Global Vector Autoregression: Application to Input-Output Modelling Framework

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Modelling interconnections between sectors

- Interlinkages in **intermediate** demand are well-captured by Input-Output tables
- There are multiple linkages in **final** demand between:
  - Different components within the same sector
  - Same components of different sectors
  - Different components of different sectors
- These linkages are usually taken into account through:
  - Dependence on common factors, such as in regressions of sectoral consumer spending on disposal income, interest rate or child dependency ratio.
  - Relative prices
- Could Global Vector Autoregression (GVAR) modelling technique bring value added to capturing empirical interdependencies of final demand components within and between sectors?

Components of final demand are highly correlated between sectors

Correlation coefficients between log-differences of sector-specific final demand components in Chinese economy, 1970-2013

Sector code		Household FC										GFCF										Government FC									
		1	106	4	19	103	116	101	117	115	28	88	65	67	74	63	106	101	75	70	64	122	116	117	111	110	114	119	92	118	6
Household FC	1	1.00																													
	106	0.70	1.00																												
	4	0.82	0.72	1.00																											
	19	0.85	0.69	0.96	1.00																										
	103	0.91	0.70	0.94	0.97	1.00																									
	116	0.42	0.73	0.41	0.38	0.49	1.00																								
	101	0.93	0.84	0.79	0.80	0.89	0.70	1.00																							
	117	0.48	0.94	0.50	0.48	0.51	0.84	0.70	1.00																						
	115	0.50	0.95	0.54	0.49	0.52	0.83	0.72	0.99	1.00																					
	28	0.97	0.61	0.76	0.85	0.89	0.31	0.87	0.39	0.39	1.00																				
GFCF	88	0.87	0.84	0.75	0.80	0.80	0.39	0.84	0.66	0.67	0.86	1.00																			
	65	0.88	0.57	0.82	0.91	0.93	0.34	0.81	0.37	0.37	0.92	0.82	1.00																		
	67	0.87	0.87	0.81	0.87	0.86	0.51	0.88	0.71	0.72	0.86	0.98	0.87	1.00																	
	74	0.70	0.90	0.76	0.79	0.77	0.61	0.80	0.80	0.82	0.68	0.87	0.75	0.93	1.00																
	63	0.86	0.82	0.81	0.85	0.91	0.67	0.91	0.71	0.70	0.84	0.86	0.88	0.93	0.87	1.00															
	106	0.45	0.85	0.76	0.68	0.64	0.64	0.59	0.81	0.83	0.35	0.61	0.46	0.70	0.82	0.71	1.00														
	101	0.85	0.84	0.79	0.79	0.86	0.74	0.95	0.72	0.76	0.79	0.83	0.82	0.90	0.86	0.94	0.70	1.00													
	75	0.69	0.91	0.76	0.78	0.75	0.62	0.78	0.82	0.83	0.65	0.86	0.73	0.92	0.99	0.87	0.84	0.84	1.00												
	70	0.87	0.85	0.78	0.85	0.85	0.51	0.88	0.69	0.70	0.87	0.97	0.88	1.00	0.93	0.93	0.67	0.90	0.91	1.00											
	64	0.88	0.51	0.66	0.79	0.84	0.33	0.80	0.33	0.32	0.93	0.81	0.96	0.84	0.67	0.84	0.29	0.78	0.64	0.86	1.00										
Government FC	122	0.62	0.72	0.73	0.71	0.67	0.38	0.68	0.53	0.60	0.57	0.75	0.67	0.78	0.77	0.66	0.68	0.77	0.75	0.77	0.56	1.00									
	116	0.35	0.60	0.32	0.31	0.42	0.87	0.61	0.67	0.68	0.28	0.36	0.37	0.47	0.54	0.62	0.53	0.72	0.52	0.49	0.37	0.55	1.00								
	117	0.37	0.79	0.45	0.45	0.45	0.71	0.61	0.80	0.83	0.32	0.59	0.43	0.67	0.76	0.62	0.73	0.73	0.75	0.67	0.37	0.80	0.83	1.00							
	111	0.34	0.59	0.40	0.40	0.48	0.84	0.61	0.64	0.66	0.28	0.36	0.43	0.49	0.58	0.62	0.58	0.74	0.56	0.50	0.39	0.62	0.97	0.86	1.00						
	110	0.33	0.55	0.33	0.28	0.41	0.85	0.59	0.61	0.62	0.24	0.29	0.35	0.41	0.50	0.59	0.51	0.69	0.49	0.43	0.34	0.51	0.95	0.73	0.91	1.00					
	114	0.64	0.57	0.72	0.73	0.68	0.19	0.62	0.33	0.40	0.62	0.72	0.73	0.74	0.68	0.61	0.54	0.69	0.65	0.74	0.63	0.97	0.41	0.66	0.50	0.35	1.00				
	119	0.56	0.24	0.64	0.70	0.62	-0.18	0.41	-0.05	0.01	0.62	0.58	0.74	0.58	0.45	0.43	0.26	0.44	0.41	0.58	0.64	0.75	0.05	0.29	0.17	0.02	0.89	1.00			
	92	0.55	0.59	0.63	0.65	0.67	0.54	0.67	0.46	0.51	0.52	0.57	0.70	0.68	0.69	0.68	0.58	0.79	0.65	0.68	0.62	0.89	0.77	0.82	0.84	0.73	0.86	0.66	1.00		
	118	0.36	0.81	0.42	0.42	0.43	0.76	0.61	0.84	0.87	0.30	0.59	0.39	0.66	0.76	0.62	0.73	0.72	0.75	0.66	0.35	0.76	0.84	0.99	0.86	0.74	0.60	0.21	0.77	1.00	
	6	0.61	0.45	0.69	0.71	0.70	0.26	0.62	0.23	0.30	0.61	0.60	0.76	0.66	0.59	0.62	0.45	0.71	0.55	0.67	0.67	0.89	0.53	0.63	0.63	0.48	0.95	0.86	0.93	0.56	1.00

Data source: Eora MRIO Database

GVAR: relatively noval but robust and well-developed modelling technique

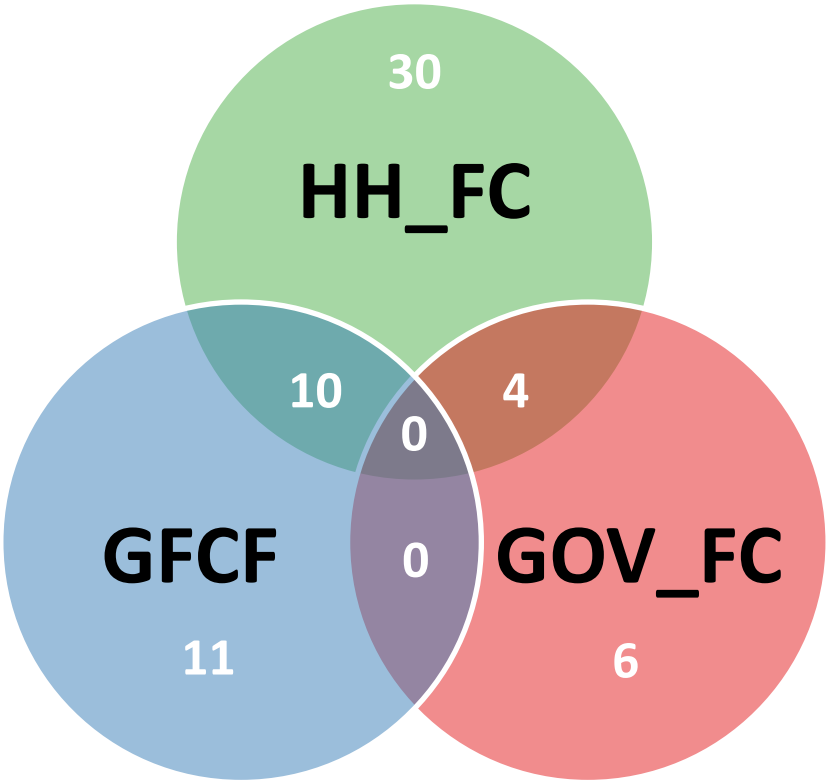
- GVAR is used to model country-level macro variables (GDP, inflation, interest rates, exchange rate, stock market indices, credit, etc.) in a global framework
  - International transmission of shocks to macro-level variables through trade and financial channels
  - Business cycle synchronization, contagion during the Asian financial crisis
  - Cross-country spillover effect of monetary and fiscal policy actions
  - Global commodity markets (crude oil, wheat)
- Sectoral applications
  - Sectoral output (Konstantakis and Michaelides (2014))
  - Labour market (employment, real compensation, productivity, etc.)
  - Housing market

GVAR has simple but rich structure

- GVAR model combines individual sector-specific VARX models
- Dealing with the “curse of dimensionality”. Shocks between sectors are transmitted via “foreign” variables constructed as weighted averages of other sectors’ domestic variables
- GVAR takes into account:
  - Time-series and cross-sectional interrelations between sectors. For instance, household final consumption of sector i is allowed to depend on:
    - its own lagged values
    - contemporaneous and lagged values of other final demand components within that sector
    - contemporaneous and lagged values of household final consumption and other final demand components of other sectors
    - common variables (households’ disposable income, oil price, etc.)
  - Long-run cointegration relations and short-term dynamics
- GVAR is estimated in error-correction representation (VECM)
- GVAR Toolbox (Smith, L.V. and A. Galesi (2014))

Model under development: Sector level GVAR model for China

Inclusion of domestic variables in sector-specific models



- Eora MRIO Database (http://www.worldmrio.com/), annual data from 1970 to 2013, basic prices
- Domestic variables: Household final consumption (HH_FC), Government final consumption (GOV_FC), Gross fixed capital formation (GFCF)
- 61 out of 122 sectors (filtering criteria: > $10 bln. in 2013) and total 75 variables

Weight matrix selection

- Foreign variables for each sector are constructed from domestic variables of other sectors using time-varying weight matrix W_t. Each element w_t^{ji} represents weight of domestic variable of sector j for construction of foreign variable for sector i

$$Var_{it}^{*} = \sum_{j=1, j\neq i}^{N} \left(Var_{jt} * w_t^{ji} \right)$$

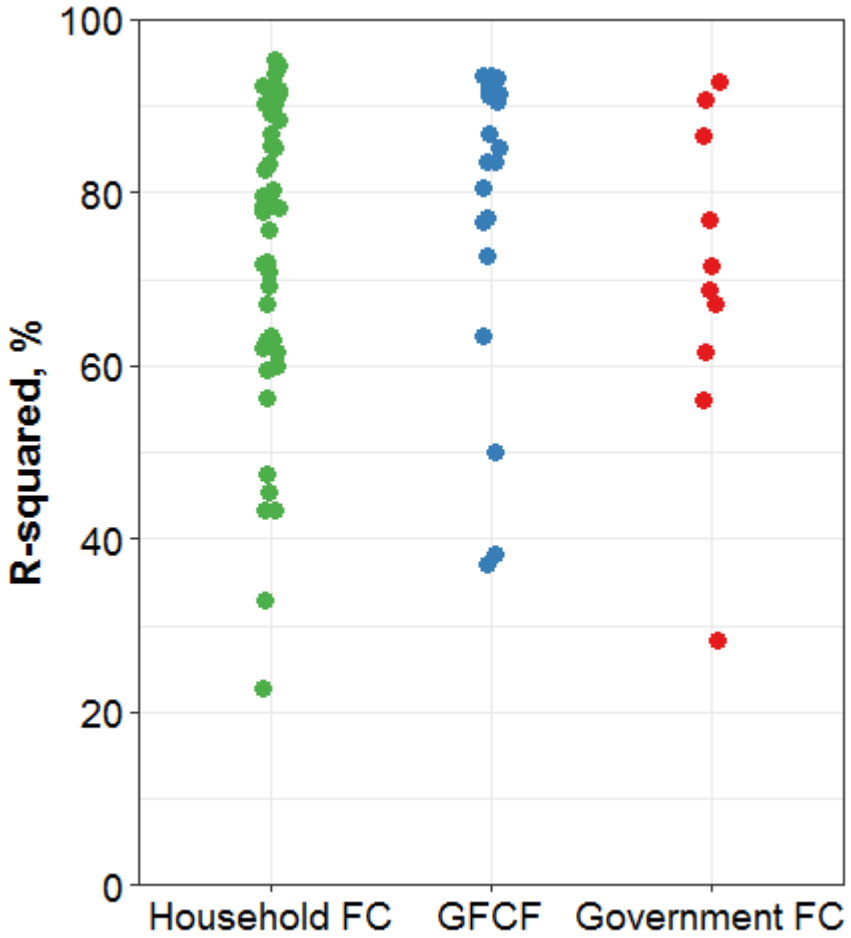
- Weight of sector j for sector i is calculated as its share in intermediate demand for product of sector i

$$w_t^{ji} = \frac{a_t^{ij}}{\sum_{k=1, k\neq i}^{N} a_t^{ik}}$$

- Weights are then averaged over 5-year rolling window

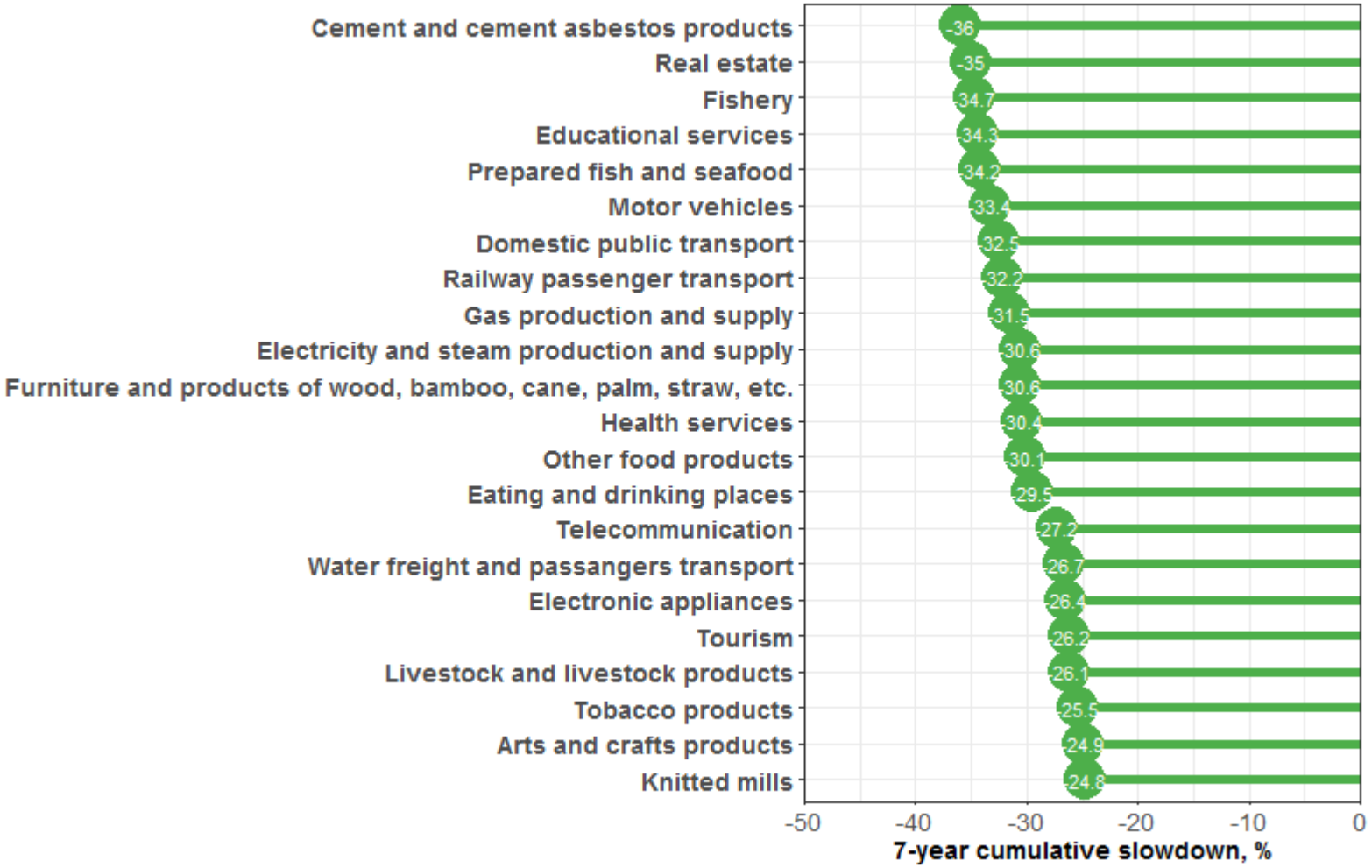
Formal tests

Distribution of R-squared coefficients for individual equations



- R-squared coefficients:
  - Out of total 75 VECM equations in log-differences:
    - 65 eq. R-squared more than 50%
    - 36 eq. R-squared more than 80%
- 10 cointegrating relationships
- Model satisfies stability conditions
  - All eigenvalues lie on or inside the unit circle
  - Persistent profiles declining

Cumulative impact of slowdown of household FC in “Real Estate” sector cumulative 35% over 7-year period on **Household FC** in other sectors (preliminary results)



Preliminary conclusions

- GVAR model is capable of estimating and forecasting relationships between sectoral final demand components with subsequent integration to an IO model
- Main advantage of integrating GVAR into IO model is that it largely expands abilities to perform scenario-based modelling. One can explicitly set any combination of shocks to final demand components of different sector and see what would be the cumulative response of all other variables
- Issues that need to be resolved in future work:
  - Data limitations. Estimation of coefficients related to contemporaneous and lagged values of domestic and “foreign” variables, as well as long-run cointegrating relationships and short-run dynamics requires data points. GVAR-models more suited to quarterly or monthly data
  - Model could benefit from inclusion relative price as a domestic variable and disposable income as a common variable, but possibly at a price of excluding GFCF and Government FC
  - Which weight matrix could best suit the model remains an open question. GVAR allows each variable to have a separate weight matrix. Using a matrix based on historical correlations for Household FC along with an IO based matrix for GFCF looks promissing

Thank you for your attention!