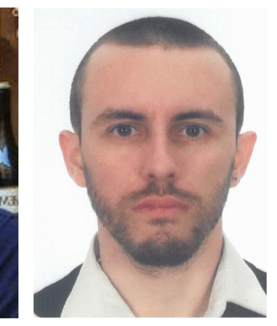
A Spatial-Filtering Zero-Inflated Approach to the Estimation of the Gravity Model of Trade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MOTIVATION /CONTRIBUTIONS

Eigenvector **spatial filtering** (SF) variants of the **Poisson/NegBin** specification have been proposed in the literature of gravity of trade to accommodate spatial autocorrelation.

Two contributions:

1) We employ a **stepwise selection criterion applied to spatial filters only**. This is based on **robust** (sandwich) **p-values** and does not require likelihood-based indicators.

2) We use the selected spatial filters to properly account for **importer- and exporter-side specific spatial effects**, and differently for the count and logit parts of zero-inflated Poisson and negative binomial models.

Where we stand

Linear spatial econometric models (Baltagi et al. 2007; Fischer and Griffith 2008; LeSage and Pace 2008; Behrens et al. 2012; Koch and LeSage 2015): these models apply and adapt traditional (linear) spatial econometric techniques to the count data case.

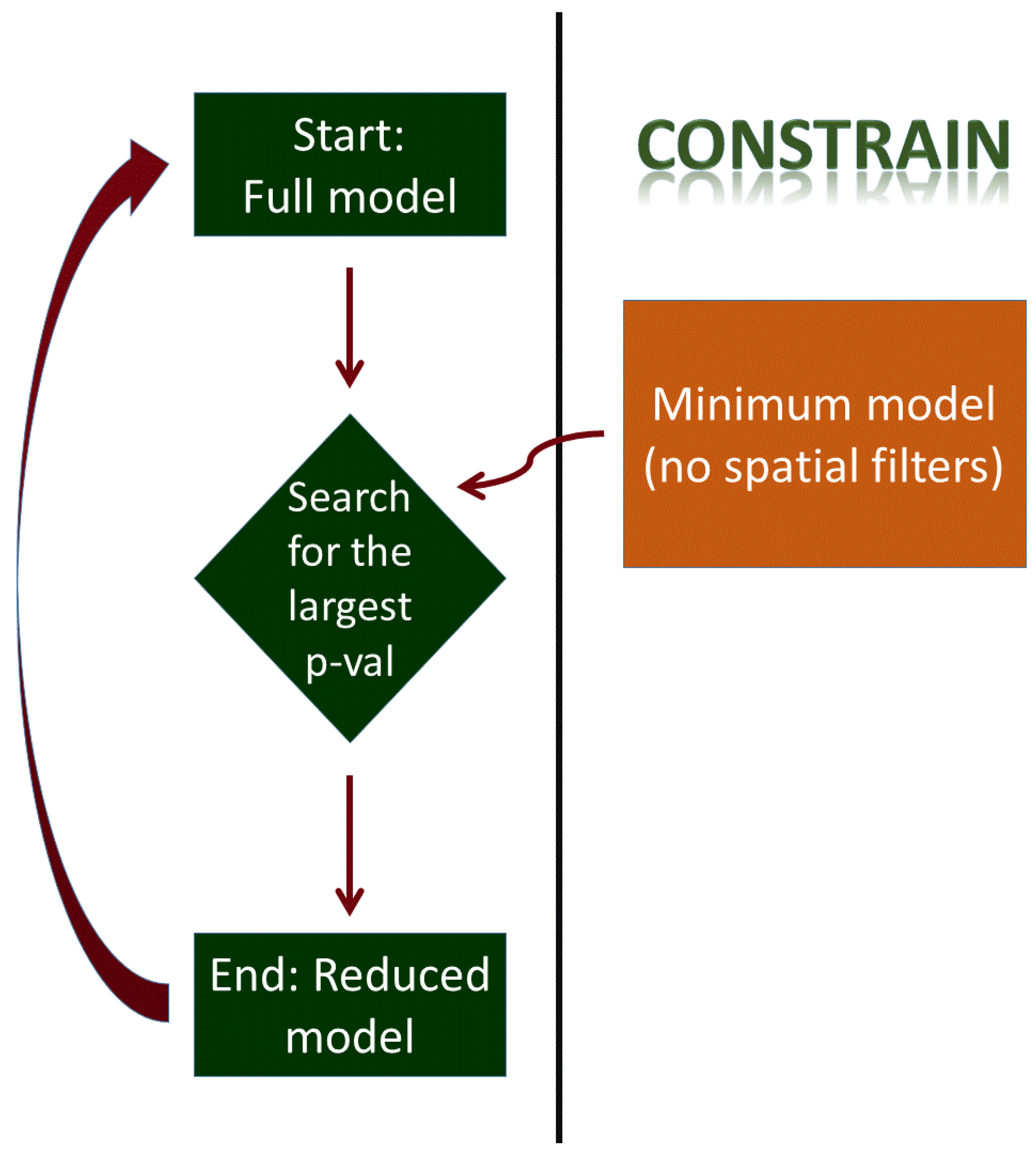
Spatial generalized linear models (Lambert et al. 2010; Sellner et al. 2013): these models extend the previous approaches by allowing for estimation based on Poisson-type models, therefore accommodating the concerns expressed in Santos Silva and Tenreyro (2006).

—> **Non-parametric (ESF) models** (Chun 2008; Fischer and Griffith 2008; Scherngell and Lata 2013; Krisztin and Fischer 2015; Patuelli et al. 2016): these models take a non-parametric approach, by employing ESF within Poisson -type models.

Method

SF consists on decomposing a spatial weight matrix **W** to extract independent eigenvectors. When including these eigenvectors as additional origin- and destination-specific regressors, the model can be estimated by standard regression techniques, such as OLS or Poisson methods.

The workhorse for SF decomposition is a transformation procedure based upon eigenvector extraction from the matrix $(\mathbf{I} - \mathbf{1}\mathbf{1}^{T}/n)\,\mathbf{W}\,(\mathbf{I} - \mathbf{1}\mathbf{1}^{T}/n)$, where **W** is a generic n x n spatial weights matrix; **I** is an n x n Identity matrix; and **1** is an n x 1 vector containing 1s. Stepwise regression can be used to select only relevant eigevectors.



Empirical application

- We use a standard specification of the gravity model of bilateral trade employing common explanatory variables, over a cross-section for the year 2000, with **64 countries** and **4032 observations.**
- Trade data compiled on the basis of COMTRADE data by Feenstra et al. (2005). GDP from the World Bank's WDI database. Distance, language, colonial history, landlocked countries, and land area data are from the CEPII institute. Free trade agreement (FTA) data have been determined on the basis of OECD data about major regional integration agreements.
- We estimate zero-inflated Poisson and negative binomial models, allowing origin- and destination-specific spatial filters for the logit and count parts.
- A modified stepwise algorithm is used for selection of eigenvectors, allowing to independently remove eigenvectors from the logit or count parts.

Estimations results

	ZINB ESF	ZINB	NB ESF
First Step			
Distance	−1.18***	0.35**	–
Contiguity	1.85*	0.24*	–
Free trade agreements	−0.86	−1.71**	–
GDP importer	−5.25***	−0.11	–
GDP exporter	−2.82***	−1.35***	–
Eigenvectors (exp)	11	–	–
Eigenvectors (imp)	24	–	–
Second Step			
Distance	−0.84***	−0.65***	−0.71***
Contiguity	0.54***	0.71***	0.66***
Free trade agreements	0.48***	0.66***	0.77***
GDP importer	1.06***	1.10***	1.00***
GDP exporter	0.63***	0.75***	0.81***
Eigenvectors (exp)	11	–	8
Eigenvectors (imp)	8	–	12
Theta	0.86	0.73	0.59
AIC	47026	48370	48414
Log-likelihood	2.32e+04	2.42e+04	2.42e+04
McFadden's pseudo-R^2	0.131	0.102	0.102
Observations	4032	4032	4032

Predictions of small flows

Trade flow	0	1	2	3	4	5	6	7	8	9
Observed	484	136	112	76	64	39	42	49	35	29
ZINB ESF	440	88	75	66	59	54	50	46	43	40
ZINB	474	86	71	62	55	50	47	43	41	38
NB ESF	281	156	117	95	82	72	64	58	53	49

Main finding

Proposed specification **outperforms the benchmark models** (ZINB and NB with spatial filters) in terms of: (i) **model fitting**, both considering **AIC** and **log-likelihood**, and (ii) in **predicting zero (and small) flows.**