The Transmission of Foreign Demand Shocks

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Motivation

- From the viewpoint of a small open economy, shocks to foreign demand for domestic goods are perceived to be important drivers of the domestic business cycle.
- *Missing*: A structural account of such shocks that can fit the data...
- ...perhaps because existing DSGE models typically find that they account for a very *small* share of the domestic business cycle (e.g., Justiniano and Preston (2010): < 5 percent).
- **This paper**: Establish a set of **stylized empirical facts** documenting the effects of foreign demand shocks, and show that an **open-economy HANK model** can account for these facts, in contrast to existing RANK models.

Main findings

- We first conduct an empirical study of 31 small open (mostly advanced) economies, using pooled local projections (LP).
- Our main finding is that a foreign demand shock leads to an **increase** in domestic consumption in the small open economy.
  - This includes consumption of both tradeable and non-tradeable goods, i.e., the two sectors co-move positively.
- Furthermore, we document that foreign demand shocks are **quantitatively important** for domestic business cycles.

Main findings

- An open-economy HANK model is consistent with our findings:
  - Higher foreign demand stimulates domestic labor income.
  - In the presence of realistic MPC's, consumption (of both types of goods) **increases**.
  - In contrast, a corresponding RANK model predicts a **drop** in domestic consumption, driven by intertemporal substitution (cf. Kaplan, Moll, and Violante (2018)).
- In the data, the *unconditional* correlation of aggregate domestic consumption with foreign consumption—and with domestic output—is **strongly positive**.
  - Since the HANK model reproduces these positive comovements *conditional* on a foreign demand shock, this paves the way for such shocks to be important drivers of business cycles in HANK (unlike in RANK).
- We finally study the implications for stabilization policy.

Stylized model

- Our main findings can be derived analytically using a stylized HANK model of a small open economy.
- Consider the canonical **small open economy** RANK model of Gali and Monacelli (2005), *combined with* **household heterogeneity** and **incomplete financial markets**, following the tradition of Bewley-Imrohoroglu-Huggett-Aiyagari.
  - Minor difference: Sticky wages instead of sticky prices.
  - A similar model is considered in Auclert et al. (2021b).
- We also solve a corresponding RANK model (with no international risk sharing).

PROPOSITION:

The response of domestic consumption ($d\boldsymbol{C}$) to a foreign demand shock ($d\boldsymbol{Y^*}$) is

$$d\boldsymbol{C} = \left[\boldsymbol{M} + \frac{\alpha}{1-\alpha}\boldsymbol{M}\boldsymbol{G}^{Q,Y} + \boldsymbol{M}^r\boldsymbol{G}^{r,Q}\boldsymbol{G}^{Q,Y}\right]\boldsymbol{G}^{Y,Y^*}d\boldsymbol{Y^*}.$$

$d\boldsymbol{X} = (dX_0, dX_1, \ldots, dX_T)'$ is the sequence of deviations from steady state of X.

$\boldsymbol{M}$ is the matrix of intertemporal MPC's, and $\boldsymbol{M}^r$ is the matrix of consumption responses to the real interest rate. Note that "$\boldsymbol{M} \geq 0$" and "$\boldsymbol{M}^r < 0$".

$\boldsymbol{G}^{X,Z} \geq 0$ captures the equilibrium relationship between variables X and Z, and is a known function of the structural parameters of the model. $1-\alpha$ is the home bias.

PROPOSITION:

The response of domestic consumption ($d\boldsymbol{C}$) to a foreign demand shock ($d\boldsymbol{Y^*}$) is

$$d\boldsymbol{C} = \Big[\overbrace{\boldsymbol{M}}^{\text{Labor income} \geq 0} + \overbrace{\frac{\alpha}{1-\alpha}\boldsymbol{M}\boldsymbol{G}^{Q,Y}}^{\text{Real income} \geq 0} + \overbrace{\boldsymbol{M}^r\boldsymbol{G}^{r,Q}\boldsymbol{G}^{Q,Y}}^{\text{Inter. sub.} < 0} \Big] \boldsymbol{G}^{Y,Y^*} d\boldsymbol{Y^*}.$$

- In RANK, MPC's are very close to zero ($\boldsymbol{M} \approx 0$).
  - Since $\boldsymbol{G}^{r,Q}$, $\boldsymbol{G}^{Q,Y}$, and $\boldsymbol{G}^{Y,Y^*}$ are positive, the fact that $\boldsymbol{M}^r < 0$ implies $d\boldsymbol{C} < 0$.
  - Intertemporal substitution response to higher domestic interest rate $\Rightarrow$ consumption $\downarrow$
- In HANK, realistic MPCs imply $\boldsymbol{M} > 0$, paving the way for $d\boldsymbol{C} > 0$.
  - Higher labor income stimulates consumption via high MPCs $\Rightarrow$ consumption $\uparrow$
  - "Real income channel" of Auclert et al. (2021b) $\Rightarrow$ consumption $\uparrow$

Roadmap

1. Empirical findings
2. Numerical results from full-scale quantitative model
3. Policy implications
4. **Not today:** Augmented model with capital, estimated using impulse-response matching.

Related literature

- **Empirical studies of foreign demand shocks** (usually SVARs with sign restrictions).
  - Canova (2005), Eickmeier (2007), Mumtaz and Surico (2009), Charnavoki and Dolado (2014), and Feldkircher and Huber (2016).
- **Model-based analyses of foreign demand shocks** typically rely on estimated open-economy DSGE models with a RANK structure.
  - Lubik and Schorfheide (2007), Justiniano and Preston (2010), Christiano, Trabandt, and Walentin (2011), Adolfson et al. (2013), and Bergholt (2015).
- **Open-economy HANK models**: De Ferra, Mitman, and Romei (2020), Auclert et al. (2021b), Zhou (2021), Bayer et al. (2022), Chen et al. (2022), Guo, Ottonello, and Perez (2023), and Oskolkov (2023).

Empirical strategy

- We use **pooled local projections** and identify foreign demand shocks using **sign and zero restrictions**, building on the work of Plagborg-Møller and Wolf (2021).
- **Identification** builds on two steps:
  - The first step is a standard small open economy (SOE) assumption: The domestic economy is affected by the foreign economy, but **not** vice versa.
  - Second, we use sign restrictions on the **foreign variables** to identify shocks to foreign demand, foreign supply, and foreign monetary policy (domestic variables are unrestricted).
    - In line with existing literature, a foreign demand shock moves foreign output, inflation, and the nominal interest rate in the *same direction* (imposed only on impact).
    - This separates it from shocks to foreign supply and monetary policy.

Empirical strategy

- **Data:** We use data for all 38 OECD countries, starting when data is available for each country and ending by 2019:Q4.
  - 31 of these are considered as small open economies (SOE's).
  - The remaining are the G7 countries, which are used only for constructing the "foreign economy" data.
- For each SOE, we construct the **country-specific "foreign economy"** $(Y^*_{j,t}, \pi^*_{j,t}, i^*_{j,t})'$ by computing trade-weighted measures of GDP, inflation, and interest rates of country j's most important trading partners.
  - While the SOE assumption is valid for each SOE against "the rest of the world", it may not hold against each country used in the foreign-economy variable. (e.g., Finland vs. Sweden).
  - We therefore exclude all trading partners for which more than 1 pct. of exports go to country j (using only large economies on the RHS yields similar results).

Empirical strategy

- We obtain IRFs $\{\beta_h\}_{h=0}^{H}$ by estimating (with OLS) the following pooled LP regressions:

$$Z_{j,t+h} = \beta_h X_{j,t} + \sum_{k=1}^{p} \delta_{h,k} X_{j,t-k} + \varepsilon_{j,t,h},$$

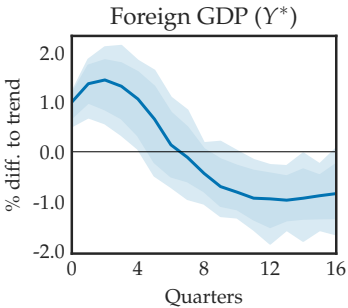
  where $X_{j,t} = (Z_{j,t}, Y^*_{j,t}, \pi^*_{j,t}, i^*_{j,t})'$, with $Z_{j,t}$ denoting a domestic outcome variable (e.g., GDP), and $Y^*_{j,t}, \pi^*_{j,t}, i^*_{j,t}$ denoting the country-specific foreign variables.

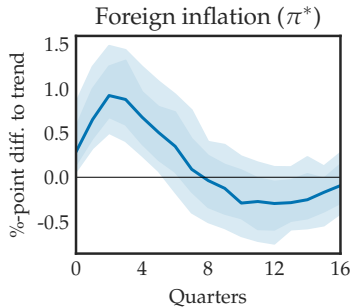
- We estimate equivalent regressions for the foreign variables; $V = \{Y, \pi, i\}$:

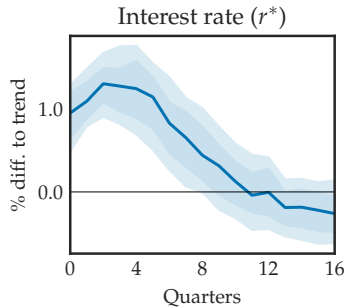
$$V^*_{j,t+h} = \beta^V_h X_{j,t} + \sum_{k=1}^{p} \delta^V_{h,k} X_{j,t-k} + \varepsilon^V_{j,t,h}.$$

- We then keep only the rotations of the IRFs satisfying our identifying assumptions.

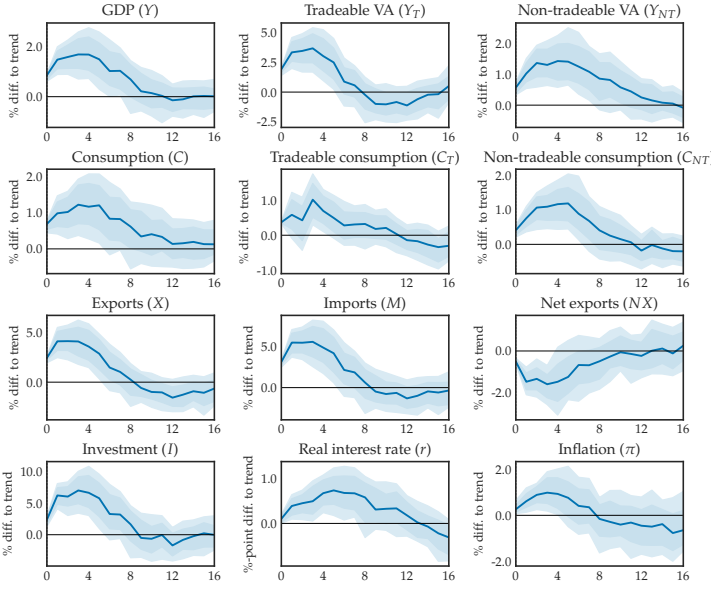
Response of the foreign economy







Response of the domestic economy



Variance decomposition

- **Q:** How much of the variance in the domestic economy is explained by the shock?
- **A:** Variance decomposition for LP's, as in Gorodnichenko and Lee (2020):

h	Y	C	X	M	NX
4	25.4 (5.1,42.6)	9.4 (1.4,24.5)	13.8 (4.0,50.0)	26.9 (7.2,48.5)	4.5 (1.7,23.0)
8	28.9 (15.2,39.6)	20.2 (6.7,26.6)	23.4 (10.9,33.4)	34.9 (13.8,51.4)	18.3 (8.4,29.2)
∞	28.9 (15.9,39.3)	20.7 (7,28.5)	23.9 (11.2,33.5)	34.8 (14.6,50.1)	21.4 (8.6,31.2)

Table: Forecast error variance decomposition (FEVD) of foreign demand shocks

5 stylized empirical facts

- We summarize our findings in 5 stylized empirical facts regarding the effects of a shock to foreign demand:
  1. GDP increases
  2. Aggregate consumption increases
  3. Exports and imports *both* increase
  4. Consumption of tradeable and non-tradeable goods co-moves positively (both increase)
  5. Foreign demand shocks explain a large share of the variance of domestic variables
- These results are generally in line with the existing literature.

Robustness

- We conduct a series of robustness checks. Most significantly:

1. **All five facts are confirmed** for both *fixed* and *floating* exchange-rate countries.
2. Results are confirmed if we abandon sign restrictions and regress domestic variables directly against $Y^*_{j,t}$ (with lags) and a time-fixed effect.
3. Results are robust to including time-fixed effects or OECD-wide GDP on the right-hand side to control for common shocks (e.g., commodity price shocks, financial crises, etc.).

- Additional robustness checks include:
  - **Variables:** HP filter, Hamilton filter, shock to foreign imports instead of GDP.
  - **LP specification:** More lags, using common "foreign economy" for all countries (i.e., $Y^*_{j,t} = Y^*_t, \forall j$), using a structural VAR model instead of LP.
  - Results are very robust: Virtually all findings carry over to all specifications.

Full model: The building blocks

- We turn next to a full-scale quantitative business-cycle model.
- Full model $=$ Baseline model from above augmented with
  - Distinction of tradeables and non-tradeables
  - Input-output structure in production
  - Both prices and wages are sticky
  - Public sector
  - Foreign economy is a 3-equation NK model
- Shock **before:** $dY^* \uparrow$
- Shock **now:** $\beta^* \downarrow$, leading to $dY^* \uparrow$, $d\pi^* \uparrow$, and $dr^* \uparrow$, in line with our empirical analysis.

Household problem

- **States:** Assets (a_{t-1}), idiosyncratic earnings (e_t), discount factor (β), and sector (s). β and s are permanent.

$$
\begin{aligned}
V_t^{s,k}(e_t, a_{t-1}) = \max_{c_t, a_t} & \, u(c_t) - \nu(n_t) + \beta_t^k \mathbb{E}_t \left[V_{t+1}^{s,k}(e_{t+1}, a_t) \right] \\
& \text{s.t.} \\
c_t + a_t &= (1 + r_t^a) a_{t-1} + w_{s,t} n_{s,t} e_t + T_t - \tau(\tau_t, e_t), \\
\ln e_t &= \rho_e \ln e_{t-1} + \epsilon_t^e, \quad \epsilon_t^e \sim \mathcal{N}(0, \sigma_e^2), \\
a_t &\geq 0.
\end{aligned}
$$

Portfolio choice

- Domestic households invest their savings into a mutual fund, which can invest in three types of assets: domestic bonds, foreign bonds, and domestic shares.

$$A_t = B_t + B_t^* + p_t^D.$$

- Due to free international capital movements, this gives rise to two arbitrage conditions; one between domestic bonds and shares, and one between domestic and foreign bonds, i.e., a UIP condition.

Corresponding RANK model

- In RANK, there is complete markets with perfect risk-sharing and no preference heterogeneity, giving a representative agent following a standard Euler equation:

$$u'(C_t) = (1 + r^a_{t+1})\bar{\beta}_t u'(C_{t+1}).$$

- We still assume that there is no international risk sharing.

Optimal CES demand functions

- Choice between tradeables and non-tradeables:

$$C_{T,t} = \alpha_T \left(\frac{P_{T,t}}{P_t} \right)^{-\eta_{T,NT}} C_t,$$

$$C_{NT,t} = (1 - \alpha_T) \left(\frac{P_{NT,t}}{P_t} \right)^{-\eta_{T,NT}} C_t.$$

- Choice between foreign tradeables and domestic tradeables:

$$C_{F,t} = \alpha_F \left(\frac{P_{F,t}}{P_{T,t}} \right)^{-\eta_{H,F}} C_{T,t},$$

$$C_{H,t} = (1 - \alpha_F) \left(\frac{P_{H,t}}{P_{T,t}} \right)^{-\eta_{H,F}} C_{T,t}.$$

Remaining model components

- The remaining model ingredients are standard in the NK literature.
- **Firms:**
  - Production requires inputs of labor and of intermediate goods (input-output structure).
  - Intermediate goods can be purchased domestically or imported from abroad.
  - Price adjustment costs $\Rightarrow$ New Keynesian Phillips Curve.
- **Unions:** Households are members of labor unions, which face wage adjustment costs $\Rightarrow$ New Keynesian Wage Phillips Curve.
- **Central bank:** Taylor rule responding to PPI inflation.
- **Government:** Finances public consumption, transfers, and debt services using bonds and taxes.

The foreign economy

- Foreign demand for domestic goods is given by:

$$C^*_{H,t} = \alpha^* \left(\frac{P^*_{H,t}}{P^*_{F,t}} \right)^{-\eta^*} C^*_t .$$

- We model the foreign economy as a standard New Keynesian (RANK) model (Galí 2015):
  - Demand side: IS relationship
  - Supply side: NKPC
  - Taylor rule

Solution method

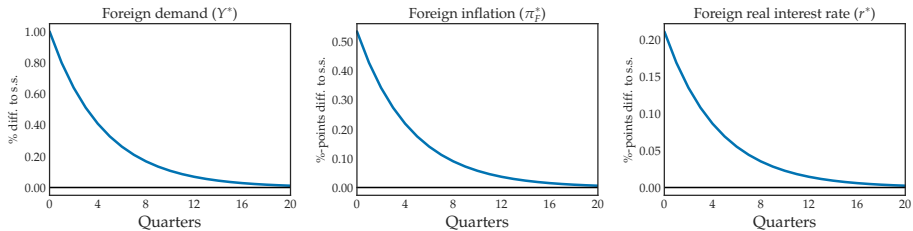
- We solve the households' problem using the endogenous grid method of Carroll (2006).
- We use the "fake news algorithm" from Auclert et al. (2021a) to compute the Jacobian of the households' problem around a deterministic steady state with zero inflation and a balanced net foreign asset position.
- We solve for the full non-linear transition path to each shock using Broyden's method.

Calibration

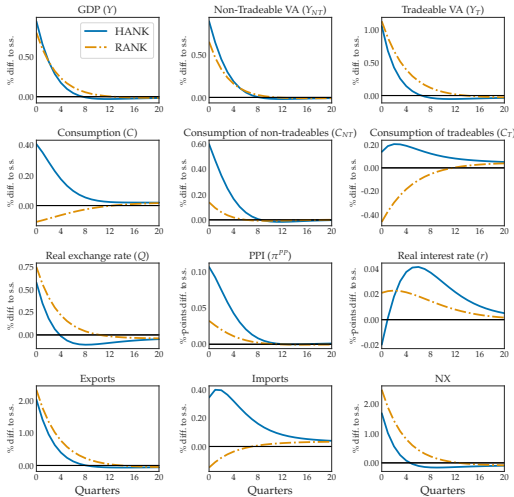
- We calibrate the model at the quarterly frequency, with the aim of matching the average advanced small open economy in the OECD.
- Calibration of households' preferences, income and consumption baskets is fairly standard.
  - Match annual MPC $= 0.55$ (Fagereng, Holm, and Natvik 2021).
- The input-output production structure is matched to OECD input-output tables.
- Public sector calibration is standard, including composition of G.
- Phillips curve parameters are taken from the literature.
- Calibration of the foreign economy follows the NK literature.

Foreign demand shock

- We model the foreign demand shock as a foreign discount factor shock ($\beta^* \downarrow$).
- Effects of the shock in the foreign economy:

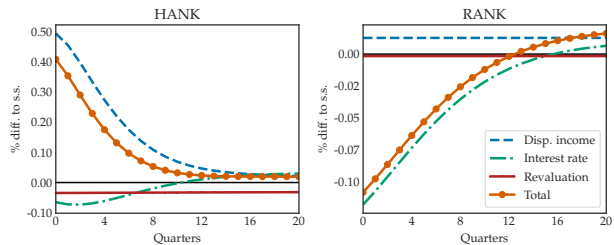


Foreign demand shock: Domestic responses (*Facts 1-4*)



Decomposition of consumption response (*Fact 2*)

- Decompose response of consumption using linearized consumption function:



- **HANK:** Response is driven by changes in disposable income.
- **RANK:** Response is determined by r through intertemporal substitution.

Sectoral comovement (*Fact 4*)

- Empirically, we observed that $\text{Cov}(C_T, C_{NT}) > 0$ (*Fact 4*).
- In both HANK and RANK, CES demand for C_T, C_{NT} gives:

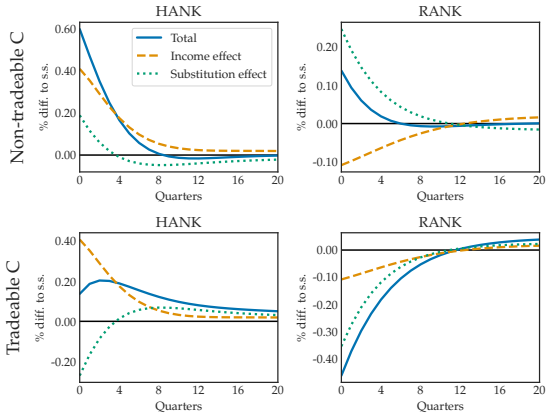
$$C_{T,t} = \alpha_T \left(\frac{P_{T,t}}{P_t} \right)^{-\eta_{T,NT}} C_t,$$

$$C_{NT,t} = (1 - \alpha_T) \left(\frac{P_{NT,t}}{P_t} \right)^{-\eta_{T,NT}} C_t,$$

- Positive co-movement requires that the *income* (or level) effect ($C_t \uparrow$) dominates the *substitution* effect from movements in relative prices ($\frac{P_{T,t}}{P_{NT,t}} \uparrow$).

Sectoral comovement (*Fact 4*)

- HANK: Income effect $\rightarrow$ Cov$(C_T, C_{NT}) > 0$.
- RANK: Substitution effect $\rightarrow$ Cov$(C_T, C_{NT}) < 0$.



Can foreign demand shocks be quantitatively important? (*Fact 5*)

- HANK: $cov(C_t, C_t^*) > 0$ and $cov(C_t, Y_t) > 0$ *conditional* on a foreign demand shock.
- RANK: $cov(C_t, C_t^*) < 0$ and $cov(C_t, Y_t) < 0$ *conditional* on a foreign demand shock.
- *Unconditionally*, in the data, $cov(C_t, C_t^*)$ and and $cov(C_t, Y_t)$ are strongly positive.
- Thus, foreign demand shocks are much better suited to **account for domestic business-cycle fluctuations** in HANK!
- **Exercise**: Introduce domestic β-shocks correlated with foreign β^*-shocks; $\rho(\beta, \beta^*) \neq 0$.
  - What is the value of ρ required for HANK/RANK to match $cov(C_t, C_t^*)$ from the data?
  - **Answer**: Very high in RANK (0.89), quite low in HANK (0.19).

The case of a fixed exchange rate

- Recall that under a float, the Taylor rule is crucial to obtain $i_t \uparrow$, $r_t \uparrow$, and $C_t \downarrow$ in RANK.
- Does this mean that our result changes under a fixed exchange rate?
- **No**! UIP condition + Fisher equation:

$$1 + i_t = 1 + i_t^* \quad \Leftrightarrow \quad 1 + r_t = \frac{1 + i_t^*}{1 + \pi_{t+1}}.$$

- A foreign demand shock entails an increase in i_t^* (*in line with the data*!).
- UIP forces domestic central bank to raise i_t accordingly, ensuring $r_t \uparrow$ (unless $\pi_{t+1} \uparrow\uparrow$).
- Thus, all of our model-based findings are confirmed in the case of a fixed exchange rate.

Stabilization policy

- How to counteract/stabilize foreign demand shocks?
  - In response to a negative foreign demand shock, we consider a range of policies, each of them scaled to completely offset the cumulative drop in *aggregate* consumption.
  - For given effects on aggregate consumption, how successful are these policies in terms of stabilizing consumption of households working *in each of the two sectors* (tradeable and non-tradeable)?

Stabilization policy: Results

	Floating				Fixed			
	C	C_T^{hh}	C_{NT}^{hh}	$\frac{C_T^{hh}}{C_{NT}^{hh}}$	C	C_T^{hh}	C_{NT}^{hh}	$\frac{C_T^{hh}}{C_{NT}^{hh}}$
Foreign demand, β^*	-1.00	-1.23	-0.90	1.37	-1.00	-0.95	-1.02	0.92
Public transfers, T	1.00	0.57	1.19	0.48	1.00	0.64	1.16	0.55
Public spending, G	1.00	0.01	1.44	0.01	1.00	0.23	1.34	0.17
Monetary policy, i	1.00	0.95	1.02	0.93	-	-	-	-
Nominal devaluation	-	-	-	-	1.00	1.05	0.98	1.07
Fiscal devaluation	-	-	-	-	1.00	1.03	0.99	1.04

Table: Cumulative multipliers of foreign demand shock and policy instruments.

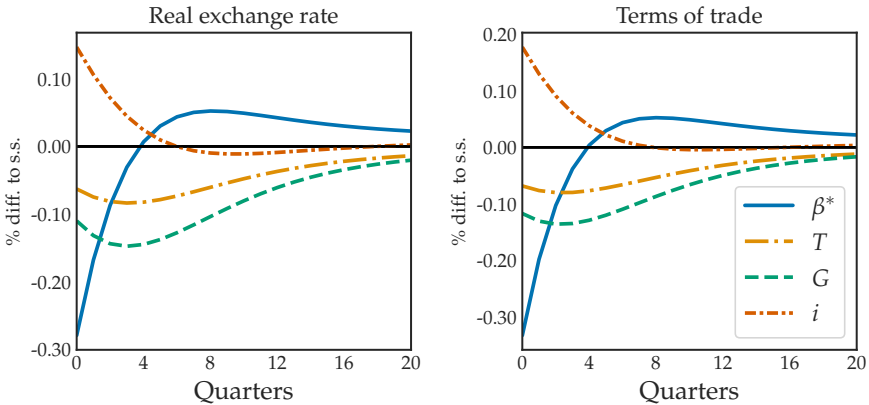
Stabilization policy: Insights

- Expansionary **fiscal policy** (G or T) stimulates non-tradeables, but *appreciates* the terms of trade $\rightarrow$ aggravates shortfall in foreign demand for tradeables.
- Expansionary **monetary policy** is much more successful: stimulates demand for both non-tradeables and tradeables, the latter via a *depreciation* of the terms of trade.
- This poses a challenge for countries without an independent monetary policy!

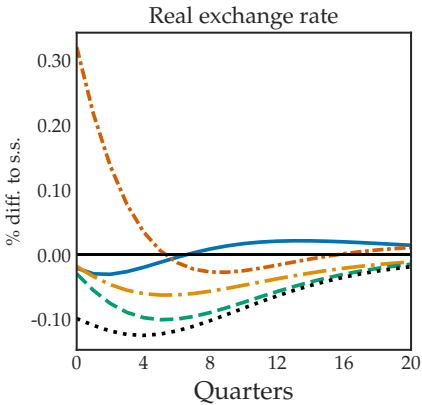
Stabilization policy: Insights

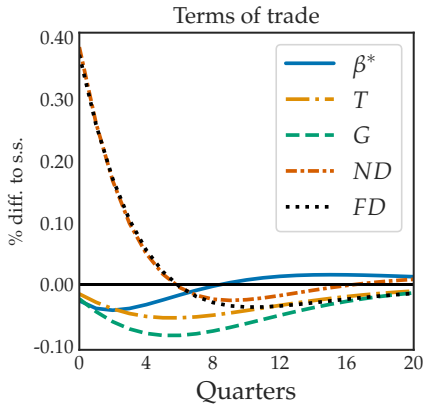
- *In theory*, a nominal devaluation would do the job (depreciates RER/ToT, next slide).
  - This may not be a viable or attractive option in practice.
- There is a way out: **A fiscal devaluation**, as studied, e.g., by Farhi, Gopinath, and Itskhoki (2014) in a representative-agent setting.
  - Reduction in payroll taxes (reducing domestic production costs) + Increase in VAT (manipulates international relative prices, since levied on imports, but not exports).
  - Does not affect real exchange rate, but delivers the desired depreciation of ToT.

RER and ToT under floating exchange rates



RER and ToT under a fixed exchange rate





Conclusion

- Foreign demand shocks induce positive comovement of consumption across countries and across sectors in the data, and are important drivers of SOE business cycles.
- An open-economy HANK model can account for these findings, while standard RANK models cannot.
- Conventional fiscal policy tools are not well-suited to counteract such shocks.
  - Challenge for countries with peg/currency union, especially if foreign demand shocks are quantitatively important, as we argue.
  - A fiscal devaluation may be a way out for such countries.

Sign restrictions: Implementation (Back)

- Our implementation of sign restrictions builds on Rubio-Ramírez, Waggoner, and Zha (2010) and Arias, Rubio-Ramírez, and Waggoner (2018).
- The 4×4 matrix of horizon-h impulse responses is:

$$C_h \equiv \begin{pmatrix} \beta_{1,h} & \beta^Y_{1,h} & \beta^\pi_{1,h} & \beta^r_{1,h} \\ \beta_{2,h} & \beta^Y_{2,h} & \beta^\pi_{2,h} & \beta^r_{2,h} \\ \beta_{3,h} & \beta^Y_{3,h} & \beta^\pi_{3,h} & \beta^r_{3,h} \\ \beta_{4,h} & \beta^Y_{4,h} & \beta^\pi_{4,h} & \beta^r_{4,h} \end{pmatrix}$$

- The structural horizon-h impulse response matrix is $\Theta_h = C_h B Q$, where Q is an 4×4 orthogonal matrix and BB' is the Cholesky decomposition of the covariance matrix.

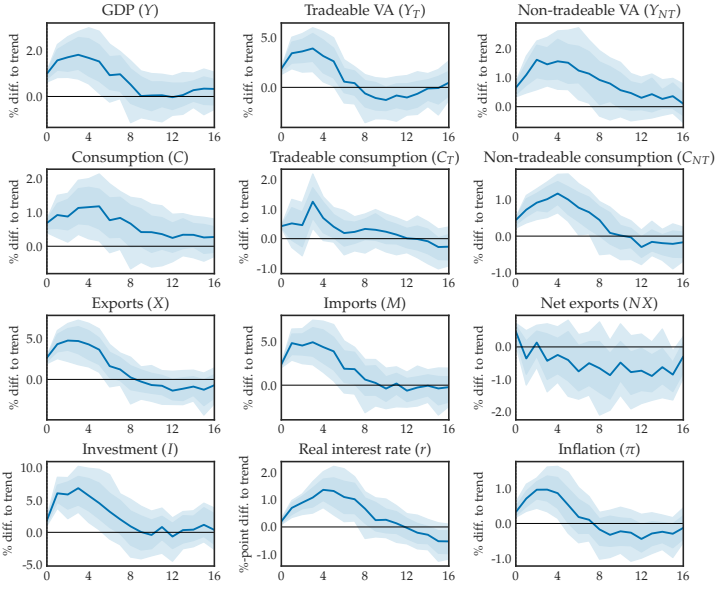
Sign restrictions: Implementation (Back)

- The sign restrictions are then imposed as follows:
  1. Draw Q from the subspace consistent with the imposed zero restrictions.
  2. Use Q to compute $\Theta_h = C_h B Q$.
  3. If the following conditions are satisfied, keep the draw of Q:

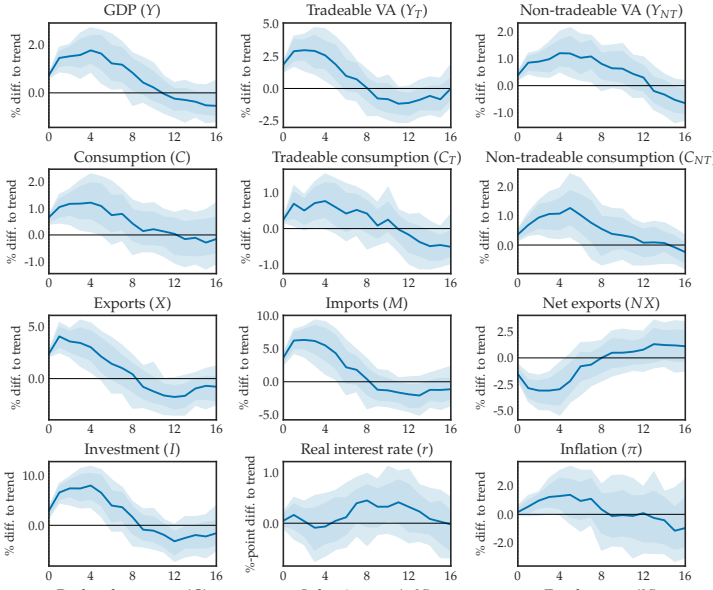
$$S_j \Theta e_j \geq 0, \quad j = 1, 2, 3, 4,$$
$$Z_j \Theta e_j = 0, \quad j = 1, 2, 3, 4,$$

     where $\Theta \equiv (\Theta_0', \Theta_1', \ldots, \Theta_H')'$, and S_j and Z_j are matrices set to impose the restrictions.
  4. If enough draws of Q are accepted, stop. Otherwise, return to 1.

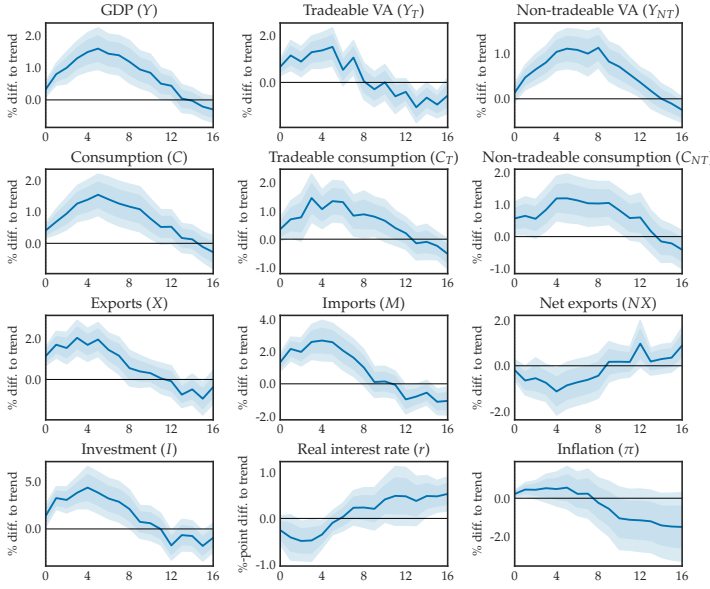
Fixed countries only (Back)



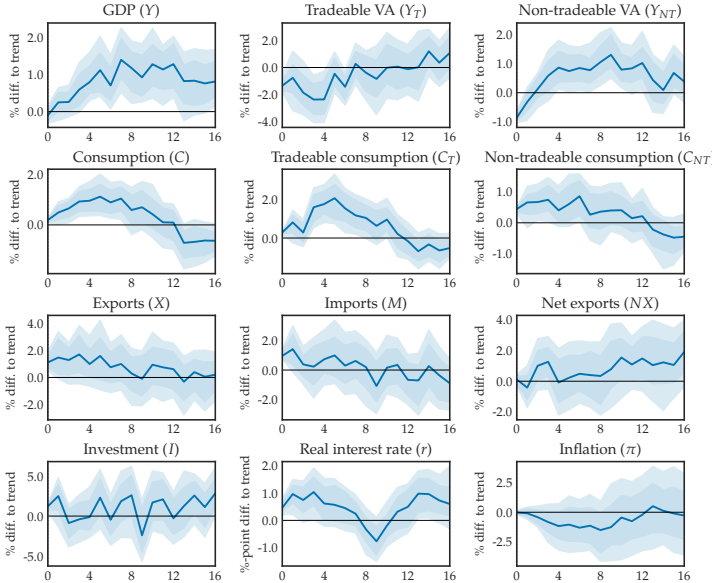
Floating countries only (Back)



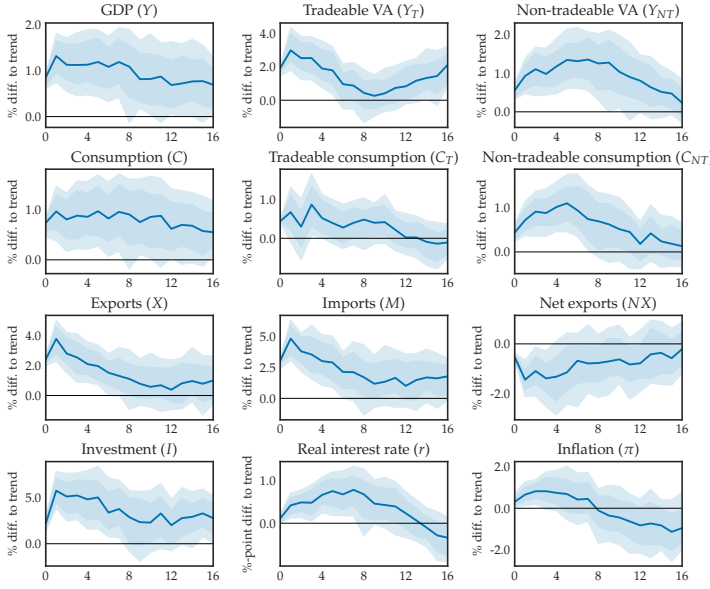
No sign restrictions (Back)



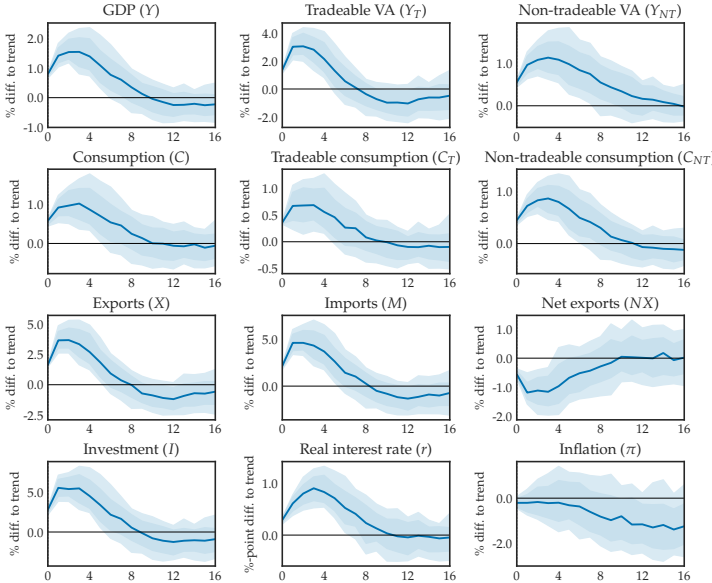
Time-fixed effects (Back)



Common world economy (Back)



SVAR (Back)


GDP (Y)
Tradeable VA (Y_T)
Non-tradeable VA (Y_{NT})
Consumption (C)
Tradeable consumption (C_T)
Non-tradeable consumption (C_{NT})
Exports (X)
Imports (M)
Net exports (NX)
Investment (I)
Real interest rate (r)
Inflation (π)
% diff. to trend
%-point diff. to trend

Data (Back)

- **Sample:** 31 ”small” and 7 ”large” OECD countries.
  - Largest SOE: Spain
  - All OECD countries with quarterly national accounts data starting in 1996 or earlier.
- The frequency is quarterly and for most countries data starts in the early-mid 1990’s.
- Variables are detrended by a country-specific regression on $(1, t, t^2, t^3, t^4)$.

Countries (Back)

Large countries	Canada, France, Germany, Italy, Japan, United Kingdom, United States of America
Small countries	Australia, Austria, Belgium, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, Greece, Hungary, Iceland, Ireland, Israel, Latvia, Lithuania, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovakia, Slovenia, South Korea, Spain, Sweden, Switzerland, Turkey.

Variable description (Back)

Variable	Description	Transformation
Y	GDP	Log
C	Consumption	Log
I	Investment	Log
X	Exports	Log
M	Imports	Log
Y_T	Tradeable VA	Log
Y_{NT}	Non-tradeable VA	Log
C_T	Tradeable consumption	Log
C_{NT}	Non-tradeable consumption	Log
Q	Real effective exchange rate	Log
P	Consumer price index	–
i	Short nominal interest rate	–
NX	Net exports	$NX = X - M$
π	Inflation	$\pi = P/P_{-4}$
r	Short real interest rate	$r = (1 + i)/(1 + \pi_{+4}) - 1$

Calibration (Back)

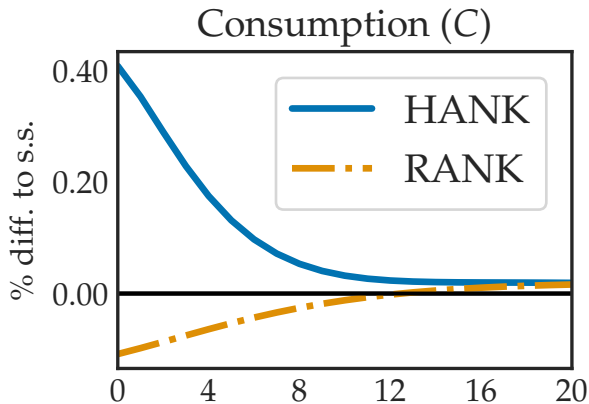
Parameter	Description	Value	Target
$1/\sigma$	EIS	0.5	Standard value
$\bar{\beta}$ (HANK)	Mean discount factor	0.972	$\frac{A}{GDP} = 3$ (annual)
$\bar{\beta}$ (RANK)	Mean discount factor	0.995	$r = 2\%$ p.a.
$\Delta\beta$	Discount factor dispersion	0.02	$MPC = 0.55$ (annual)
ρ^e	persistent of idiosyncratic income	0.95	Standard value
σ^e	Std. of idiosyncratic income	0.25	Standard value
s_T	Share of households working in tradeable sector	0.35	OECD average
η_T	Elasticity of sub. between C_T and C_{NT}	1.5	See text
η	Elasticity of sub. between C_F and C_H	1.5	See text
α_T	Share of tradeables in home basket	0.41	OECD average
α	Share of foreign tradeables in home basket	0.33	$\frac{CF}{Imports} = 30\%$
$\frac{G}{GDP}$	Public consumption	0.17	17%
$\frac{B}{GDP}$	Government debt to GDP	0.95	95% (annual)
s_T^G	Share of G going to tradeables	0.2	Cardi and Restout (2022)
ϕ^π	Taylor rule coefficient	1.5	Standard value
ρ^i	Degree of interest rate smoothing	0.85	Standard value

Calibration (II)

Parameter	Description	Value	Target
α_T^X	Intermediate goods share	0.79	$\frac{P_T^X X_s}{P_s^X X_s + W_s N_s} = 0.8$
α_{NT}^X	Intermediate goods share	0.59	$\frac{P_s^X X_s}{P_s^X X_s + W_s N_s} = 0.6$
Θ_T^X	Share of own final goods in X_T	0.65	65%
Θ_{NT}^X	Share of own final goods in X_{NT}	0.65	65%
η_x	Elasticity of sub. between intermediate goods	0.5	See text
$\epsilon_T^P, \epsilon_{NT}^P$	Elasticity of substitution for final goods	11	Markup=10%
$\epsilon_T^w, \epsilon_{NT}^w$	Elasticity of substitution for labor	11	Markup=10%
$\theta_T^P, \theta_{NT}^P$	Rotemberg price parameter	73.3	Slope of NKPC = 0.15
$\theta_T^w, \theta_{NT}^w$	Rotemberg wage parameter	366.6	Slope of NKWPC = 0.03
$1/\sigma^*$	EIS	0.5	Standard value
φ^*	Frisch elasticity	0.5	Standard value
β^*	Discount factor	0.995	$r^* = 2\%$ p.a.
ϕ^*	Taylor rule coefficient	1.5	Standard value
ϵ^*	Elasticity of substitution for final goods	11	Markup=10%
θ^*	Rotemberg price parameter	366.6	Slope of NKPC = 0.03
η^*	Export elasticity	1.5	See text

Zooming in: Response of consumption (*Fact 2*) (Back)

- IRF of domestic consumption to a foreign demand shock — HANK vs. RANK:



Domestic responses under a fixed exchange rate (Back)