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Structural interconnectedness of regional inflationary processes: case of Russia

Spatial studies are mainly conducted to estimate spillover (indirect) effects that raised from interconnectedness of spatially distributed units (regions, economies): a shock occurred in one unit's economy impacts other units' economies and vice versa. The main set of tools to study such indirect effects are spatial econometrics models [1].

In the spatial econometrics approach, one estimates spatial weights (the metric of spatial interconnectedness among two spatially distributed units) based on its exogenous carcasses, i.e. on spatial weights matrixes, that determine the strength of relations among spatially distributed processes (in this work's case – regional inflations) in the following way: typically, the closer regions to each other, the greater their interconnectedness. The advantage of this approach is that it's logically coherent and tractable, it's relatively simple and resilient in the spatial weights design. The disadvantage is that it relies too much on exogenous (to model) variables: in the end, the task is to find out which spatial weights matrix (i.e. an exogenous substance) has more explanatory power among others exogenous substance [2].

Keep in mind the merits of spatial econometrics, I do in a different matter and pose no exogenous restrictions on spatial weights (i.e. do not use exogenous spatial weights) except those that arise from that underline theoretical model that is built in this work [2]. Therefore, theory (in the form of model that structures interconnectedness of regional inflationary processes in Russian economy) comes first in this research. To sum up, there are two goals of this work. First one, is to estimate unrestricted ('*structural*') spatial weights in the frame of developed methodology. Second one, is to compare explanatory power of structural weights versus exogenous weights (spatial econometrics style model) in the task to predict inflation in Russian regions.

The summary of developed in this work setup is the following econometric model of inflation in a spatial unit (region) ***i***:

$$\log\left(1+\Pi_i^{t-s}\right) = a_i * \log(1+\mathrm{M}^{t-s}) + \sum_{\substack{j=1\\ j\neq i}}^{N} b_{ij}\log\left(1+\Pi_j^{t-s}\right) + \xi_i^{t-s} \tag{1}$$

where $\boldsymbol{t}$ and $\boldsymbol{s}$ (such that $s<t$) are two time points, Π_i^{t-s} is the pace of inflation in the region $\boldsymbol{i}$ occurred from time point $\boldsymbol{s}$ to time point $\boldsymbol{t}$, M^{t-s} is the growth of monetary aggregate M2 occurred from time point $\boldsymbol{s}$ to time point $\boldsymbol{t}$, $\xi_i^{t-s} \sim N(0,(t-s)\sigma^2)$ – random component of the model, a_i and b_{ij} are positive scalars of the model to be estimated.

The challenger model (2) is formulated in the spirit of spatial econometrics approach:

$$\log\left(1+\Pi_i^{t-s}\right) = c_i * \log(1+\mathrm{M}^{t-s}) + \rho_i \sum_{\substack{j=1\\ j\neq i}}^{N} w_{ij}\log\left(1+\Pi_j^{t-s}\right) + \xi_i^{t-s} \tag{2}$$

where w_{ij} are exogenous spatial weights and the rest of the model is the same as in (1).

The model (1) is estimated with method of moments based on monthly data on general (all goods and services) and food CPI of seven Russian Federal districts[1]. The model (2) is estimated with MLE on the same data. Time span for both models is from January 2022 to October 2024 [4]. The moments to estimate model (1) parameters are designed to exact identification.

A standard setup cross-validation procedure is conducted to test which model has more predictive power. That is, the models are estimated on the train sets of data while their explanatory powers measured on test sets. The measure of explanatory power is RMSE.

Preliminary results suggest that model (1) with '*structural*' spatial weights has higher explanatory power in terms of RMSE. That is, the empirical distribution of RMSE of model (1) (constructed with cross-validation results) has empirical mean of 1,03% and empirical standard deviation of about 0.38%. In contrast the same characteristics of model (2) performance are 2.1% and 0.47% respectively.

Interesting result of this study is that if final estimates of models (1) and (2) are set as averages of all estimates among cross-validations folds then the estimates of spillover effects of these two models are relatively comparable.

References:

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[1] In this study we combine Caucasian FD and Uzhniy FD into one territory.