Regional Output Growth in the United Kingdom: More Timely and Higher Frequency Estimates, 1970-2017

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Background: Frequency and Timeliness

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1. Regional UK GVA data is currently available at annual frequency
2. Want regional data at higher frequency (quarterly)
3. Regional UK GVA data is currently released with long delay (right now only have 2017)
4. Desirable to have quicker estimates
5. Other data is available more frequently and in a more timely fashion
6. GVA for UK as a whole is available quarterly with shorter release delay (right now have 2018Q4)
7. Can we use this higher frequency and more timely data to produce estimates (historical, present and future) of regional GVA growth?

Mixed Frequency Econometrics

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1. Growing interest in econometric models which combine data of different frequencies
2. Intuition: Estimate econometric model using high and low frequency variables
3. Use estimated relationships to "fill in" values for low frequency variables
4. We build on approach of Schorfheide and Song (2015, JBES)
5. Advantage 1: Can predict UK regional GVA at time t+h given data available at time t
6. Useful for forecasting/nowcasting (flash estimates)
7. Advantage 2: Can provide historical estimates (estimate time t given all data up to time T)

MF-VAR: Notation

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1. $t = 1, .., T$ runs at the *quarterly* frequency.
2. $r = 1, .., R$ denotes the R regions in the UK.
3. y_t^{UK} is the quarterly change in GVA in the UK. We observe this.
4. $y_t^{r,A}$ is annual GVA growth in region r. It is observed, but only in quarter 4 of each year.
5. y_t^r is the quarterly change in GVA in region r. It is never observed.
6. y_t is a $n = R + 1$ vector containing quarterly growth rates. The regional ones are not observed.

MF-VAR-SV: Definition

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1. The MF-VAR is a VAR using y_t as the dependent variables:

$$y_t = \Phi_0 + \Phi_1 y_{t-1} + ... + \Phi_p y_{t-p} + u_t \tag{1}$$

2. u_t is i.i.d. $N(0, \Sigma_t)$.
3. Note: it is Σ_t not Σ
4. We allow for multivariate stochastic volatility (SV).
5. Empirically important for density forecasts.
6. Thus we have MF-VAR-SV

MF-VAR-SV: Definition

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1. This VAR contains lots of missing observations: we do not observe quarterly regional growth rates
2. We do observe (every fourth quarter) the annual regional growth rate
3. Relationship between observed annual growth rate to unobserved quarterly growth rate is approximately:

$$y_t^{r,A} = \frac{1}{4}y_t^r + \frac{1}{2}y_{t-1}^r + \frac{3}{4}y_{t-2}^r + y_{t-3}^r + \frac{3}{4}y_{t-4}^r + \frac{1}{2}y_{t-5}^r + \frac{1}{4}y_{t-6}^r \quad (2)$$

4. Call this the inter-temporal restriction
5. We also observe y_t^{UK}

What We Add: Machine Learning Methods

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1. With Big Data often have similar problems
2. E.g. regression with many more predictors than observations
3. Machine learning methods very popular in such cases
4. We take a popular machine learning method: using Dirichlet-Laplace hierarchical prior
5. Automatically sorts through huge numbers of parameters and sets to zero irrelevant ones
6. Big gain in parsimony

What We Add: Cross-Sectional Restriction

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1. We can draw on another source of information based on the fact that UK GVA is the sum of the regions
2. Call this cross-sectional restriction
3. How to incorporate this in the econometric model?
4. Doran, (1992). Constraining Kalman filter and smoothing estimates to satisfy time-varying restrictions. The Review of Economics and Statistics.
5. This is what we add

Econometric Methods: Summary

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1. Our goal is to produce estimates of regional GVA growth y_t^r
2. To do so, our MF-VAR-SV uses information in:
3. Annual regional growth rate $y_t^{r,A}$
4. Quarterly UK growth rate y_t^{UK}
5. The cross-sectional restriction
6. The Dirichlet-Laplace prior
7. It is state space model + machine learning prior estimated using Markov Chain Monte Carlo methods

Data: Time Series Aspects

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1. Nominal and Real GVA growth data from 1967 through 2017
2. Annual for regions and quarterly for UK
3. Two versions of Nominal data: final vintage and real time
4. Real data: final vintage only
5. Regional real data goes back to 1999
6. Prior to 1999 "real" regional data is nominal divided by UK deflator
7. We also use extra UK quarterly variables in the MF-VAR
8. Inflation, interest rates, change in oil prices and exchange rates
9. Largest MF-VAR involves 17 variables

Data: Regional Aspects

1. Data is for NUTS-1 regions
2. Data for NUTS-1 regions goes back to 1995.
3. Statistical regions changed
4. Need to reconcile data prior to 1995 (see Data Appendix)

Historical Estimates of Regional GVA Growth

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1. Nominal GVA growth rates using final vintage data
2. Next figures take quarterly estimates y_t^r and convert to annual growth rates
3. Compare these estimates to actual annual regional growth rate
4. Last quarter each year these two will coincide (inter-temporal restriction)
5. Other quarters can differ
6. Within year variation in regional growth rates reflect UK GVA growth and other quarterly variables
7. Following two figures plot credible intervals to give idea of accuracy of estimates

GVA Growth and Estimates for the UK Regions

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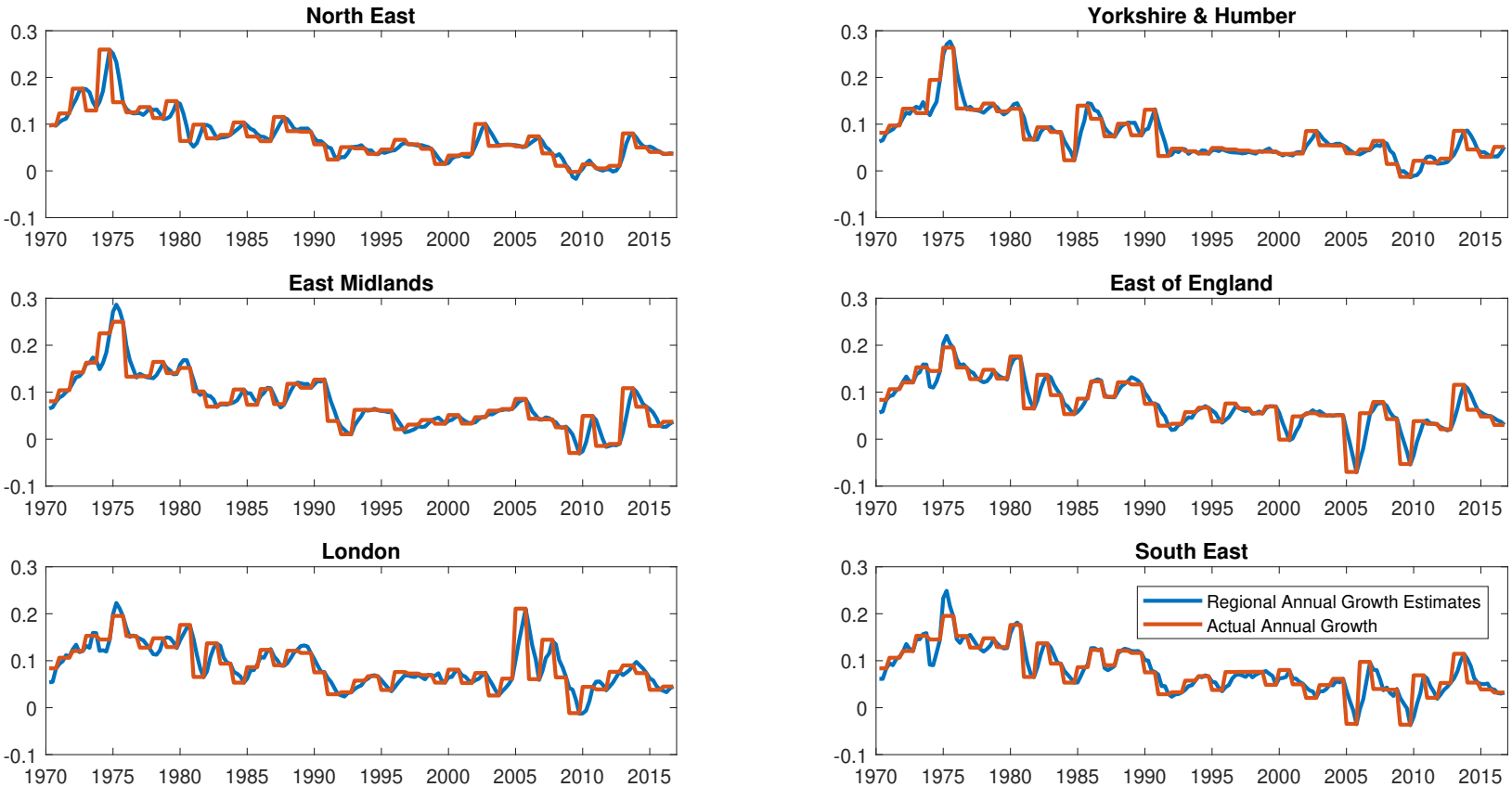
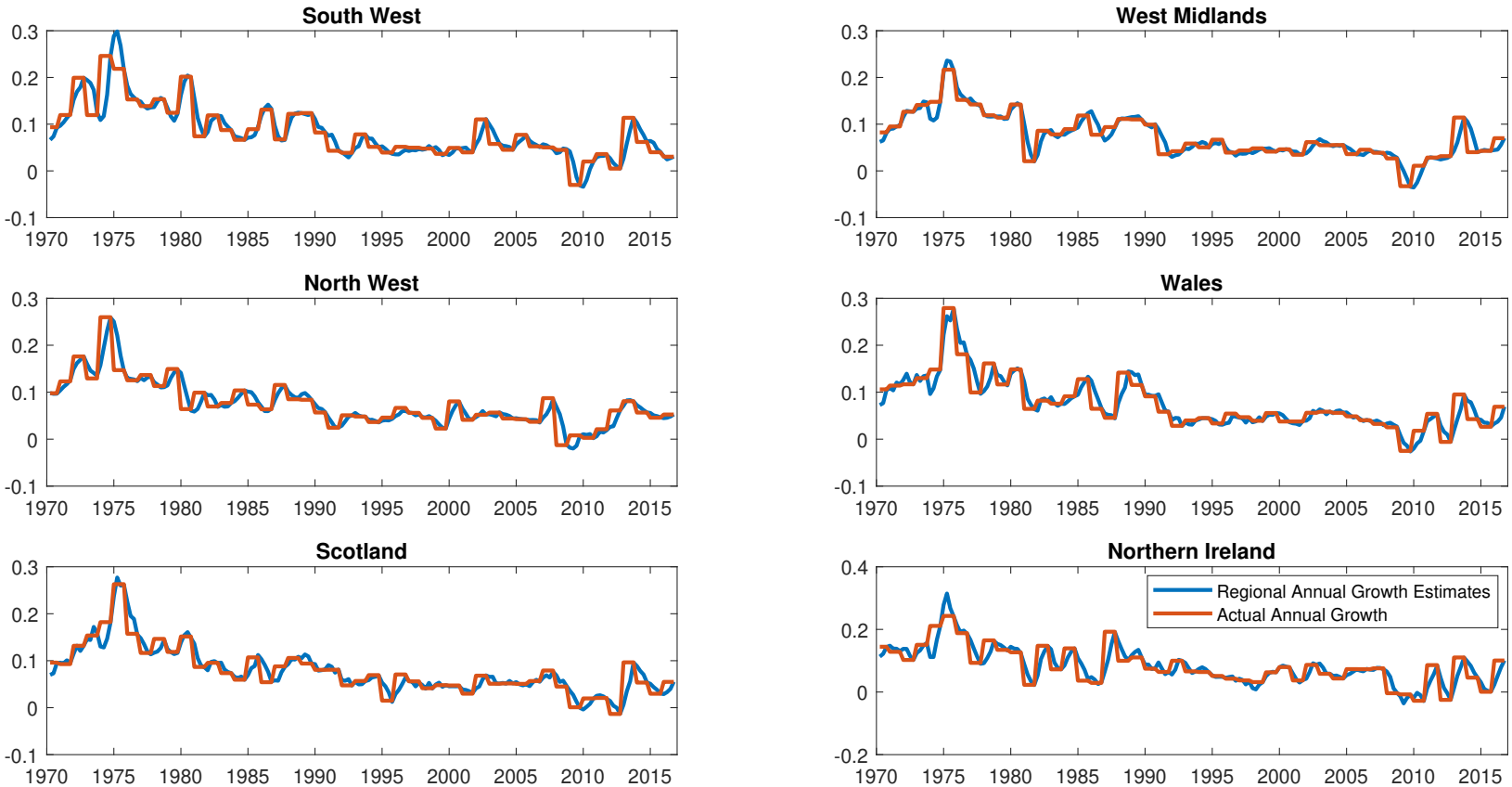
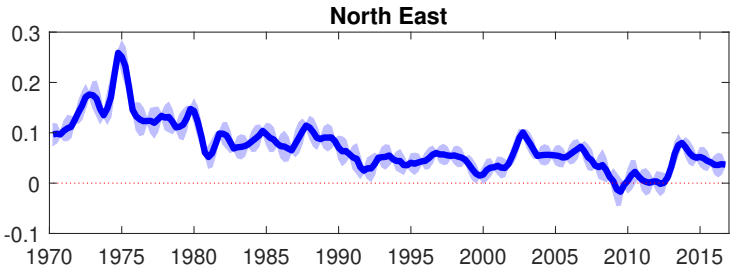
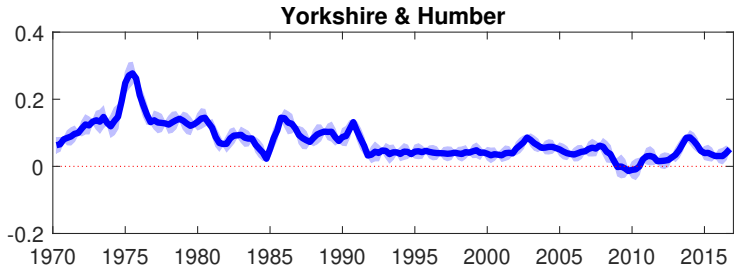


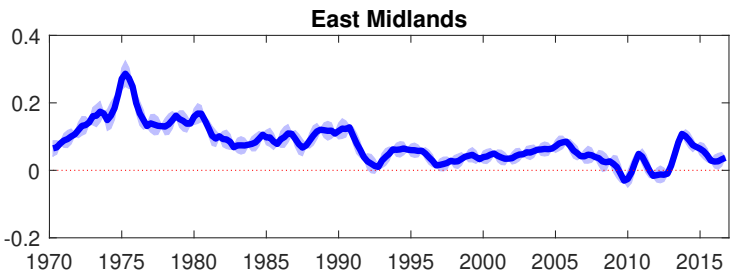
GVA Growth and Estimates for the UK Regions

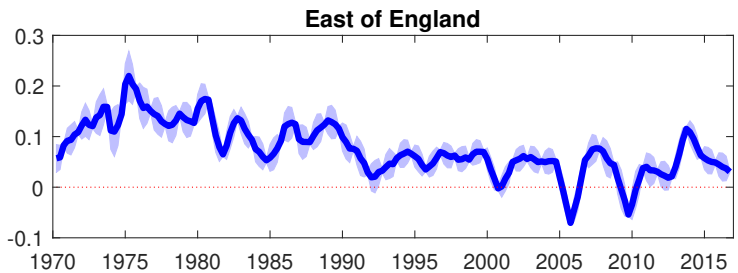


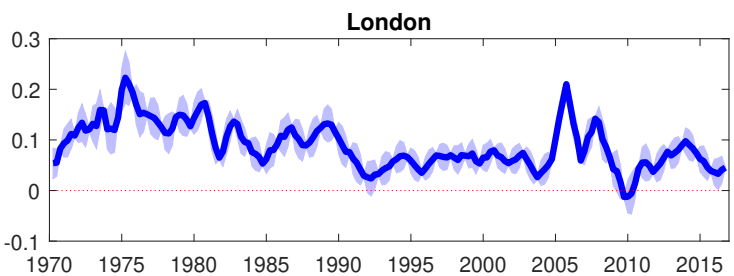
GVA Growth Estimates with Credible Intervals

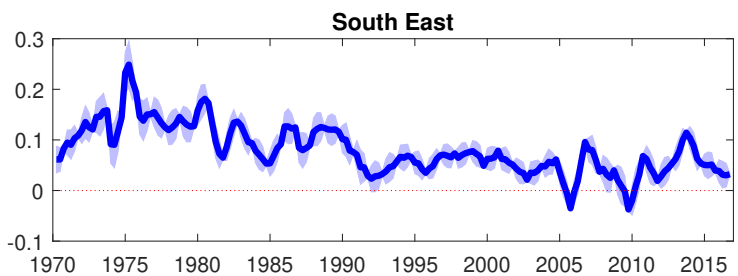












GVA Growth Estimates with Credible Intervals

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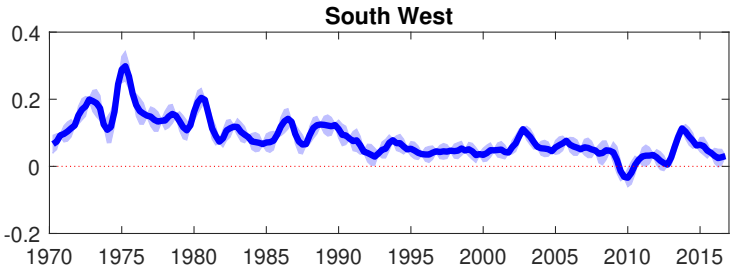

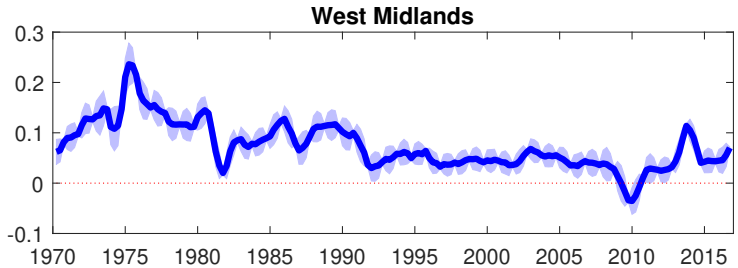

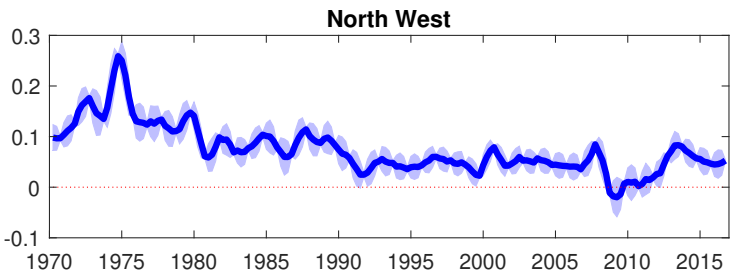

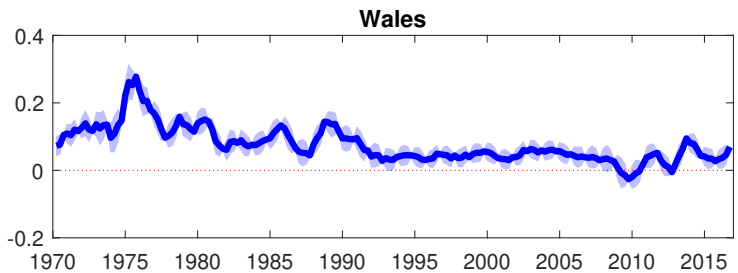

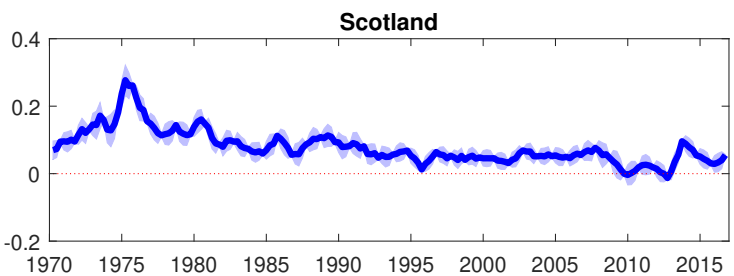

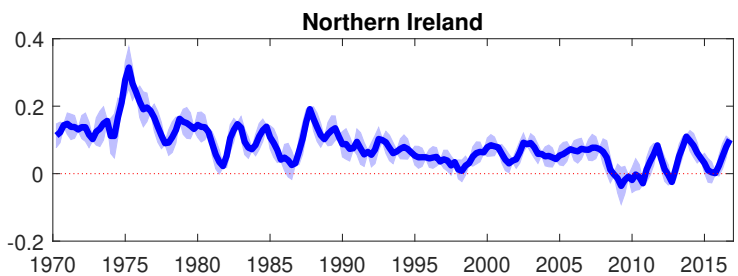

Using the New Data

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1. One goal of research is to provide historical high frequency regional data sets
2. These are available on ESCoE website (updated quarterly)
3. They can be used to address many economic and policy issues where high frequency data is important
4. In paper we use new data to:
5. Investigate high-frequency connectedness of UK regions
6. Investigate regional heterogeneity in recession profiles
7. In interests of time, I will not discuss these

Nowcasts of Quarterly Regional Growth

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1. Another goal of research is to provide timely, high frequency nowcasts of regional data
2. ESCoE website to be updated every quarter (after release of UK GVA) with latest nowcasts
3. Here investigate the performance of our approach in pseudo real time forecasting exercise beginning in 2000
4. This exercise uses real-time Nominal GVA data
5. Forecasts are evaluated using:
6. Root mean squared forecast errors (RMSFEs): evaluate quality of point forecasts
7. Log scores: evaluate quality of density forecasts

Timing of Nowcasts

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1. For any year, τ, we produce 7 different nowcasts
2. Remember: year τ regional data releasaed in Q4 of year $\tau + 1$
3. First nowcast of year τ produced in Q1 of $\tau + 1$ using:
4. Regional data for $\tau - 2$ and UK data for Q3 of $\tau - 1$
5. Second nowcast of year τ produced in Q2 of τ using:
6. Regional data for $\tau - 2$ and UK data through Q4 of $\tau - 1$
7. ...
8. Seventh nowcast of τ produced in Q3 of $\tau + 1$ using:
9. Regional data for $\tau - 1$ and UK data through Q2 of $\tau + 1$
10. Note Q4 of year τ is special: regional data for $\tau - 1$ released

Nowcasting Results

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1. Next two tables presents nowcasting results for each region
2. Substantial improvements in nowcast performance relative to AR benchmark
3. RMSFEs suggest point nowcasts are good
4. Log scores suggest density nowcasts are good
5. Nowcasts for a specific τ improve as new information becomes available
6. In Q4 of year τ improvements particularly noticeable
7. Another test on our methods:
8. Scottish quarterly data available since 1999 and our (model based) estimates match up well

Nowcasts of Quarterly Regional Growth

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Table: Log Scores for Nominal GVA Growth Forecasts, 2000-2016

	N. East	Y. and H.	E. Mid.	E. Eng.	Lond.	S. East	S. West	W. Mid	N. West	Wales	Scot.	N. Ire.
1. Q1 in year τ	1.31	1.37	1.33	1.18	1.07	1.23	1.23	1.28	1.12	1.07	1.16	0.96
2. Q2 in year τ	1.33	1.38	1.36	1.20	1.05	1.23	1.25	1.29	1.13	1.07	1.17	0.97
3. Q3 in year τ	1.33	1.40	1.37	1.22	1.04	1.23	1.26	1.30	1.14	1.09	1.19	0.99
4. Q4 in year τ	1.46	1.52	1.44	1.29	1.16	1.30	1.36	1.38	1.23	1.15	1.25	1.06
5. Q1 in year $\tau+1$	1.47	1.51	1.46	1.30	1.12	1.29	1.36	1.37	1.21	1.15	1.23	1.06
6. Q2 in year $\tau+1$	1.42	1.44	1.37	1.25	1.06	1.21	1.24	1.31	1.20	1.12	1.21	1.05
7. Q3 in year $\tau+1$	1.44	1.47	1.40	1.31	1.09	1.27	1.31	1.35	1.20	1.12	1.21	1.05
AR(1) (Non-informative)	0.56	0.56	0.55	0.52	0.53	0.54	0.54	0.56	0.56	0.55	0.56	0.52

Nowcasts of Quarterly Regional Growth

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Table: RMSFEs for Nominal GVA Growth Forecasts, 2000-2016

	N. East	Y. and H.	E. Mid.	E. Eng.	Lond.	S. East	S. West	W. Mid	N. West	Wales	Scot.	N. Ire.
1. Q1 in year τ	0.067	0.060	0.064	0.070	0.078	0.066	0.069	0.060	0.073	0.071	0.063	0.087
2. Q2 in year τ	0.066	0.059	0.061	0.068	0.080	0.065	0.067	0.059	0.072	0.070	0.061	0.085
3. Q3 in year τ	0.064	0.056	0.059	0.066	0.078	0.065	0.064	0.058	0.069	0.067	0.058	0.080
4. Q4 in year τ	0.051	0.045	0.052	0.057	0.064	0.057	0.053	0.048	0.056	0.057	0.050	0.069
5. Q1 in year $\tau+1$	0.050	0.045	0.050	0.055	0.067	0.058	0.053	0.049	0.059	0.057	0.052	0.069
6. Q2 in year $\tau+1$	0.055	0.052	0.058	0.061	0.075	0.066	0.065	0.056	0.060	0.061	0.055	0.071
7. Q3 in year $\tau+1$	0.053	0.049	0.056	0.055	0.071	0.060	0.059	0.051	0.059	0.061	0.054	0.070
AR(1) (Non-informative)	0.134	0.133	0.136	0.142	0.139	0.137	0.136	0.133	0.133	0.134	0.133	0.140

Summary

1. MF-VAR-SV with Dirichlet-Laplace prior works well for producing quarterly regional estimates of real and nominal GVA
2. Our historical estimates of quarterly regional GVA growth are available on the ESCoE website
3. Each quarter (after release of UK GVA) we update these estimates
4. Nowcasts of high frequency regional GVA growth available on ESCoE website
5. Current work: Extend the model to include high frequency regional data
6. Problems of obtaining long time series of regional data

Future Work: Regional Short Term Indicators

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1. As of 2019 ONS will produce RSTIs
2. Quarterly frequency for English NUTS-1 regions
3. This will lessen interest in our quarterly nowcasts, but our historical estimates still of interest
4. RSTIs released with longer delay than UK data, ours can be released faster
5. Goal: Development of econometric methods for incorporating RSTIs
6. Entropic tilting/conditional forecasting?
7. MF-VAR with frequency mis-match changing over time?
8. Monthly updates?
9. NUTS-2?