Learning and Cross-Country Correlations in a Multi-Country DSGE Model

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Motivation

- DSGE models with trade do not generate significant international spillovers. See, for example, Justiniano and Preston (2010)
- I aim to capture the correlation between international variables with the departure from full information rational expectations:
  - There is evidence of agents deviating from rational expectations (e.g. Adam 2007, Hommes 2011, Andrade and Le Bihan 2013)
  - Models with adaptive learning and restricted perception better fit the data (Slobodyan and Wouters 2012, Ormeno and Molnar 2015)

Model and Technical Insights

Two-country workhorse DSGE model as in de Walque et al. (2017): two economies connected by trade in goods and international bonds (Smets and Wouters, 2003). Estimated on US and EA data.

Learning as in Slobodyan and Wouters (2012b and 2012a):

- Agents do not know the coefficients of the model (including constants): update their beliefs using Kalman filter
- Agents only observe "observables"
- Agents use AR(2) rules to forecast future variables
- No home bias

The solution to the linearized model under learning:

$$y_t = \mu_t + T_t y_{t-1} + R_t \varepsilon_t,$$

where y_t is vector of endogenous variables and exogenous processes, μ_t - vector of constants, ε_t - iid innovations.

Learning affects correlation through comovements in time-varying coefficients: μ_t, T_t, R_t.

Results:

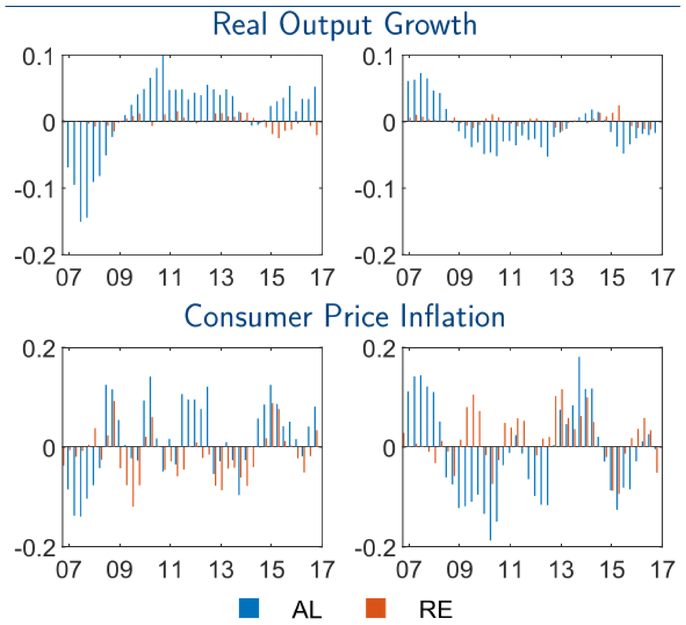
EA-US Cross-Country Correlations (5th and 95th percentiles in parentheses).

	Real Output Growth	Real Consumption Growth	Real Investment Growth	Policy Rate	Consumer Price Inflation
Learning model	**0.4**	**0.49**	**0.24**	0.91	0.998
	(0.05)(0.72)	(0.06)(0.77)	(-0.03)(0.54)	(0.72)(0.98)	(0.99)(0.999)
RE model	0.04	-0.28	-0.55	0.72	0.82
	(-0.31)(0.39)	(-0.57)(0.13)	(-0.79)(-0.11)	(0.05)(0.94)	(0.56)(0.93)
Data	0.55	0.54	0.48	0.69	0.87

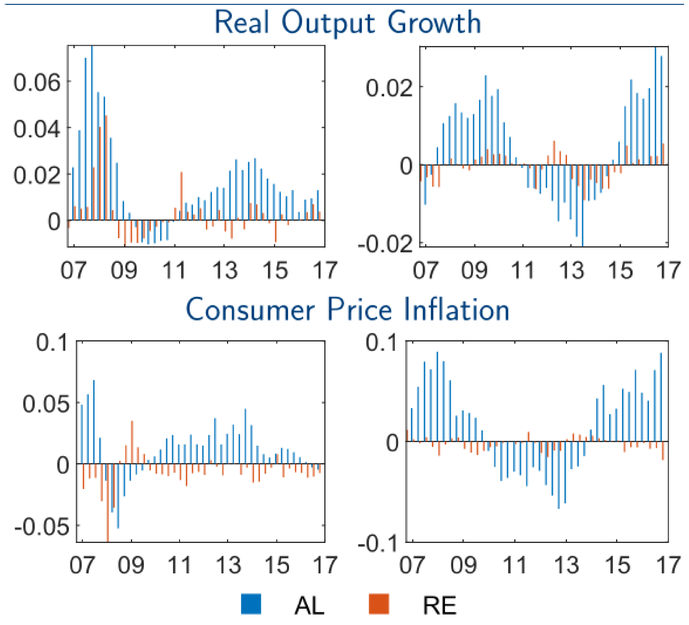
Greater Likelihood
(Log marginal data density)

Learning model	-1506.3
RE model	-1518.0

Historical shock decomposition (2006-2016), larger contribution of shocks in total absolute variation under learning:



Real Exchange Rate Shock



The Other Country's Monetary Policy Shock Spillovers
(sometimes with the opposite sign)

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Technical Appendix

Agents update their beliefs about coefficients β using Kalman filter

The agents forecast future variables using forecasting models AR(2):

$$y_t^f = X_t^T \beta_t,$$

where

$$X_t = [const, y_{t-1}^f, y_{t-2}^f].$$

They believe the coefficients follow VAR around mean $\bar{\beta}$:

$$vec(\beta_t - \bar{\beta}) = F\, vec(\beta_{t-1} - \bar{\beta}),$$

F is diagonal matrix with $\rho \leq 1$ on the diagonal.

I need to select the initial values as in Slobodyan and Wouters (2012):

- $\beta_{1|0} = \bar{\beta} = (E[X^T X])^{-1} E[X^T y]$, with $E(X^T X)$ and $E(X^T y)$ from RE solution
- given $\beta_{1|0}$, $\Sigma = E\left(\left[y_t^f - X_{t-1}^T \beta_{1|0}\right]\left[y_t^f - X_{t-1}^T \beta_{1|0}\right]^T\right)$
- $P_{1|0} = \sigma_0 \left(X^T \Sigma^{-1} X\right)^{-1}$
- $V = \sigma_v \left(X^T \Sigma^{-1} X\right)^{-1}$
- thus, I have 3 free parameters: ρ, σ_0, σ_v.

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Estimation

- I estimate the model with the following set of observables. For each country I observe real output growth, real consumption growth, real investment growth (all in per capita terms), net export (to gdp), consumer price inflation, home inflation, imported inflation, 3M interest rate. Common variables: nominal exchange rate (first difference), growth in oil price (in USD)

- The data from 1992Q3 to 2016Q4 (98 observations)

- The agents have the following set of AR(2) forwards to forecast. For each country, the agents forecast: consumption, investment, export, labour, price of capital, return on capital, wage, consumption inflation, home inflation, imported and exported inflation for consumption and production goods; and a common variable: real exchange rate.

- I estimate 120 parameters

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