Forecasting and Policy Analysis with Trend-Cycle BVARs

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Trend-Cycle VARs

TC-VARs model components of the time series:

\[ Y_t = Y_t^T + Y_t^C + Y_t^E. \] (1)

- \( Y_t^T \) — carefully specified low frequency dynamics, trends, . . .
- \( Y_t^C \) — cyclical dynamics, business cycle, . . .
- \( Y_t^E \) — high-frequency dynamics, measurement errors, . . .

\( Y_t^C \) is specified as a zero-mean VAR(k) model with appropriate transformation of variables and coefficients restrictions.
Why Trend-Cycle VARs?

- Economic theory: trends and cycles are dominated by different shocks and transmission channels. Trends are more complex.

- Well-specified steady-state levels or growth rates of the macro variables, often time-varying and known

- More flexibility in variable transformations

- If the reduced-form VAR is ‘ messed up’, no structural-shock identification wizardry will save the SVAR

Details in Andrle and Bruha (2014)
Example: Poland vs. Euro Area

Andrle, Garcia-Saltos, and Ho (2013)
Examples (I.)

- For IT country inflation must be modeled, not the price level!
- With inflation, the steady state should coincide with the inflation target (need not to happen without a restriction). For a constant target, just subtract it from the inflation series...
- With a time-varying explicit target, an explicit acknowledging of the target time variation is crucial.
- The target needs to be acknowledged also in the trend nominal interest rate or risk of serious misspecification (price puzzles, etc.)

Potential output vs. output gap and the link to inflation deviation from the long-term inflation expectations
- Steady-state growth of output is not constant in many economies and will converge to more developed countries gradually (convergence)
- A model with the level of policy rates with GDP growth rate will almost surely lead to permanent output change after transitory change of policy rates, etc.
- Trends in real exchange rates (HBS effect, etc.)
Examples (II.)

- In labor market models, Okun’s law usually stable, trend in labor-force participation, NAIRU concept, etc.
- International trade ‘trend’ openness driven by tariff changes, trade unions, EU entry, WTO policy, technology...

- In models with multiple countries, different path of inflation targets, trend GDP dynamics, or real exchange rate trends are an issue
- In emerging and developing countries rapid development in trend growth rates, great ratios, trends in relative prices, in the exchange rate, disinflation...but cyclical dynamics better behaved
- Past growth rates are often poor indicators of future growth rates in the medium term, so a constant steady state won’t do [needs to be a trend process]

Trend-Cycle models (structural or VAR) implemented successfully for Poland, Indonesia, Philippines, Kenya, Uganda, South Africa, Georgia, Armenia...
Are Trends and Cycles Independent?

NO! They are not. They are intrinsically linked.

Yet, oftentimes modeling and forecasting trends and cycles separately is a good approximation.

To model low-frequencies ‘properly’ (wealth effects, etc.), it is the structural/DSGE models that are better equipped to handle it than VARs.

Ironically, DSGE models are often ad-hoc de-trended while VARs are not...
TC-BVAR Estimation

+ **Joint estimation of the parameters and states**

+ **‘Standard’ priors for the BVAR and trends**
  (marginal-independent priors, experiments with B-Lasso/Elastic Net)

+ **System priors for the whole model**
  - stationarity of the VAR component
  - penalty for excessively slow convergence
  - variance of the cyclical component mostly at BC freqs
  - filter frequency-transfer fun properties
  - …
  - ‘spriors’ for shock identification [Andrle, Plasil 2017]

+ **Bayesian computations:**
  (a) Posterior-mode search with a homotopy, followed by RWM, or
  (b) Sequential MC as in Herbst and Schorfheide (2014) [parallel]
Links to the Literature

Builds on:

- ‘structural time-series models’ (Harvey, 1989) and

Previous work using TC-[B]VARs:

Bruha, Pierluigi, Serafini (ECB, 2011) – labor market model
Andrle, Ho, Garcia-Saltos (IMF, 2013) – MP VAR for Poland
Andrle, Bruha (2014) – Learning about MP Using VARs: Some Issues and Solutions

The use of system priors:

Andrle, Benes (2013) [DSGE models], Andrle, Plasil (2016) [tseries, VARs]
U.S. Model
Specification and Results
Simple TC-BVAR (a): The Model

[A] Aggregation:
\[ y_t = \bar{y}_t + \hat{y}_t + u_{y,t} \tag{2} \]
\[ \pi_t = \bar{\pi}_t + \hat{\pi}_t + u_{\pi,t} \tag{3} \]
\[ i_t = \max[\hat{i}_t + \bar{i}_t, i_{\text{floor},t}] + u_{i,t} \tag{4} \]

[B] Cyclical Dynamics:
\[
\begin{bmatrix}
\hat{y}_t \\
\hat{\pi}_t \\
\hat{i}_t
\end{bmatrix}
= A_0 \begin{bmatrix}
\hat{y}_{t-1} \\
\hat{\pi}_{t-1} \\
\hat{i}_{t-1}
\end{bmatrix} + \cdots + A_k \begin{bmatrix}
\hat{y}_{t-k} \\
\hat{\pi}_{t-k} \\
\hat{i}_{t-k}
\end{bmatrix} + C \begin{bmatrix}
e_{\hat{y},t} \\
e_{\hat{\pi},t} \\
e_{\hat{i},t}
\end{bmatrix}
\tag{5}
\]

[C] Trend Component:
\[ \bar{y}_t = \bar{y}_{t-1} + g_t/4 + u_{\bar{y},t} \tag{6} \]
\[ g_t = \rho g g_{t-1} + (1 - \rho g) g_{ss} + u_{g,t} \tag{7} \]
\[ \bar{\pi}_t = \bar{\pi}_{t-1} + u_{\bar{\pi},t} \quad \text{and} \quad E[\pi_{t+j|t}] = \bar{\pi}_t \text{ for } j \to \infty \tag{8} \]
\[ \bar{i}_t = \bar{r}_t + \bar{\pi}_t \tag{9} \]
\[ \bar{r}_t = \rho \bar{r}_{t-1} + (1 - \rho \bar{r}) r_{ss} + u_{\bar{r}} \tag{10} \]
\[ i_{t|t}^N = (1/N) \sum_{i=0}^{N} i_{t+i|t} \quad \text{for } N = 4, 20, 40. \tag{11} \]
Simple TC-BVAR (b): Recursive Forecasts

GDP level (100*log)

Median Inflation (QoQ, ann. %)

Short-Term Interest Rate (%, p.a.)

GDP Growth (QoQ, ann. %)
Simple TC-BVAR (c): Trend and Cycles

Output cycle

Inflation and Output Cycle

Interest Rate (%, p.a.)

Inflation–Output Co–Movement (standardized, phase–shifted)
Simple TC-BVAR (d): Inflation Decomposition

Median Inflation (%, QoQ, annualized)

QoQ Inflation Cycle [with and w/o HiFreq]

YoY Inflation (%) [with and w/o HiFreq]

High Frequency
Simple TC-BVAR (e): Yield Curve

Graph showing the yield curve from 1985:1 to 2010:1, with lines for 3M, 1Y, 5Y, and 10Y, and another graph with lines for TC-VAR and Kim-Wright (2005).
Simple TC-BVAR (f): Quasi Real-Time Output Cycle
Conclusion

TC-VARs offer a great alternative for forecasting and analysis

- Flexible and easy to use
- Separates business cycle and trends when appropriate
- Well-defined long and medium term dynamics
- Less restrictive on data transformation for the VAR
- Competitive forecasting performance
- Forecasting with expert judgment and satellite models on trends going forward is simple
Thank you for your patience...