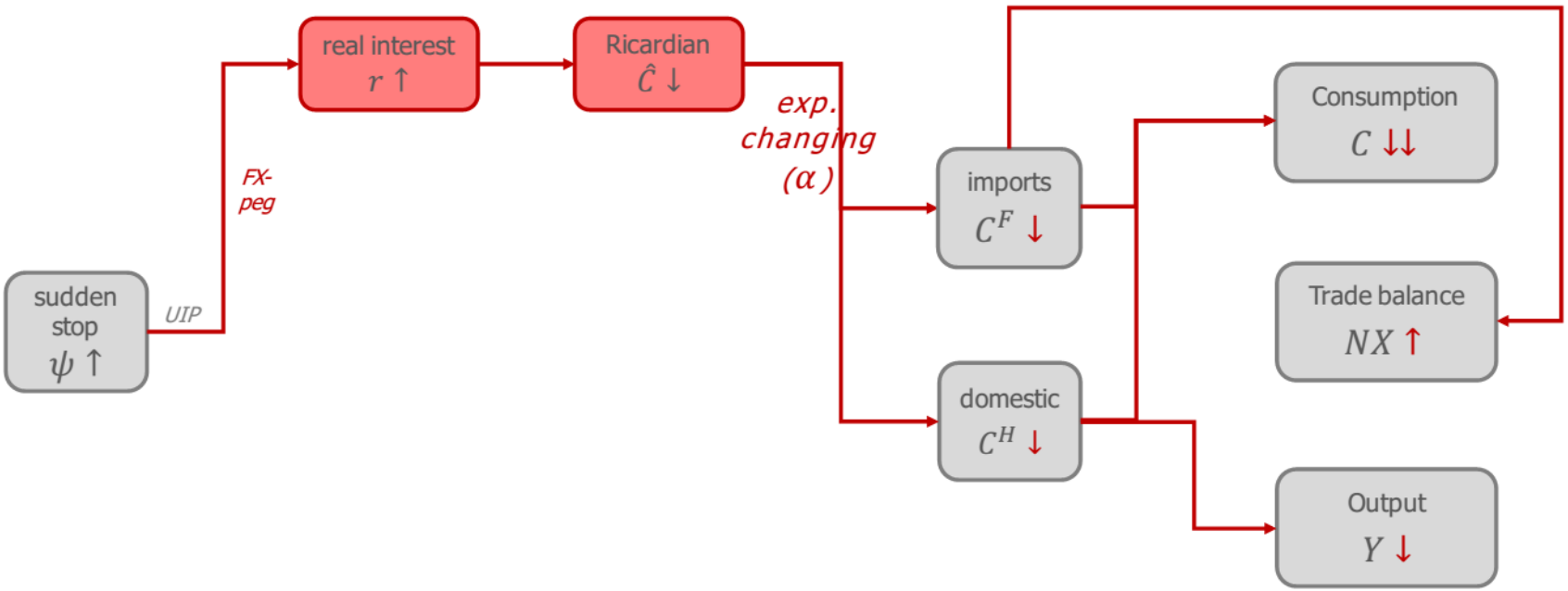


Transmission of a sudden stop – big picture



Transmission of a sudden stop – big picture



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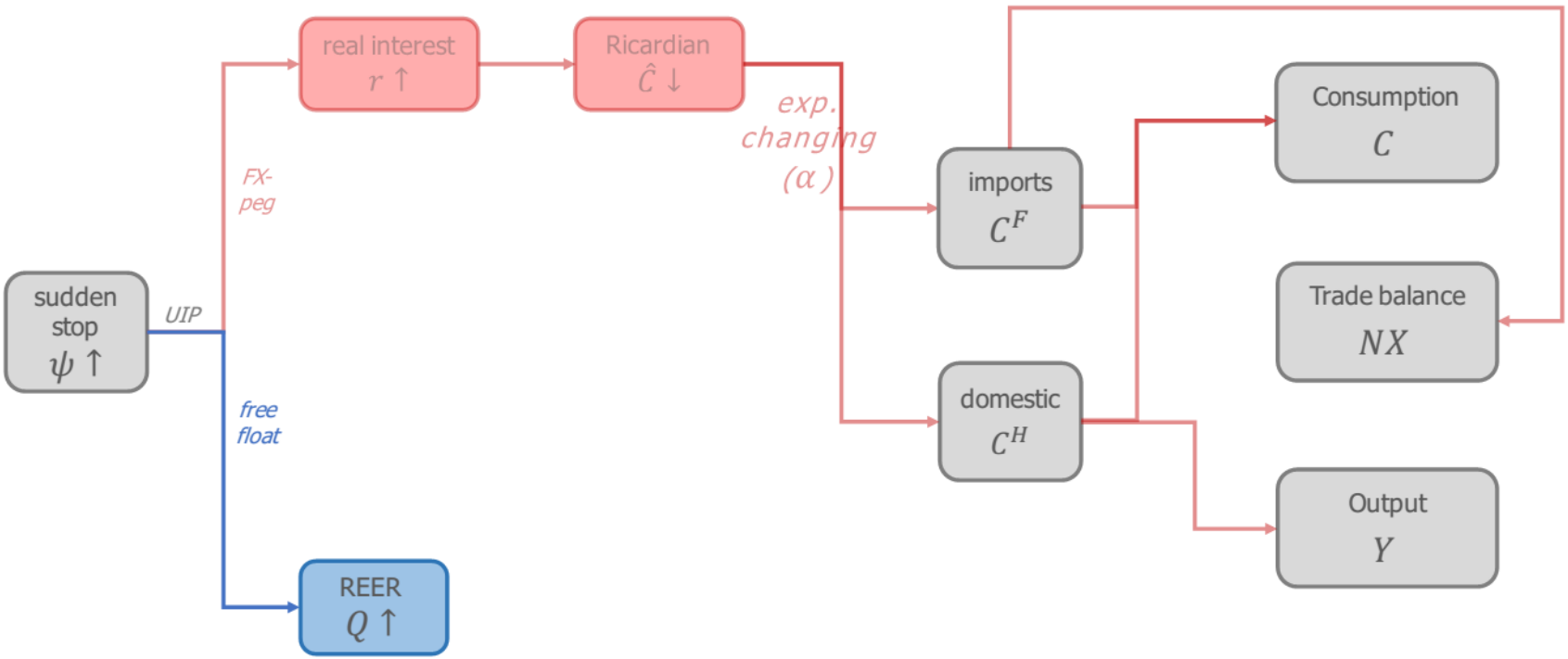

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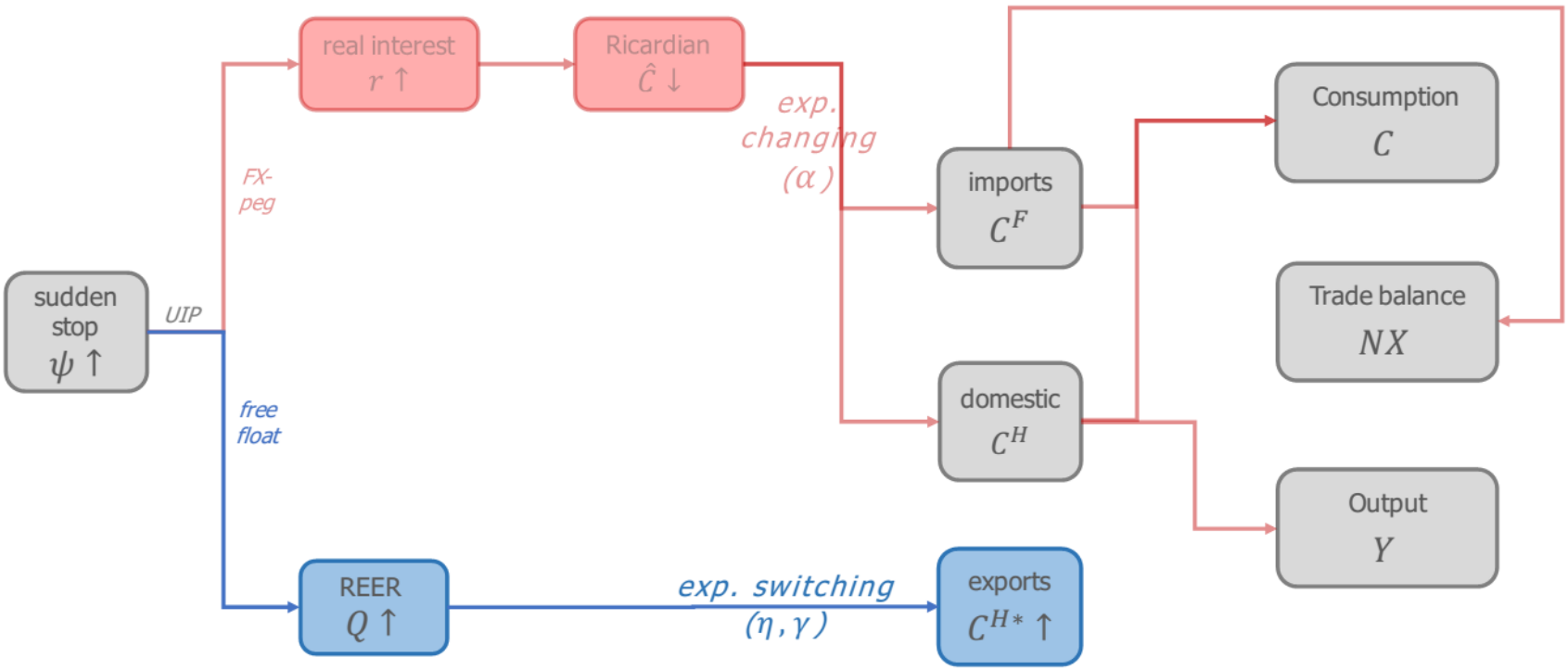

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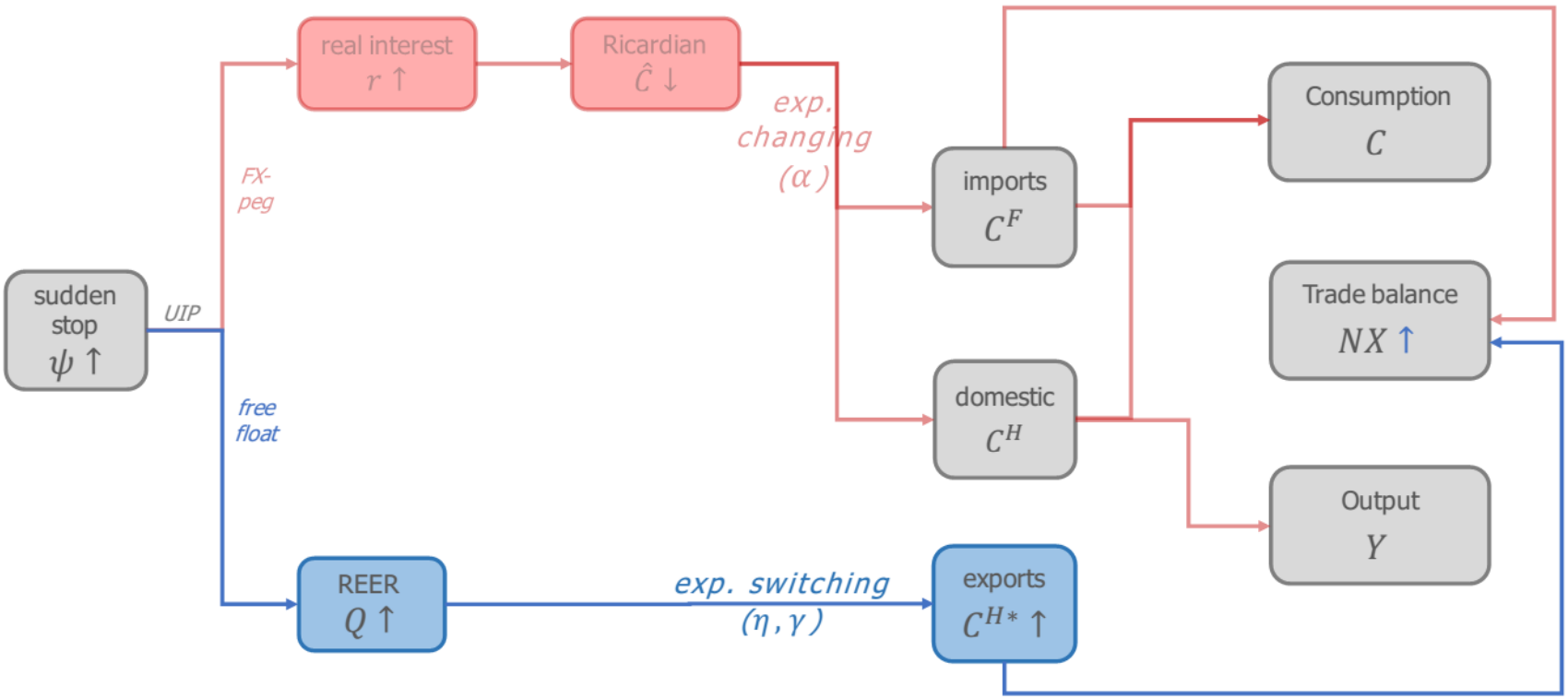

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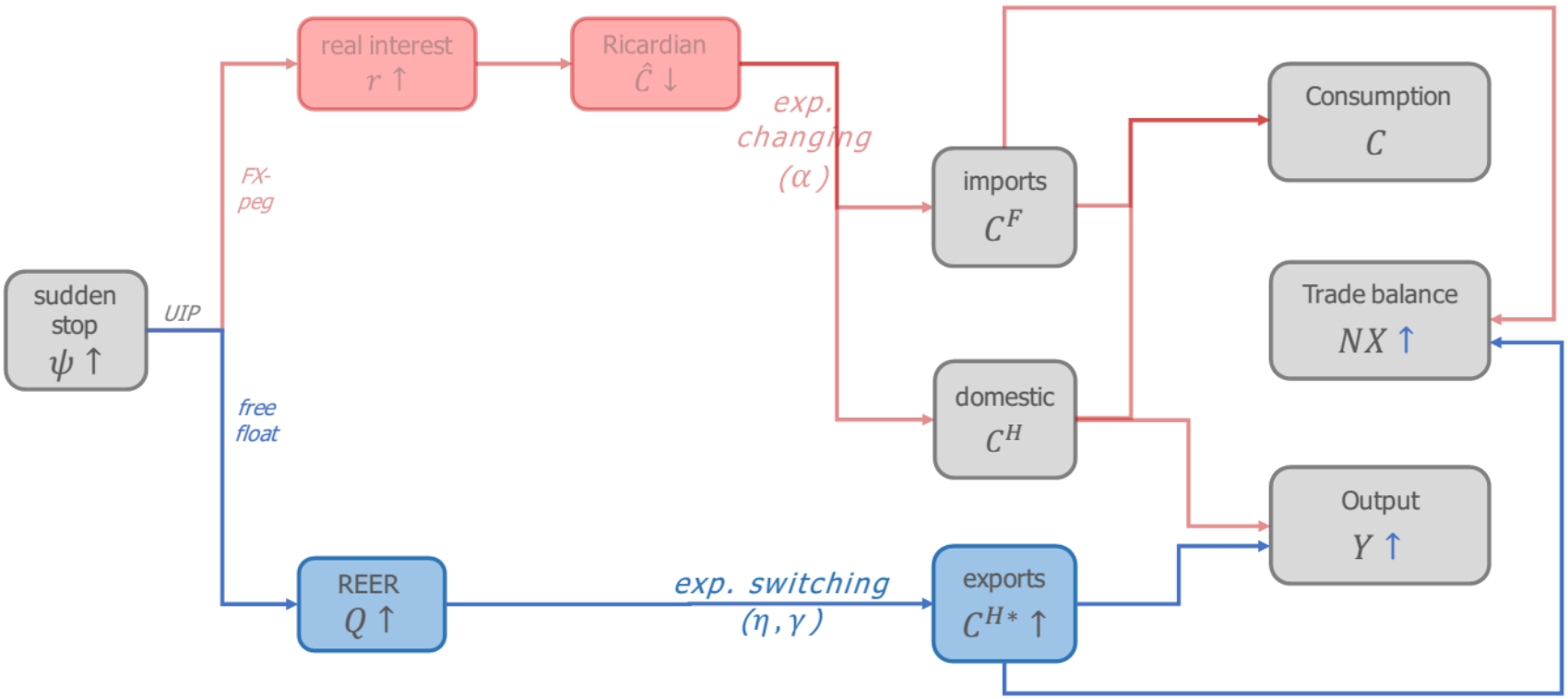

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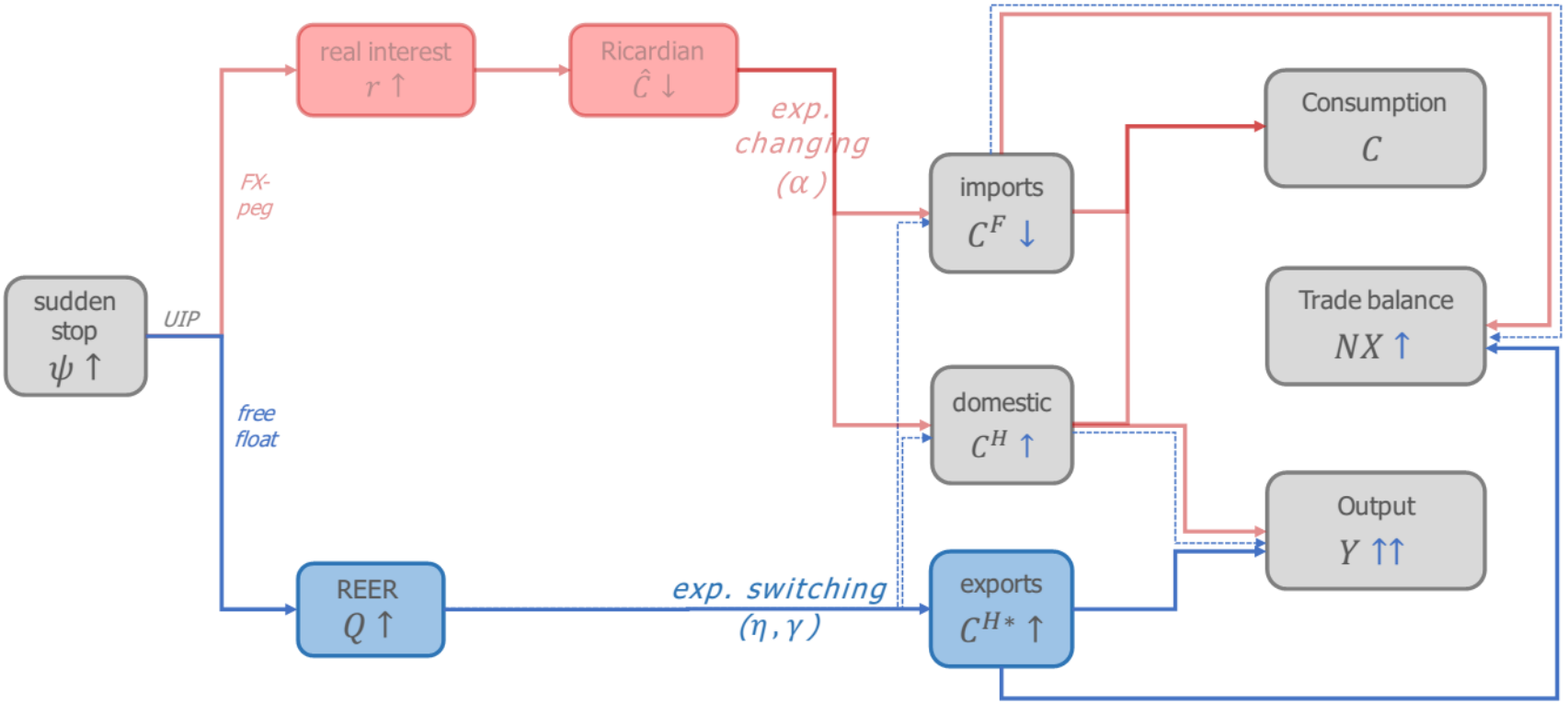
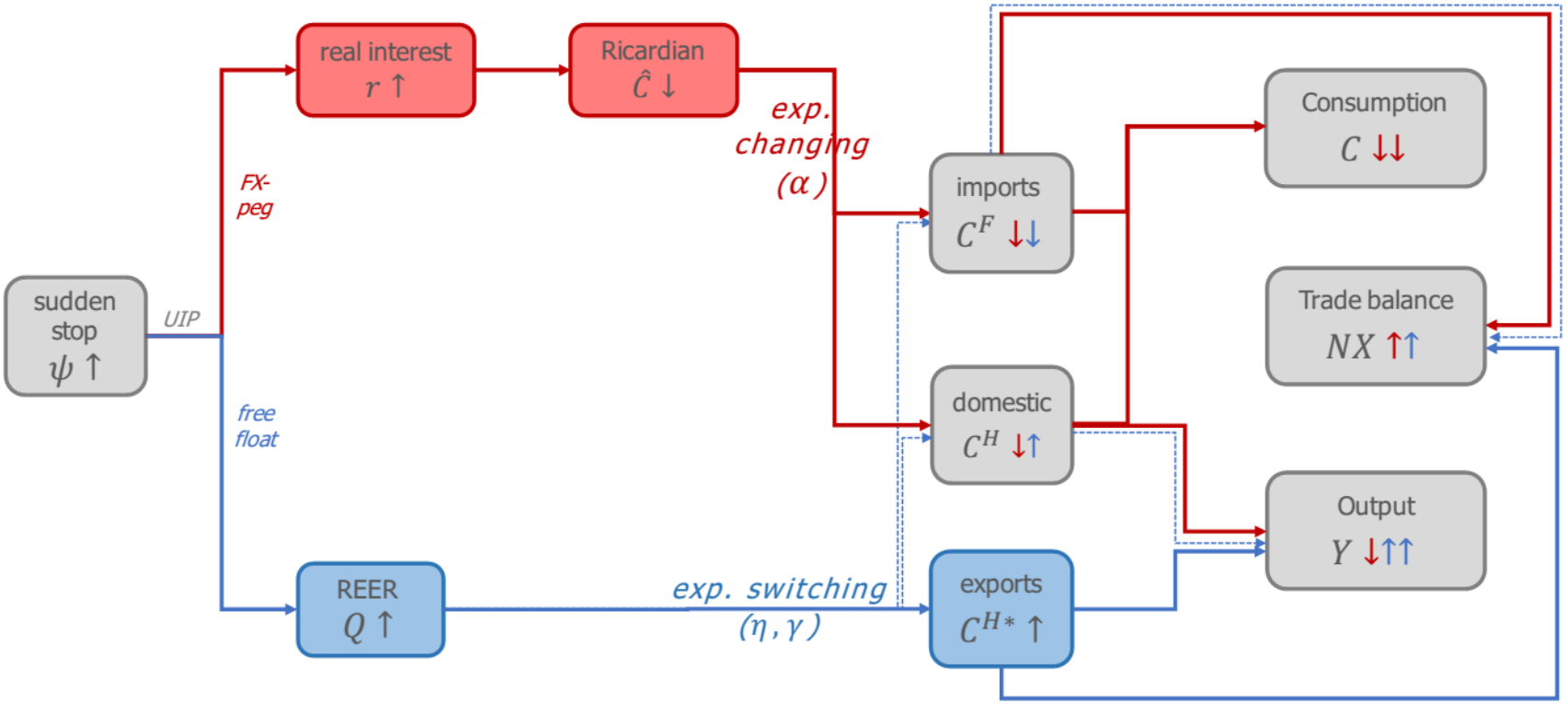
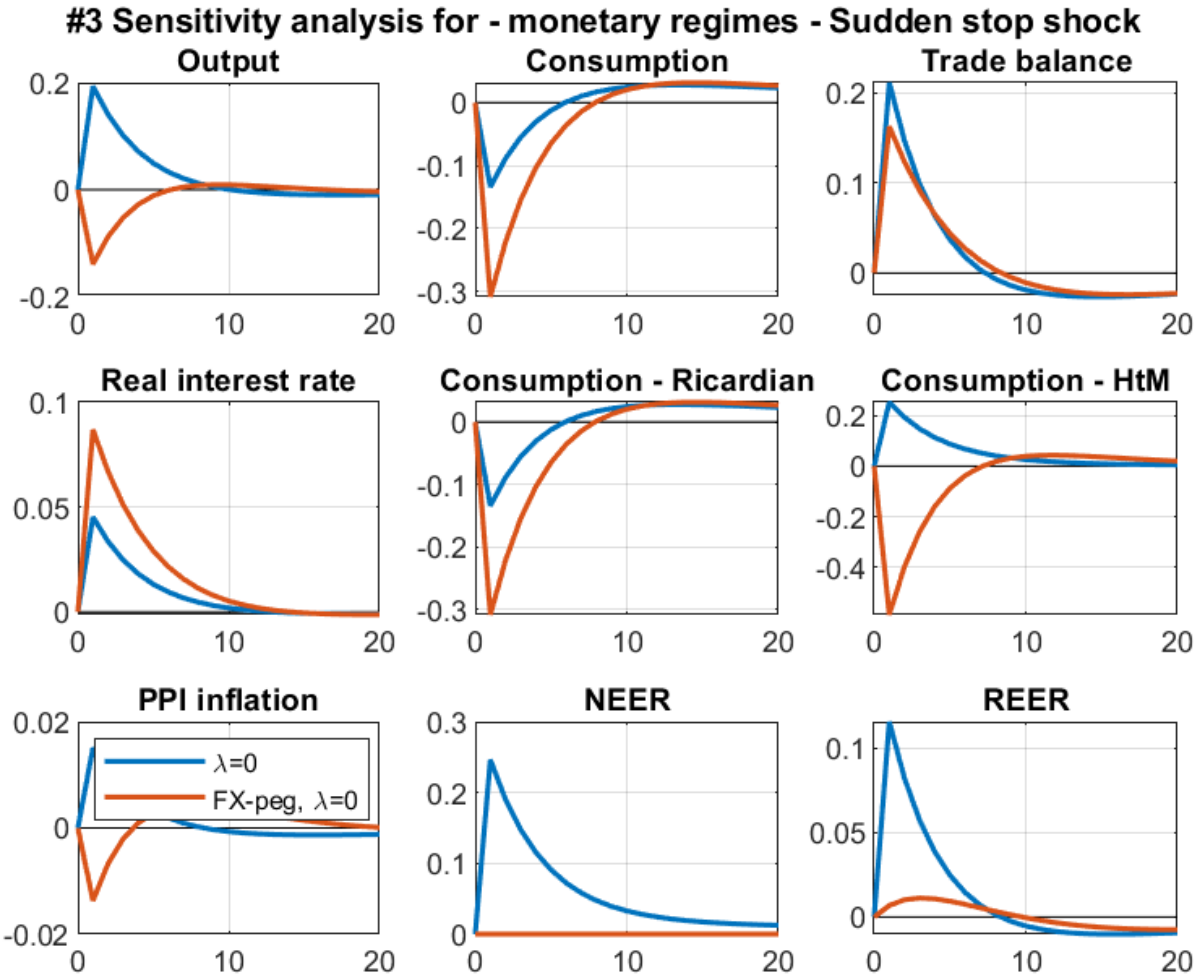


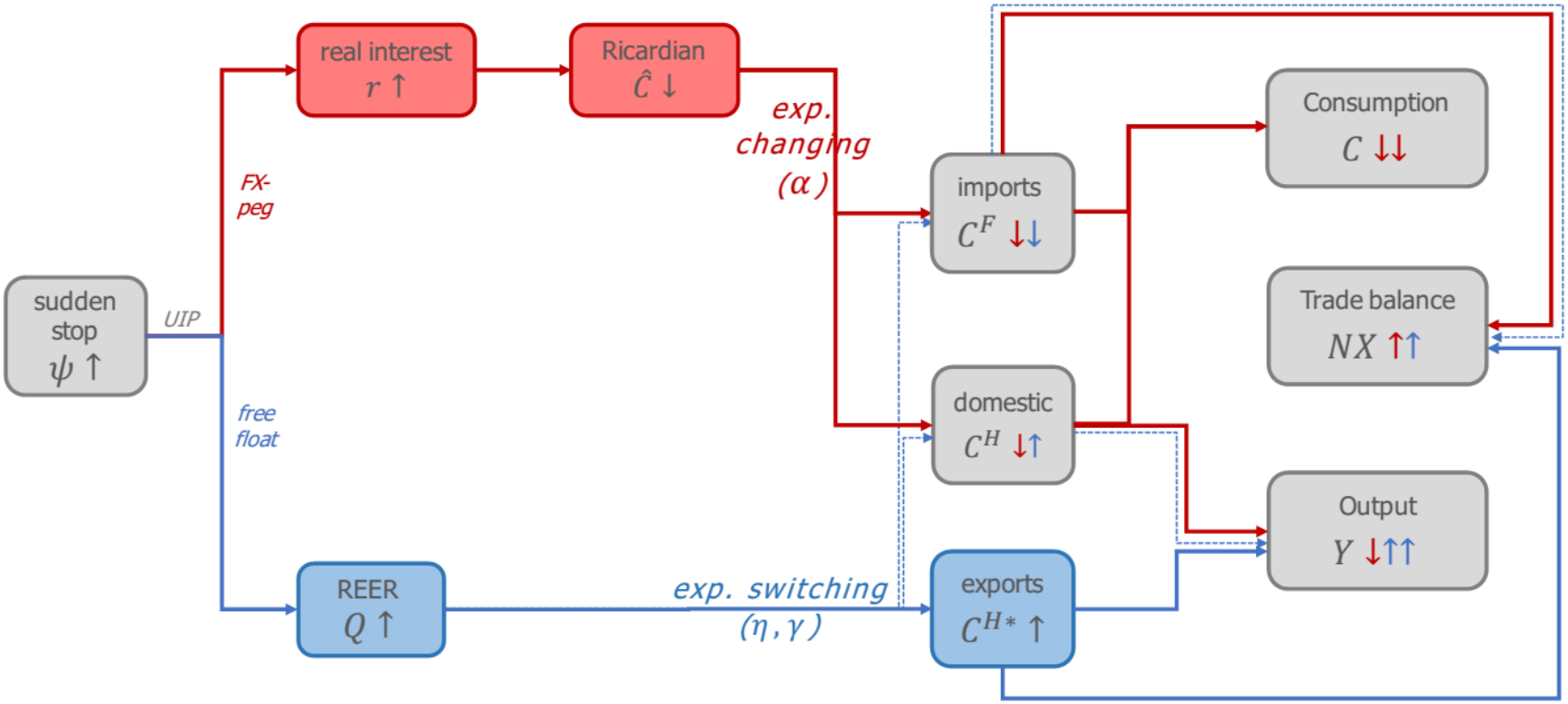
Transmission of a sudden stop – big picture



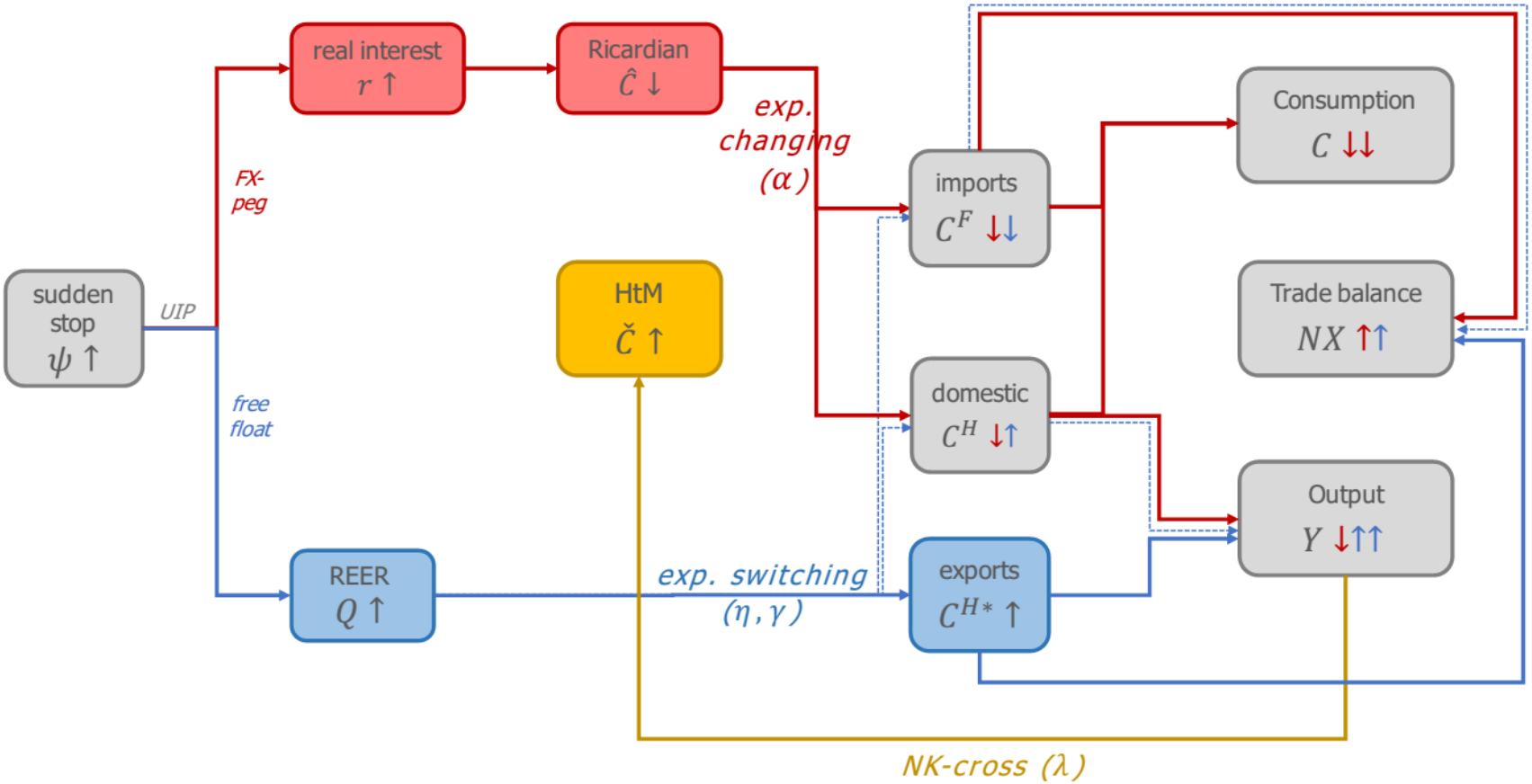
Sudden stop in RANK



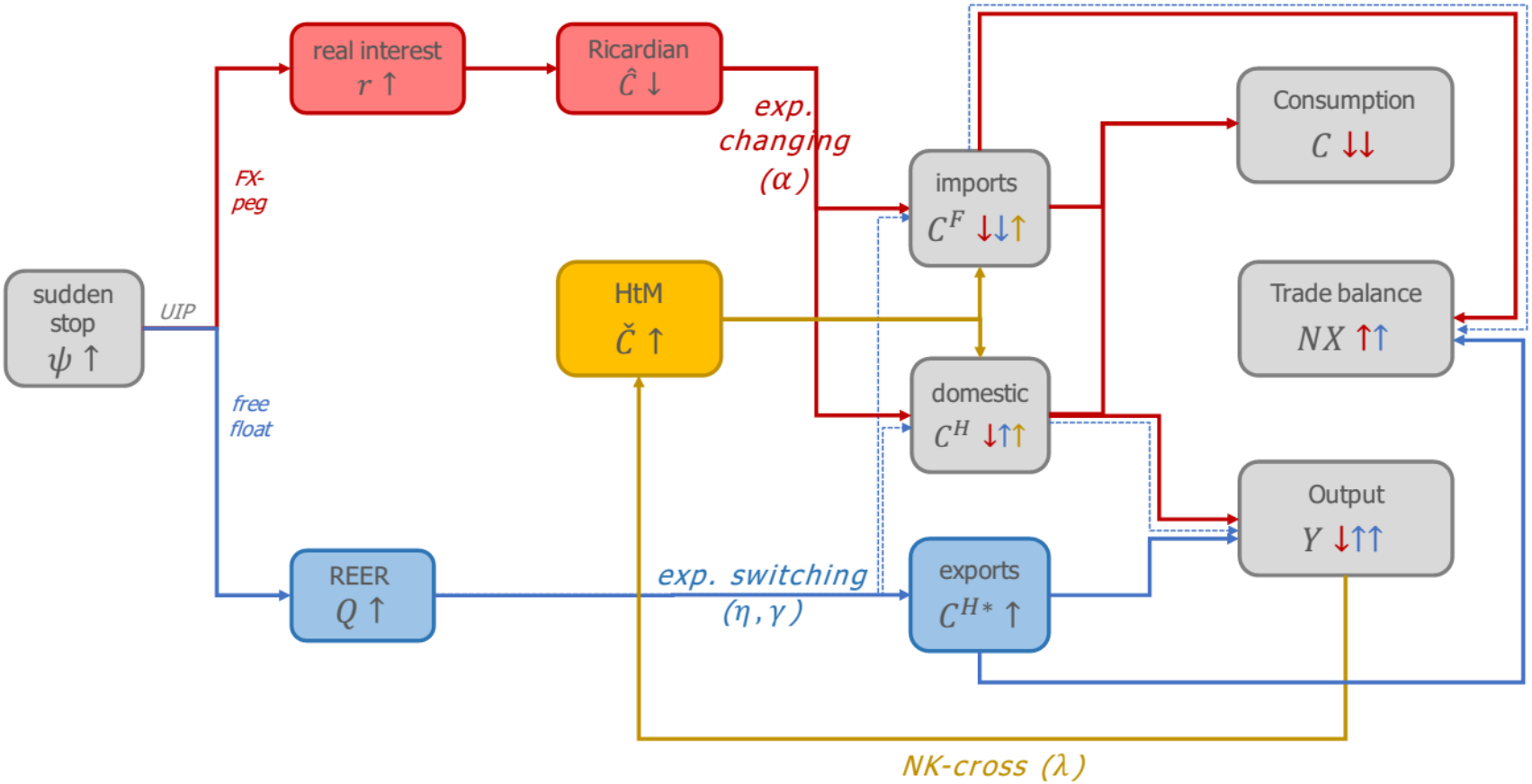
Transmission of a sudden stop – HtM channel



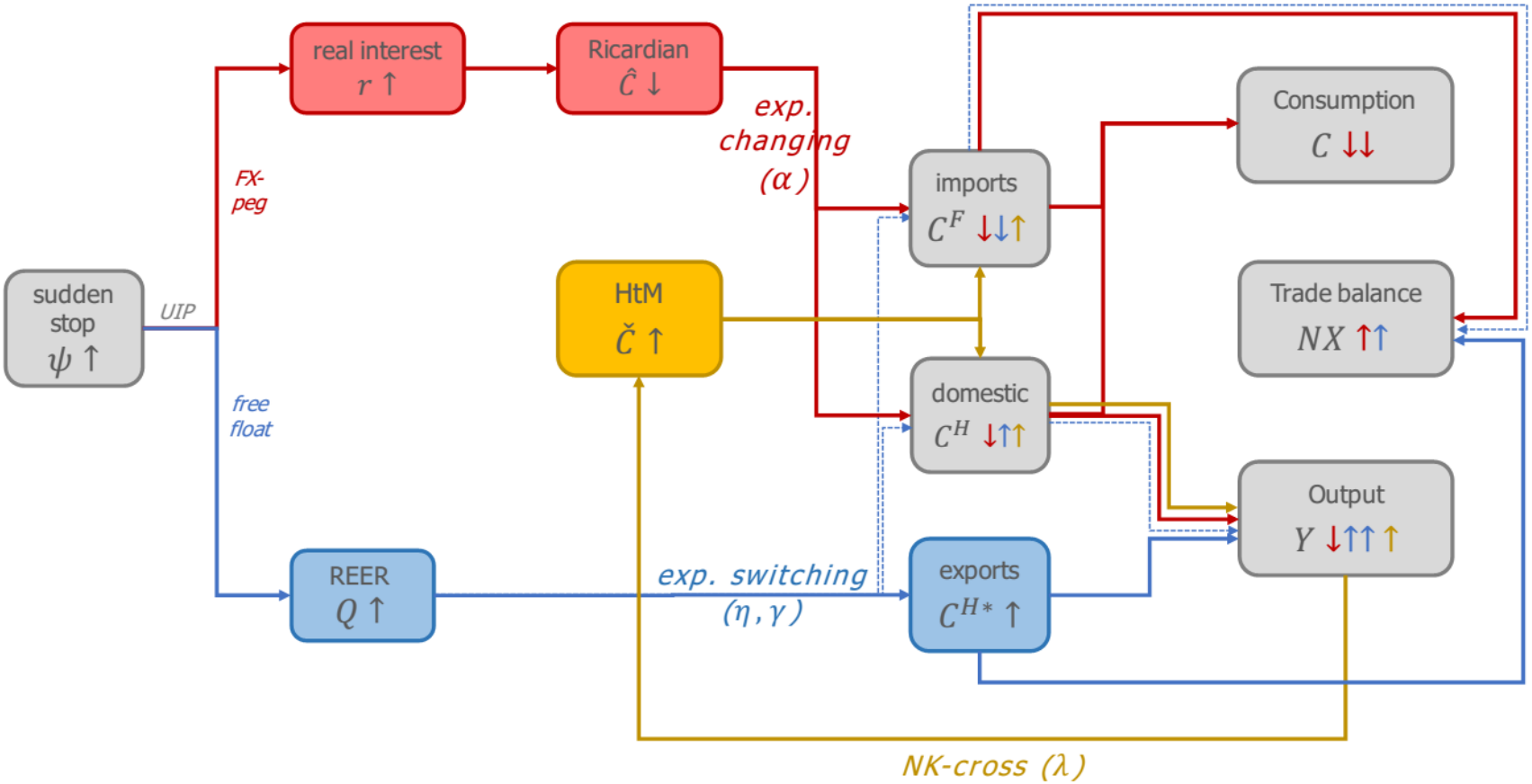
Transmission of a sudden stop – HtM channel



Transmission of a sudden stop – HtM channel



Transmission of a sudden stop – HtM channel



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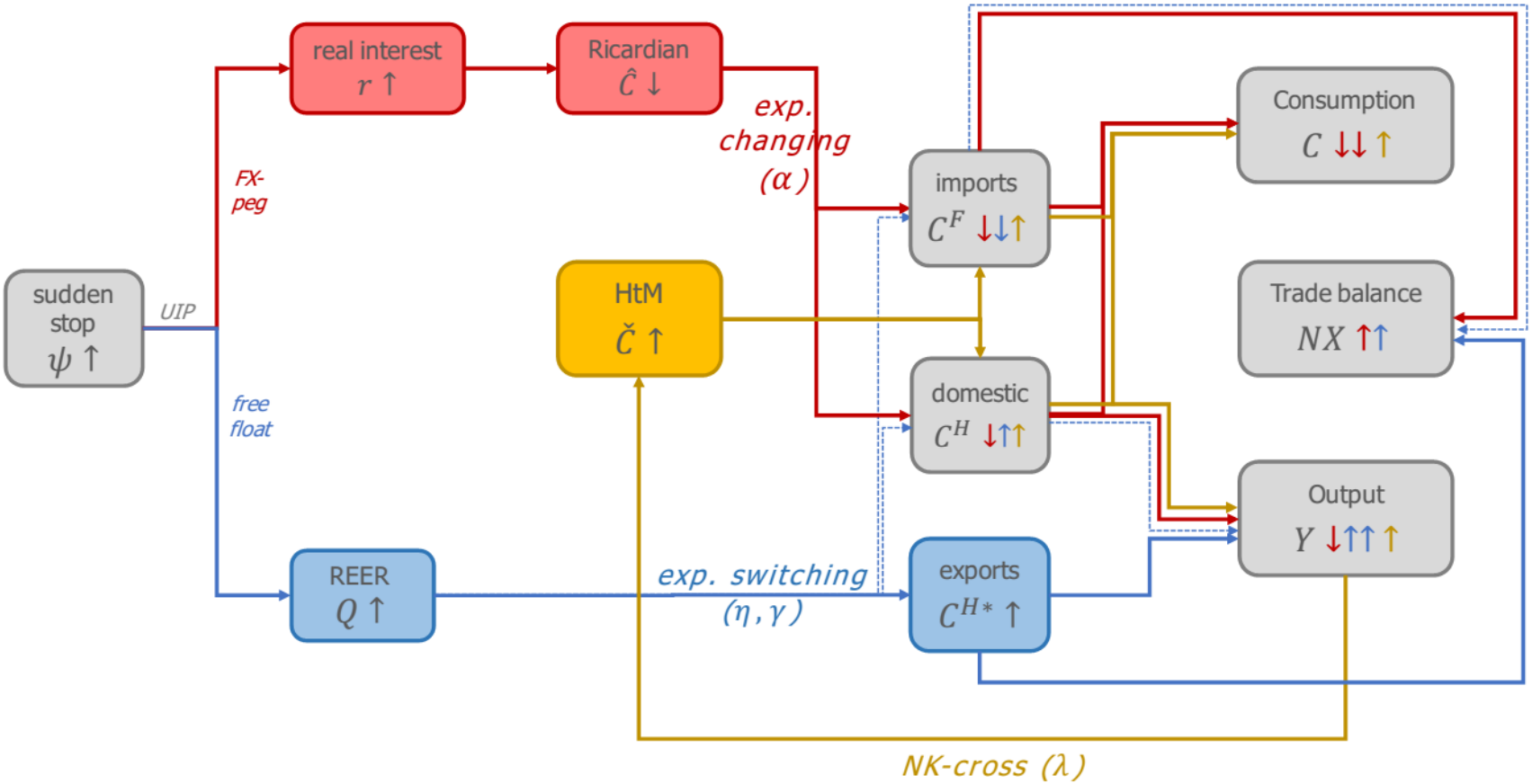
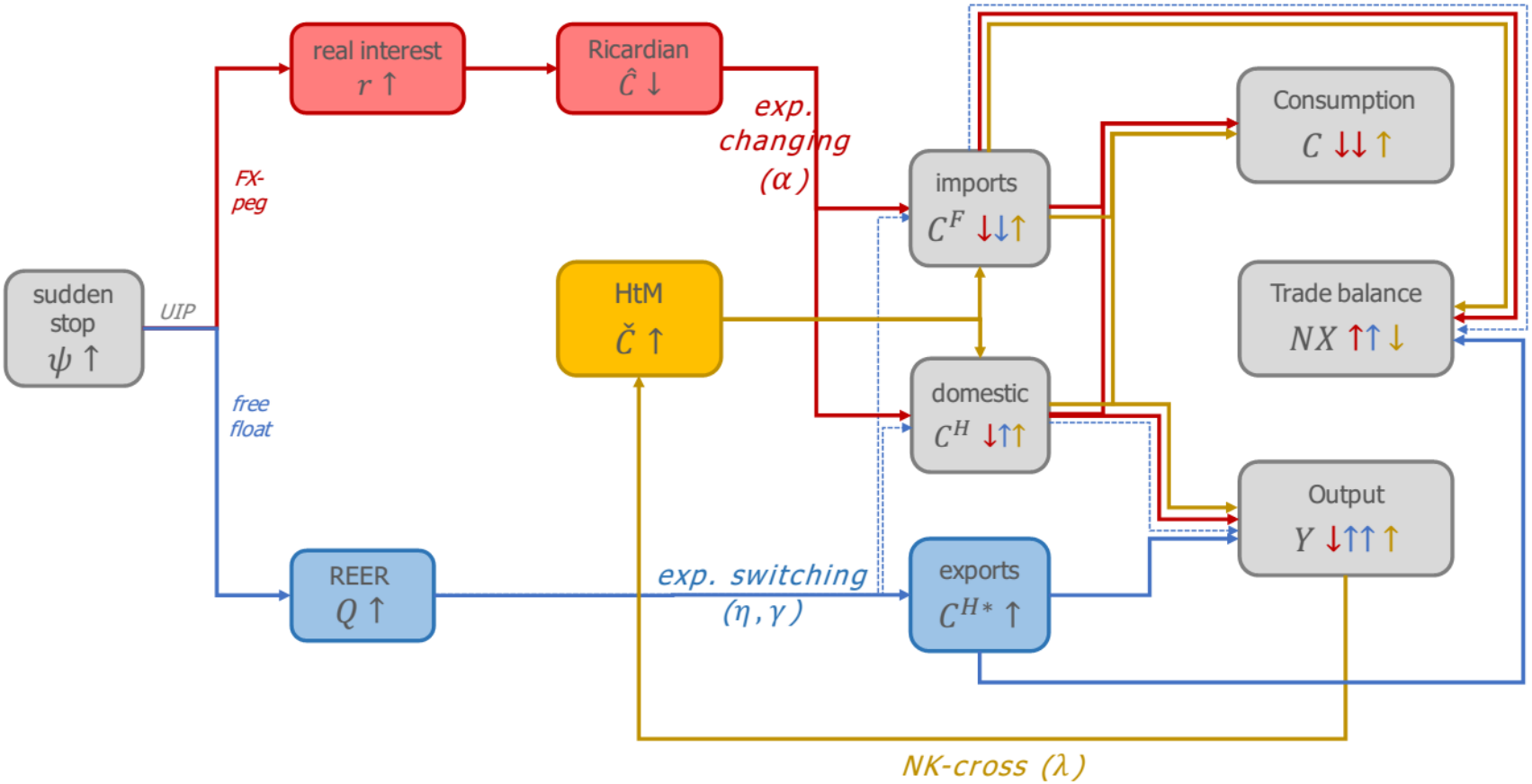
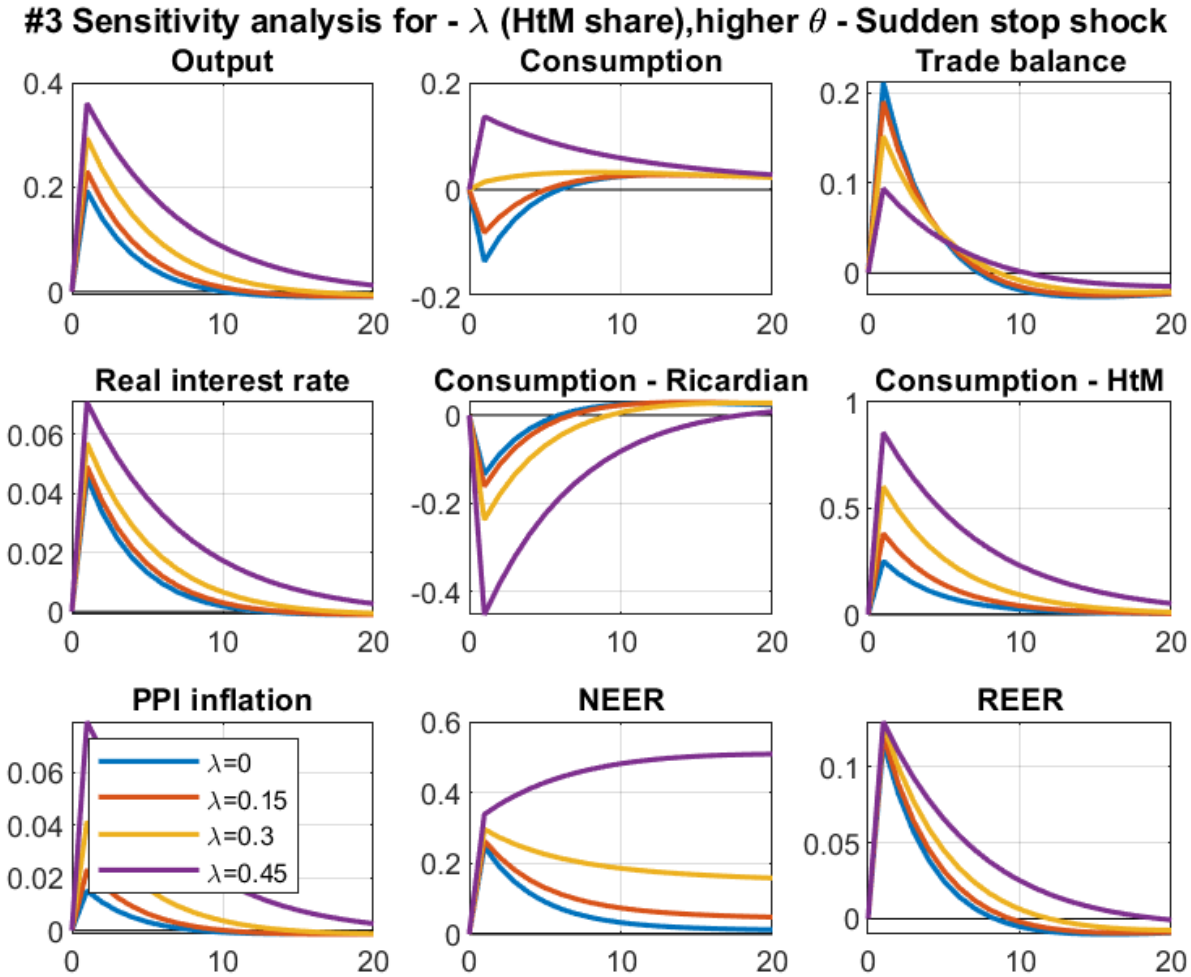


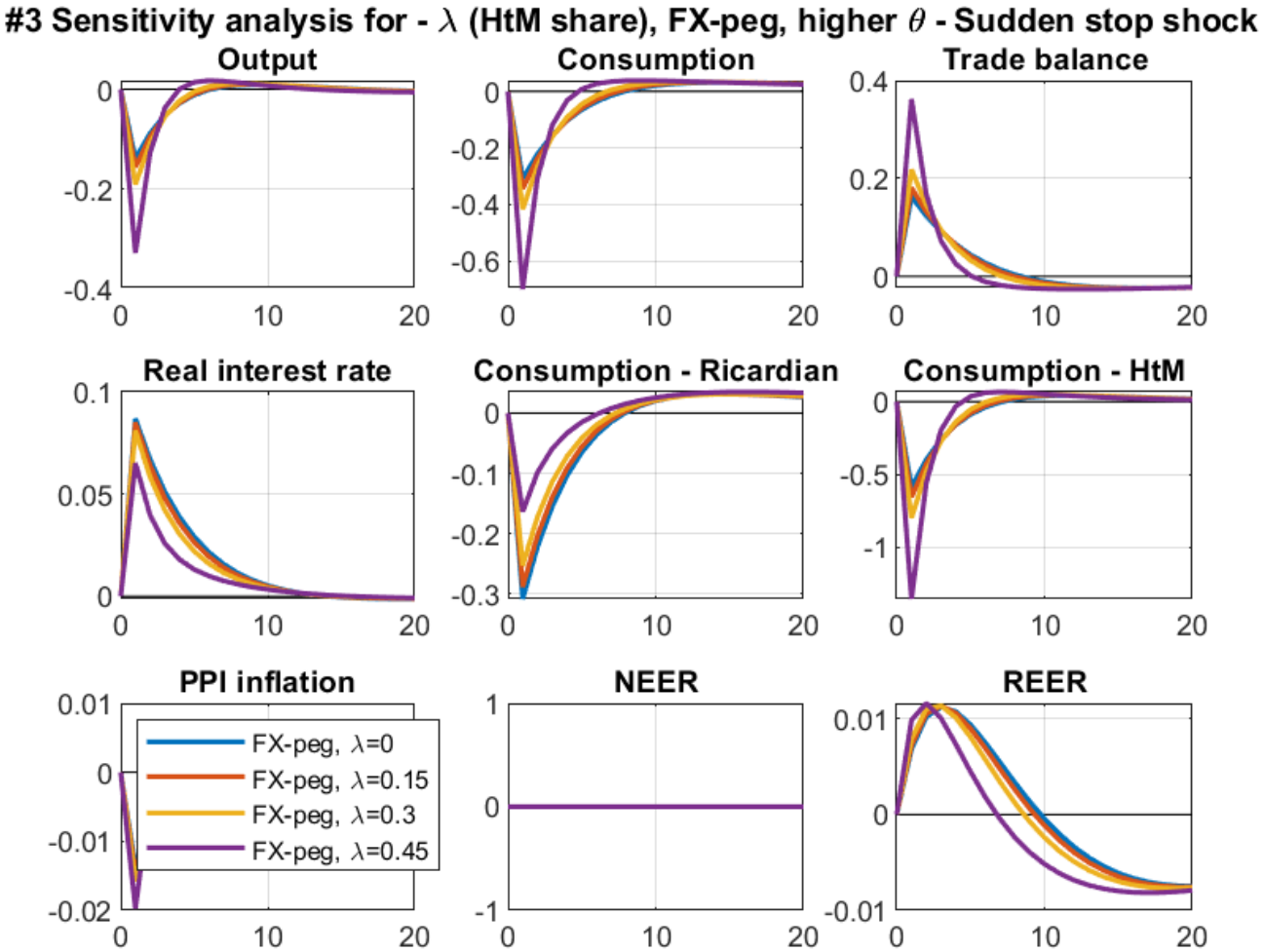
Transmission of a sudden stop – HtM channel



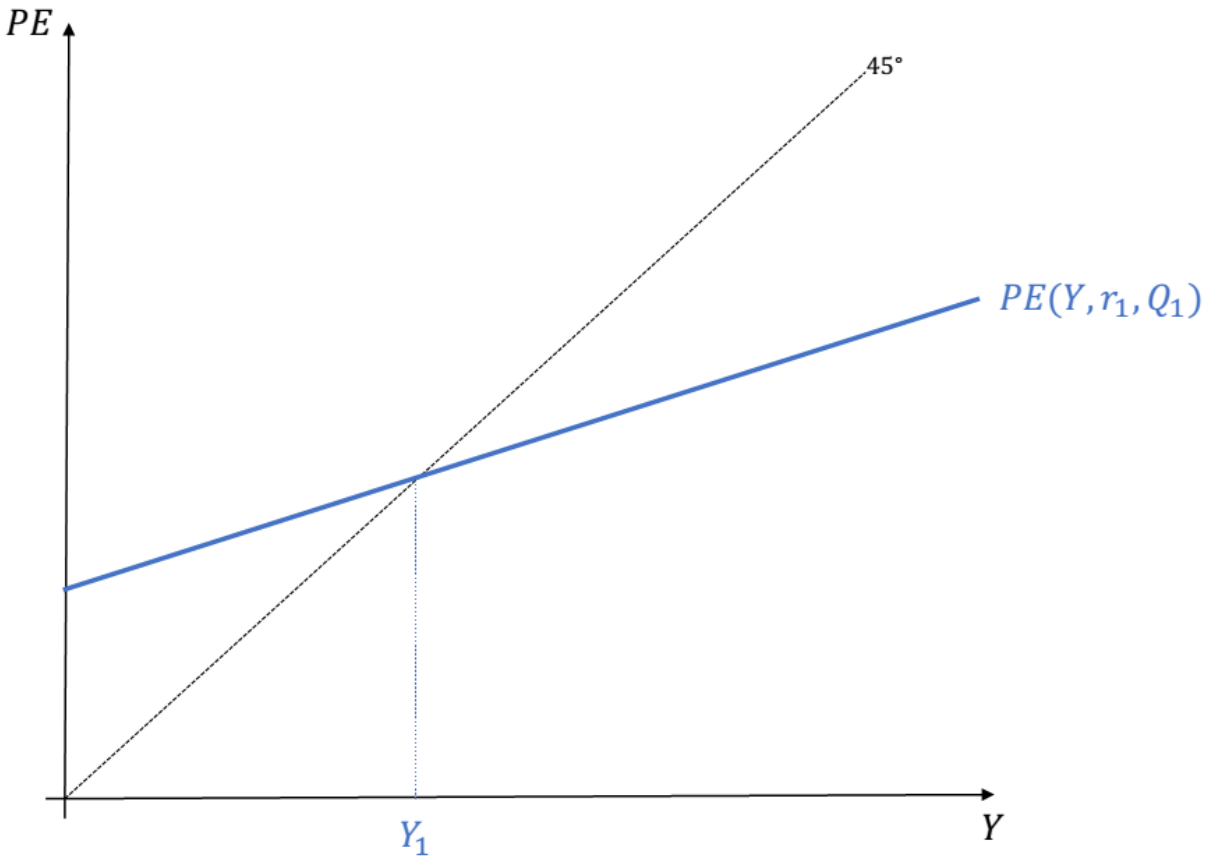
Sudden stop in TANK – floating exchange rate



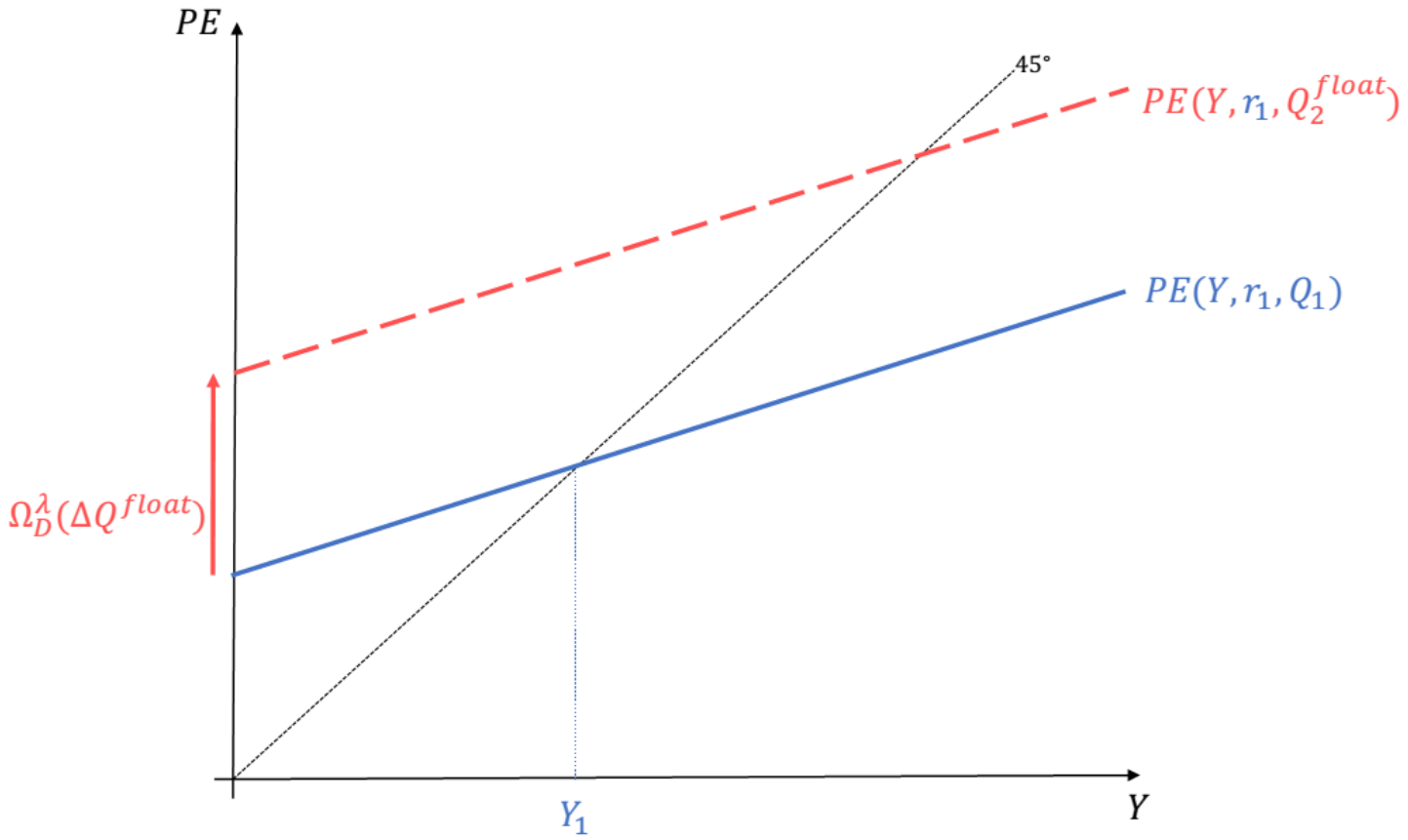
Sudden stop in TANK – fixed exchange rate



Sudden stop in the New Keynesian Cross



Sudden stop in the New Keynesian Cross



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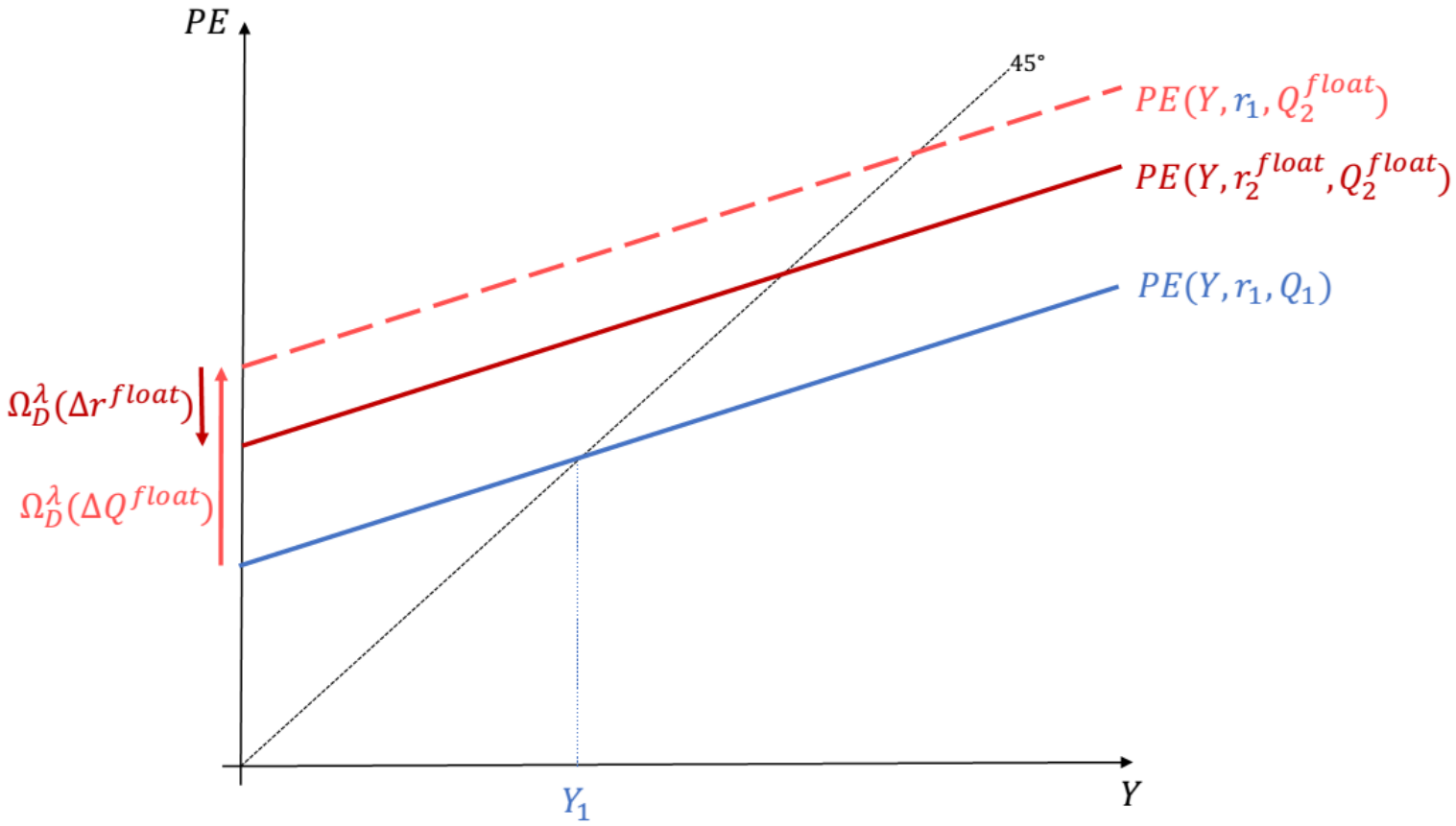

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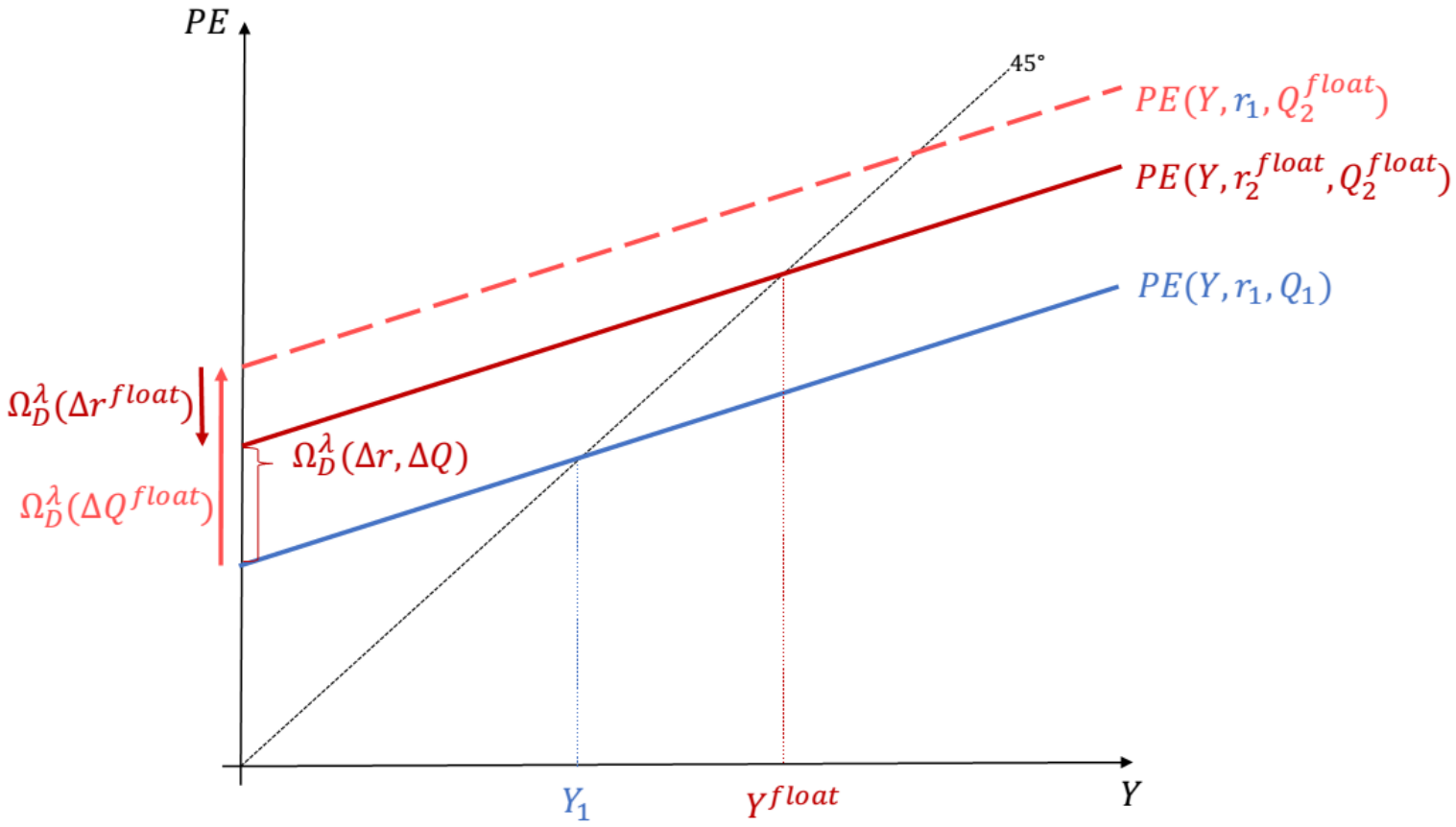

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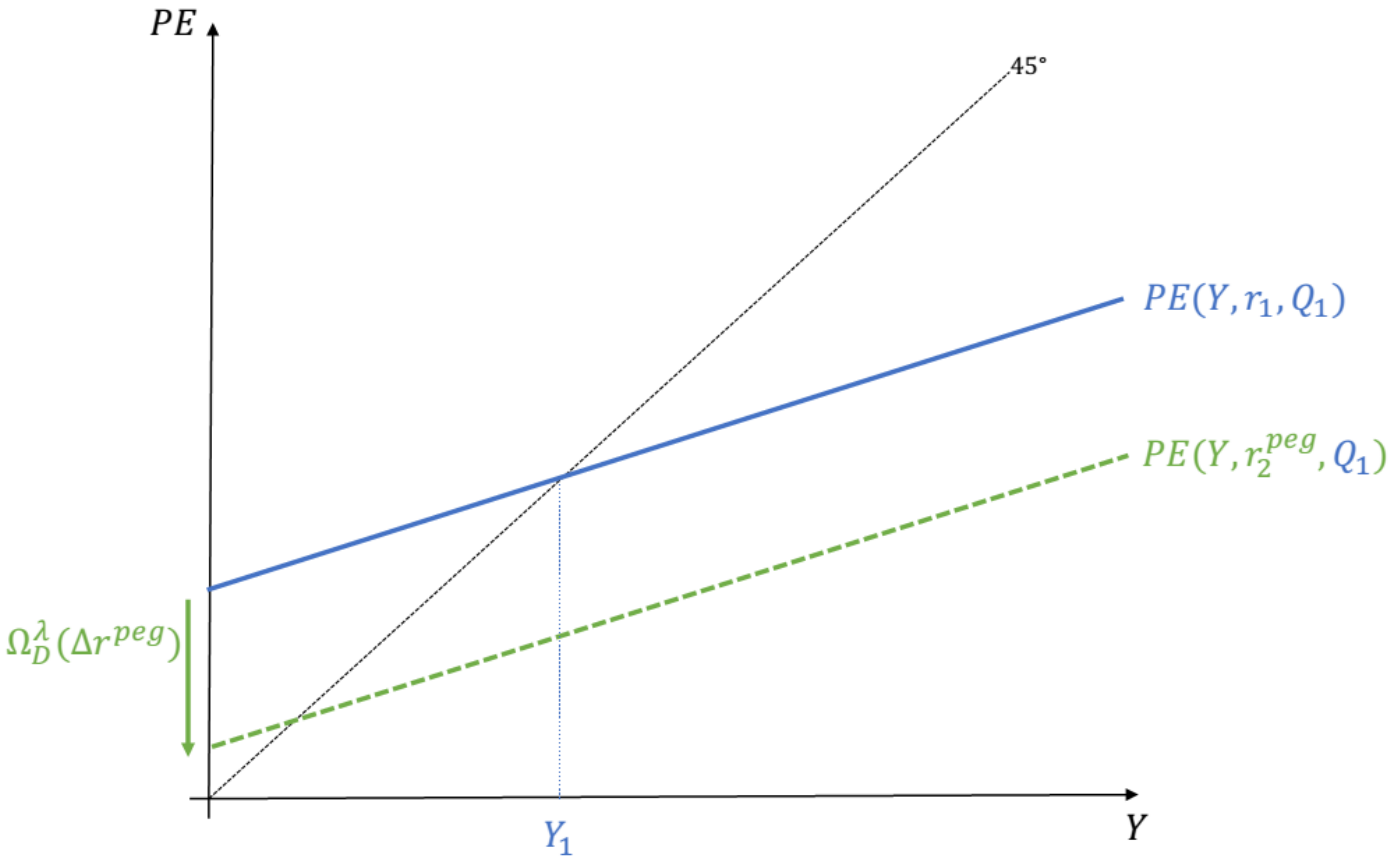

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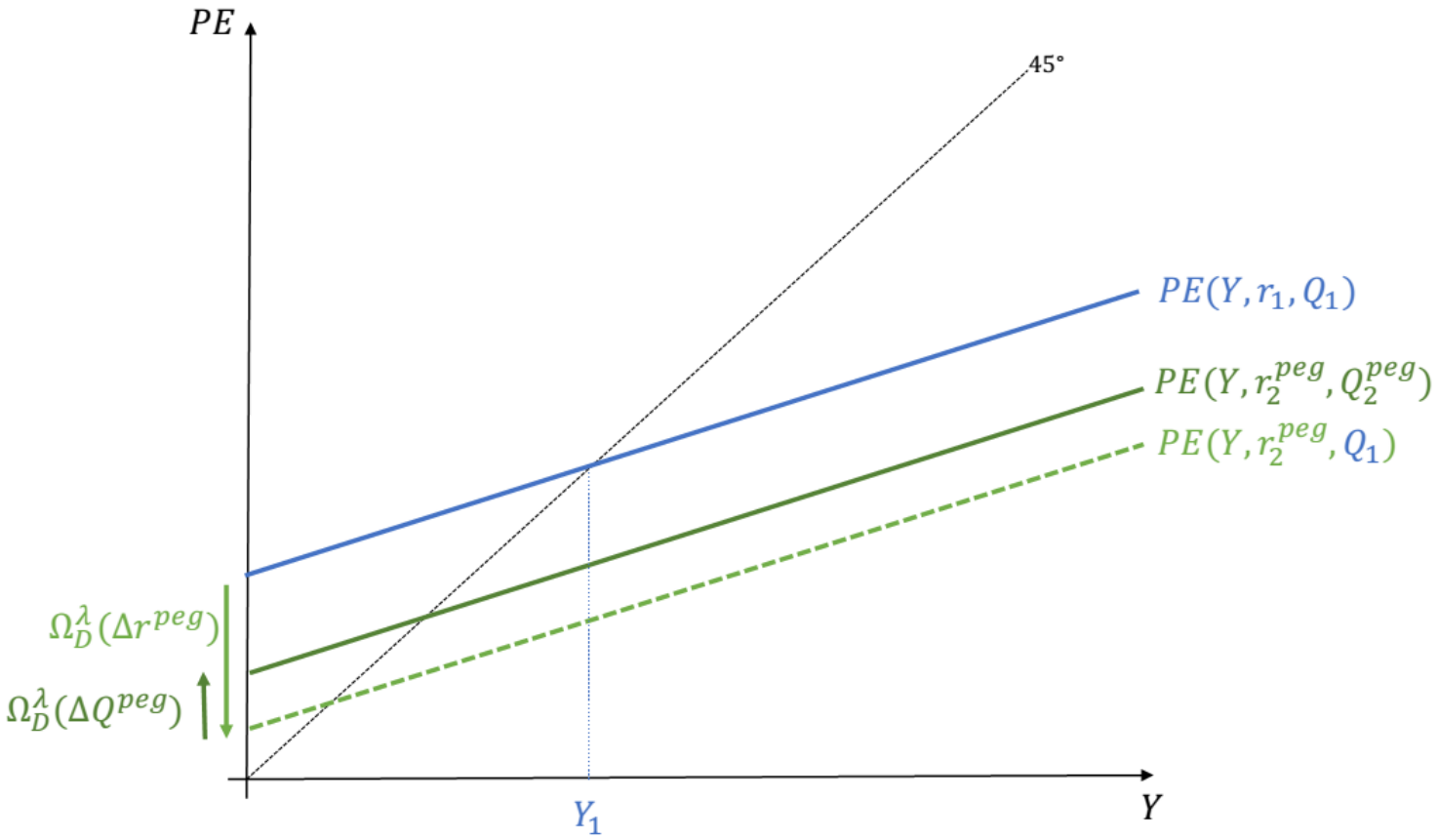

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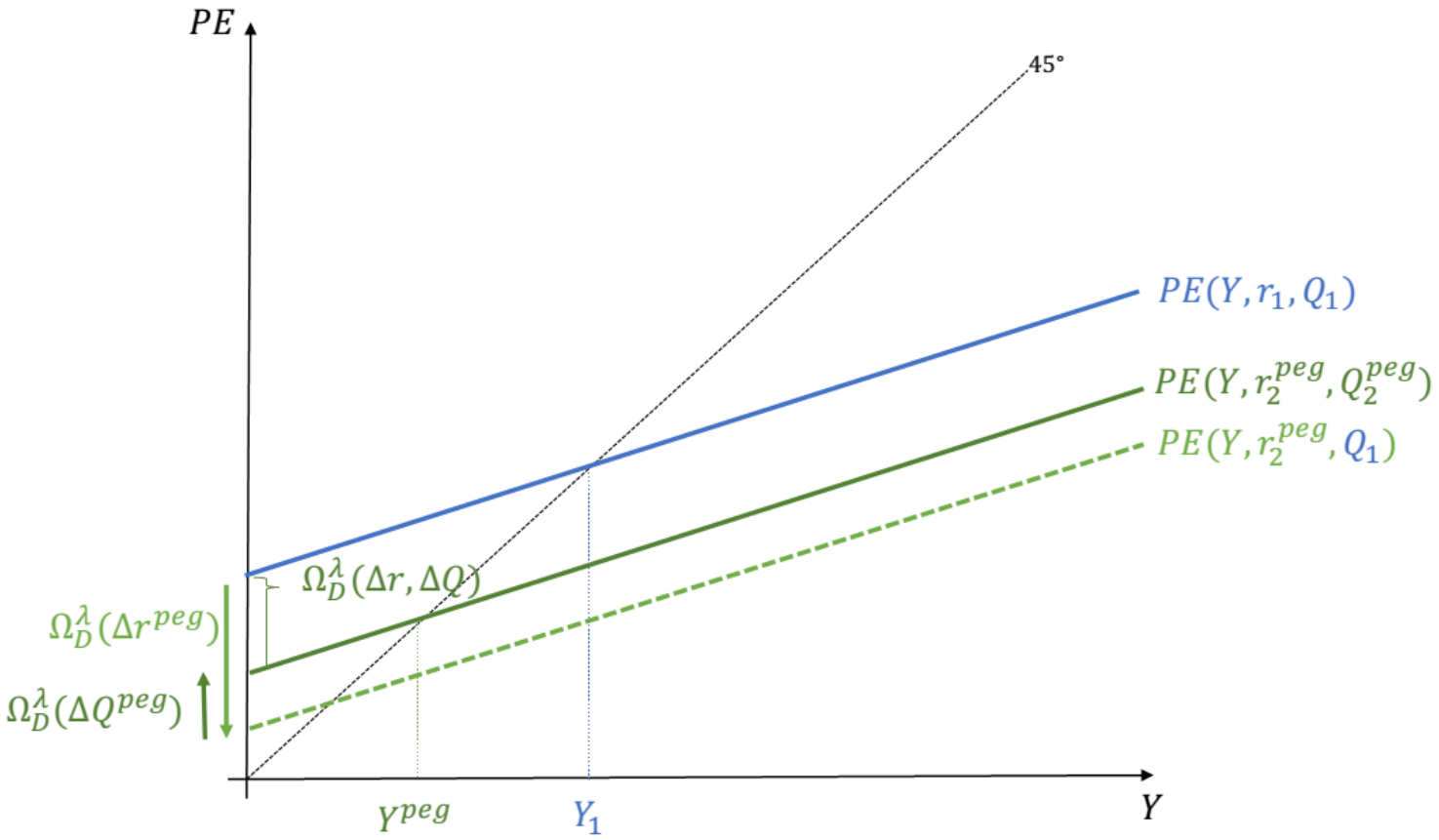
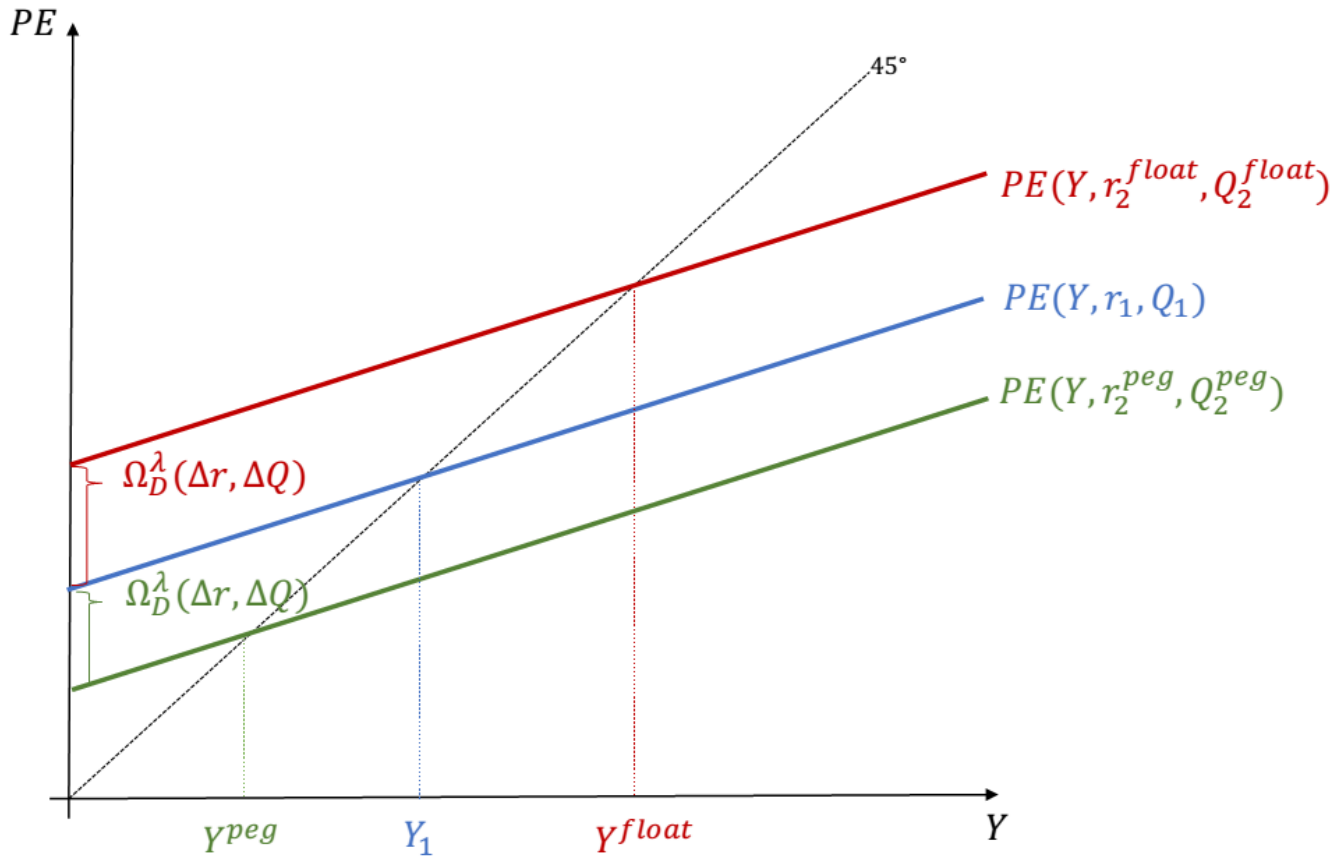
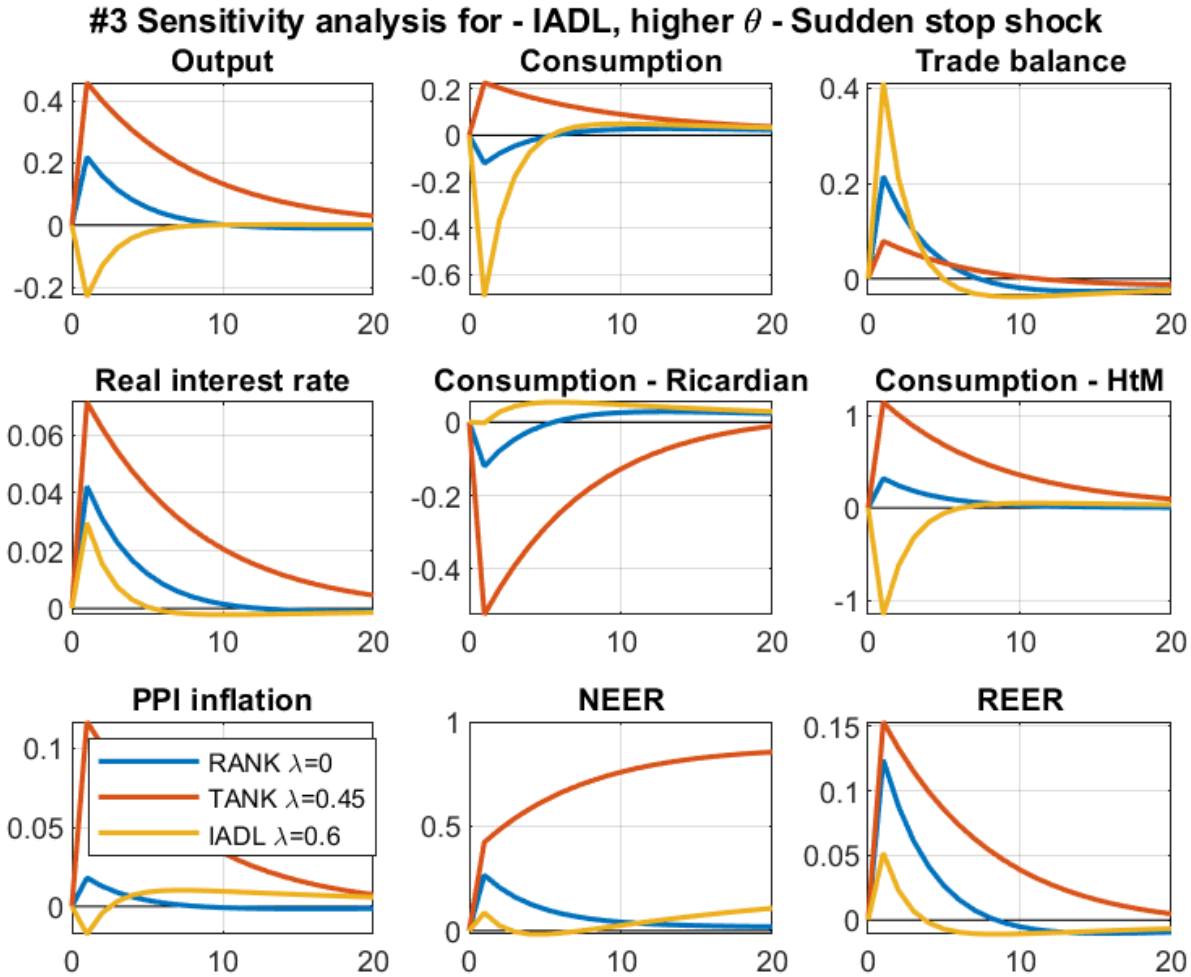


Sudden stop in the New Keynesian Cross



Inverted Aggregate Demand Logic



Summary

1. sudden stop is contractionary under FX-peg, but expansionary under free float (in RANK as well as TANK)
2. the HtM-channel (in TANK) amplifies the responses of output under both currency regimes (relative to RANK)
3. under free float the HtM-channel **mitigates** the fall in aggregate consumption (since incomes increase)
   - Ricardian and HtM consumption goes in opposite direction (instead of reinforcing, direct and indirect effects work against each other)
   - with high HtM share and nominal rigidities, HtM-channel can dominate the downward pressure from intertemporal substitution: aggregate consumption *rises* (only in TANK!)
4. under FX-peg the HtM-channel **amplifies** the fall in aggregate consumption (since incomes also fall)

$\Rightarrow$ Accounting for the HtM-channel, a FX-peg is even more detrimental relative to a free float during BoP crises.

Future plans

- empirical investigation
- analytical derivations for the Open Economy New Keynesian Cross
- monetary-fiscal interactions
  - Ricardian equivalence fails
  - redistribution and timing of taxes matter
  - active fiscal-passive monetary policy mix (emerging markets with weak institutions)
  - Fiscal Theory of the Price Level
- currency mismatch (FX-debt) in a more proper way?
- full-blown HANK??? (with idiosyncratic risk)

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