Learning about Monetary Policy using (S)VARs? Some Pitfalls and Possible Solutions

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Interim: B4/13, April 2014

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SVARs for Monetary Policy Analysis

SVAR models are one of the most widely employed tools for monetary policy analysis...

. . . and also the most debated and criticised tool

The Usual Critique:

- Identification of structural shocks
- Linearity, and thus symmmetry
- Assumption of constant coefficients

Cheap shots! We do not go in this direction

. . . since we do not have a solution

Our Argument: Reduced Form Matters

When the **reduced form VAR** is **misspecified** no identification scheme can save it. . .

Misspecification of the reduced form also severely **impacts forecasting** properties

Economic **theory**, **institutional** framework (e.g. inflation targeting regime), as well as **stylized facts** about emerging countries have strong **implications** even for the **reduced form** of SVAR.

List of VAR Commandments

- C-1 Honor the nature of your policy regime, praise your Governor's inflation target
- C-2 Thou shall not ignore units of variables
- C-3 Remember your trading partners and your size
- C-4 Thou shall not mistake convergence for business cycles
- C-5 Thou shall not confuse monetary policy shocks with purposeful monetary policy
- C-6 Not let your coefficients vary in vain

Methodology

Our approach rests on:

1. powerful and widely understood economic argument
2. simulations experiments based on structural model
3. real-world data forecasting exercise
   - the paper will be more comprehensive

- In most cases, we believe qualitative economic arguments as sufficiently
- Where quantitative arguments are needed we provide simulations

C-1: Honor the nature of your policy regime (1)

Implication of inflation targeting:

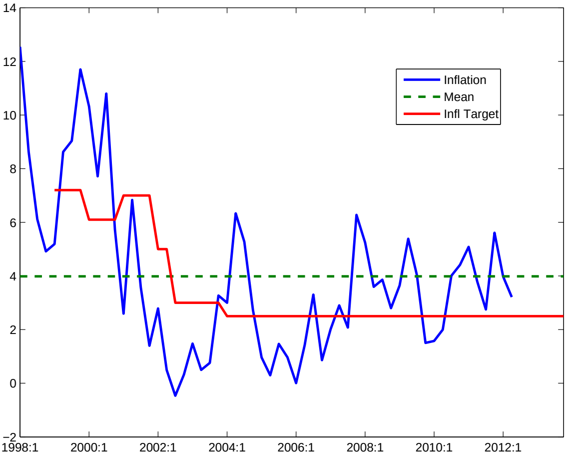
- Inflation deviation from the target is the measure of interest
- Time-varying path of inflation target must be acknowledged
- Inflation targeting implies a unit root for price level
- Modeling price level in the VAR is incorrect

Ignoring MP regime results into:

- Forecast of inflation does not converge to target
- Disconnect of inflation from fundamentals (like output and ER) and 'price puzzle'
- Spurious 'time-variation' in coefficients

C-1: Honor the nature of your policy regime (2)

Poland: Inflation and Inflation Target



.... and there is more ...

C-1: Simulation exercise – a simple NK DSGE model

We simulate a three-equation NK DSGE model with changing the target:

- Change in the target is understood and perfectly credible
- Inflation in the PC is indexed on the deviation of inflation from the target
- Relaxing these assumptions would make our point even stronger!
  (low-frequency dynamics would trickle down to business cycle)

C-1: Simulation exercise – a simple NK DSGE model (2)

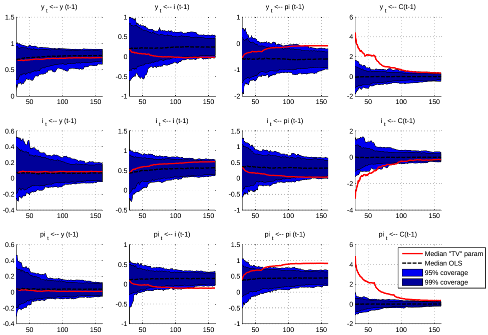
Hence the model looks like ($\overline{\pi}_t$ is the time varying target):

1. forward looking IS curve:
   $y_t = \omega_1 y_{t-1} + \omega_2 \mathbb{E}_t y_{t+1} + 1/\sigma(i_t - \mathbb{E}_t \pi_{t+1}) + \varepsilon_t^y;$
2. PC curve:
   $\pi_t - \overline{\pi}_t = \beta_1(\pi_{t-1} - \overline{\pi}_{t-1}) + \beta_2 \mathbb{E}_t(\pi_{t+1} - \overline{\pi}_{t+1}) + \kappa y_t + \varepsilon_t^\pi;$
3. MP reaction function: $i_t = \rho_0(\mathbb{E}_t \pi_{t+k} - \overline{\pi}_t) + \rho_1 i_{t-1} + \bar{\imath} + \varepsilon_t^{MP}.$

We simulate the model for 120 periods:

- the initial target is 8 p.p.
- each 30 periods it is decreased by 2 p.p.

C-1: Recursive OLS (reduced form) VAR(1)



- Ignoring changes in the IT leads to inconsistent estimates of reduced-form parameters
- Some of regression coefficients may be falsely assumed to be time varying

C-1: Inflation versus price level

The **inflation-targeting** central banks have in their reaction function **inflation**, not the price level:

- therefore, it is obvious why to use inflation in monetary VARs instead of (the log of) the price level,
- nevertheless, surprisingly many SVAR studies use (the log of) the price level,
- this holds regardless statistical considerations (that may be also important).

Can the VAR reduced form be estimated even with the price level?

- model-based arguments say no;
- real-world data confirm that.

C-1: Inflation versus price level: model-based VARs

Assume that the true model is (at least approximatively) given by a NK DSGE model, with a reduced form VAR(1):

$$\begin{bmatrix} x_t \\ \pi_t \end{bmatrix} = \begin{bmatrix} \mathbf{A}_{xx} & \mathbf{A}_{x\pi} \\ \mathbf{A}_{\pi x} & \mathbf{A}_{\pi\pi} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ \pi_{t-1} \end{bmatrix} + \begin{bmatrix} \mathbf{R}_t^x \\ \mathbf{R}_t^\pi \end{bmatrix} \varepsilon_t,$$

where x_t are all variables other than inflation, π_t is inflation, ε_t are structural shocks and $\mathbf{A}_{ij}$, $\mathbf{R}_i$ are system matrices.

The log of price level is $p_t = p_{t-1} + \pi_t$.

Is there a low order VAR that would correspond to the VAR above but with p_t instead of π_t?

- Denote them as VAR$_\pi$ for the VAR with inflation and VAR$_p$ for VAR with price level.

C-1 Inflation versus price level: model-based VARs (2)

The quest:

$$\text{VAR}_\pi(1) \overbrace{\Rightarrow}^{(1)} \text{VMA}_\pi(\infty) \overbrace{\Rightarrow}^{(2)} \text{VMA}_p(\infty) \overbrace{\Rightarrow}^{(3)} \text{VAR}_p(k),$$

for low k.

- $\overbrace{\Rightarrow}^{(1)}$ – compute impulse responses,
- $\overbrace{\Rightarrow}^{(2)}$ – integrate impulse responses for inflation to price level,
- $\overbrace{\Rightarrow}^{(3)}$ – the real problem. Is VMA_p invertible?
  - not,
  - if not, then there is no low order VAR_p (VAR with the price level) that would correspond to the model ....

C-2: Thou Shall Not Ignore Units of Variables

A great portion of [S]VAR studies mention data and units vaguely:

- Clearly define units and transformations (level, growth, gaps)
- Signs are not enough
- When doing one std. dev. shocks, say how much that is
- Create shock decomposition of the actual data

Knowing your units saves you from incredible results. . .

“ The results indicate that a monetary shock of 30 basis points decreases the output gap by about 5%. ”

No. It does not. . . It is not possible.

VARs and Steady States

A well-defined steady state is important:

- greatly enhances forecasting properties (Villani, 2009)
- important for structural interpretation (inflation target,...)

Steady state is not the constant in the VAR!

$$Y_t = C + A\ Y_{t-1} + R\varepsilon \tag{1}$$

implies

$$Y_{ss} = (I - A)^{-1} C. \tag{2}$$

To impose the mean is simple. Bayesian prior on the mean via Gibbs sampling in Villani (2009).

C-3: Remember your trading partners

Open economies cannot be modeled as ‘closed’ ones:

- Small open economy (SOE) VAR cannot ignore its trading partners
- SOE often does not affect the rest of the world too much (exogeniety assumption feasible)
- Extremely important both for forecasting and shock identification

Omission of the openness results into misspecification:

- Domestic versus foreign shocks
- Uncovered interest parity and law of one price
- Exogeneity and spurious causality

C-3: Remember your trading partners (2)

Surprisingly, many (S)VAR papers ignore that the Czech Republic is a SOE country, whose cycles are affected by the external development:

- If there is common shocks, spillovers or transmission from abroad to the domestic economy and only domestic variables are used to estimate VAR, then any estimate of the reduced form will be biased.
  - Forecasting properties will deteriorate,
  - but *more importantly*, the model will be forced to explain the whole dynamics of domestic variables by domestic shocks!
- Hence, also the SVAR properties will be wrong.
  - Also for domestic shocks!

C-3: Lets' make the point formal

Assume that the true model is that of SOE:

$$\begin{bmatrix} x_t \\ \xi_t \end{bmatrix} = \begin{bmatrix} \mathbf{A}_{xx} & \mathbf{A}_{x\xi} \\ \mathbf{0} & \mathbf{A}_{\xi\xi} \end{bmatrix} \begin{bmatrix} x_{t-1} \\ \xi_{t-1} \end{bmatrix} + \begin{bmatrix} \mathbf{R}_{xx} & \mathbf{R}_{x\xi} \\ \mathbf{0} & \mathbf{R}_{\xi\xi} \end{bmatrix} \begin{bmatrix} \omega_t^x \\ \omega_t^\xi \end{bmatrix},$$

where x_t are domestic variables, and ξ_t are foreign variables.

- If we know $\mathbf{A}_{xx}$, we know impulse responses, of domestic shocks to domestic variables (given no correlation between ω_t^x and ω_t^ξ);
- but from $\{x_t\}_{t=1}^T$ alone, we cannot estimate consistently $\mathbf{A}_{xx}$, since for $\widetilde{\mathbf{A}}_{xx} \equiv \mathbb{E}[x_{t+1}|x_t]$ holds that:

$$\text{plim } \widehat{\widetilde{\mathbf{A}}}_{xx} = \mathbf{A}_{xx} + \mathbf{A}_{x\xi} \underbrace{\mathbb{E}[\xi_t x_t^t]\mathbb{E}[x_t x_t^t]^{-1}}_{\mathbb{E}[\xi_t|x_t]} \nrightarrow \mathbf{A}_{xx},$$

C-3: The effect on shock decomposition

$$\mathbf{R}_{xx}\widehat{\widetilde{\omega_t^x}} \equiv x_t - \widehat{\widetilde{\mathbf{A}}}_{xx} x_{t-1} = \mathbf{A}_{xx} x_{t-1} - \widehat{\widetilde{\mathbf{A}}}_{xx} x_{t-1} - \mathbf{A}_{x\xi}\xi_{t-1} + \mathbf{R}_{xx}\omega_t^x + \mathbf{R}_{x\xi}\omega_t^\xi =$$

$$= \underbrace{\mathbf{R}_{xx}\omega_t^x}_{\text{true effects}} + \underbrace{(\mathbf{A}_{xx} - \widehat{\widetilde{\mathbf{A}}}_{xx})}_{\text{estimation bias}} x_{t-1} \underbrace{- \mathbf{A}_{x\xi} \sum_{s \geq 0} \mathbf{A}_{\xi\xi}^s \omega_{t-s-1}^\xi - \mathbf{R}_{x\xi}\omega_t^\xi}_{\text{and these shocks are not accounted for}} .$$

.... $\Longrightarrow$ non-fundamentalness

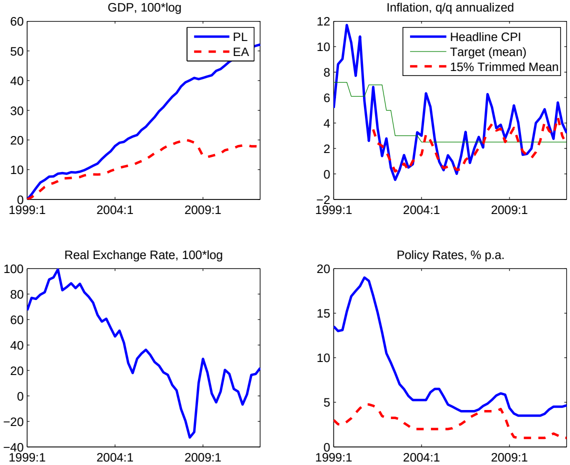
C-4: Thou Shall Not Mistake Convergence for Business Cycle

Monetary stabilisation policy is mostly a cyclical phenomenon:

- Convergence of emerging economies to advanced ones is at odds with co-integration assumptions
- Balassa-Samuelson effect causing trend ‘equilibrium’ real appreciation bears implication for ERPT estimates and such
- Different structural shocks and economic processes operate at different frequencies. . .

C-4: Thou Shall Not Mistake Convergence for Business Cycle (2)

Trend vs Cycle: Poland and Euro Area



C-5: Thou shall not confuse monetary policy shocks with purposeful monetary policy

Literature often evaluate the monetary policy transmission mechanism based on the impulse response of MP shocks:

- we view this as a fundamental confusion:
- the *systematic* reaction of the central bank to the economy and the *systematic response* of the economy to policy should be central (McCalum, 1999)!
- monetary policy is not about central bankers' amusement of shocking the economy (*at least we hope so*);
- .... something analogical can be said about fiscal policy and fiscal multipliers

C-5: Thou shall not confuse monetary policy shocks with purposeful monetary policy (2)

- Is still ‘high’ MP shock impulse response somehow related to the reactiveness of MP?
- **YES**, but **differently** from what one may think!
  - If central banks were very aggressive and did not smooth its rate, you would not observe significant correlation between policy rates, inflation and / or the rest of variables.
  - As a note: this is one of the reasons why single-equation econometric estimation of policy rules is flawed (Cochrane, 2013).

C-5: Let us illustrate this point using simple simulations

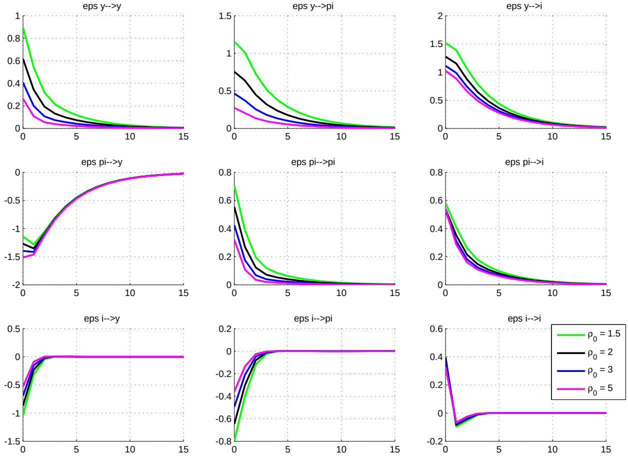
Assume a simple standard three-equation NK DSGE model:

1. forward looking IS curve:
   $y_t = \omega_1 y_{t-1} + \omega_2 \mathbb{E}_t y_{t+1} + 1/\sigma(i_t - \mathbb{E}_t \pi_{t+1}) + \varepsilon_t^y$;
2. PC curve: $\pi_t = \beta_1 \pi_{t-1} + \beta_2 \mathbb{E}_t \pi_{t+1} + \kappa y_t + \varepsilon_t^\pi$;
3. MP reaction function: $i_t = \rho_0(\mathbb{E}_t \pi_{t+k} - \overline{\pi}) + \rho_1 i_{t-1} + \varepsilon_t^{MP}$.

Is ρ_0 somehow related to impulse responses of MP shock ε_t^{MP}?

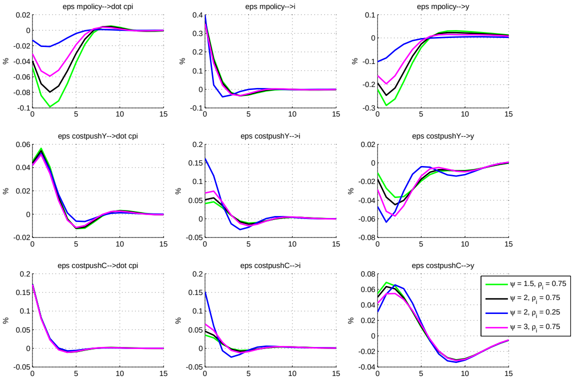
- Let's look at *model implied* impulse responses (no sampling uncertainty, no identification problem).

C-5: IR for various values of ρ_0



C-5: Does this hold also for medium-size models?

g3 reaction function: $i_t = i_{t-1}^{\rho_i} \left(\frac{\alpha}{\beta\varpi} \left(\frac{\mathbb{E}_t \pi_{t+4}^{y/y}}{\overline{\pi}_t} \right)^{\psi} \right)^{1-\rho_i} \exp(\varepsilon_t^{MP})$



Conclusion

Careful specification of the reduced form will greatly benefit VAR analysis:

- Enhances forecasting properties
  (well-defined steady state, RoW conditional forecasting,. . .)
- Lessens potential misspecification of SVARs
  (inflation vs. price level, time-varying infl. target,. . .)
- Provides additional credible structural restrictions
  (SOE exogeneity constraints, inflation gap,. . .)

Closing slides

Thank you for your attention

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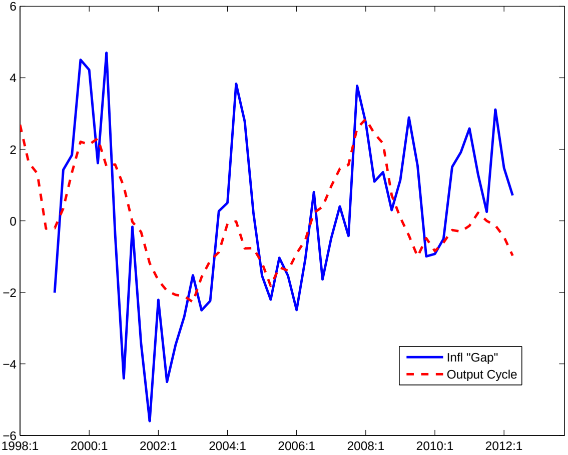
Back-up slides

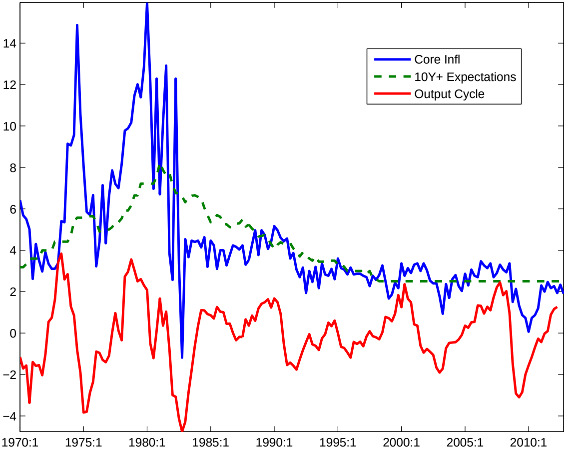
C-1: Honor the nature of your policy regime

Poland: Inflation and Inflation Target



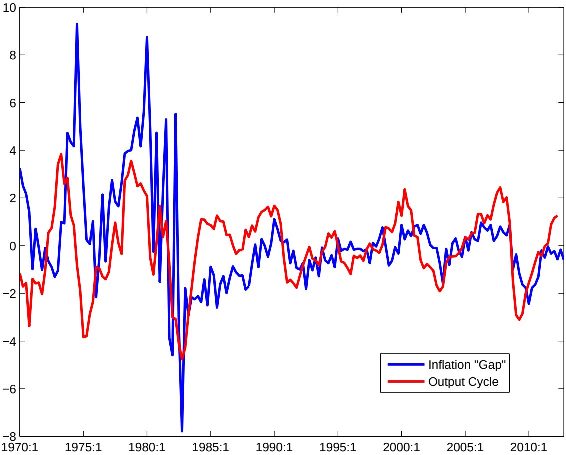
C-1: Honor the nature of your policy regime (a)

U.S. Inflation vs. Output Cycle



C-1: Honor the nature of your policy regime (b)

U.S. Inflation “Gap” vs. Output Cycle



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