

Marquette University
e-Publications@Marquette

Economics Faculty Research and Publications

Economics, Department of

11-1-2010

A Spatial Analysis of Aggregate and Industry-Level FDI in China

Shalendra Sharma
University of San Francisco

Miao Grace Wang
Marquette University, grace.wang@marquette.edu

M. C. Sunny Wong
University of San Francisco

Published version. *A Spatial Analysis of Aggregate and Industry-Level FDI in China*. Presented at the Southern Economic Association 2010 Conference. Atlanta, Georgia, November 2010. Conference Presentation. Used with permission.

A Spatial Analysis of Aggregate and Industry-Level FDI in China

Shalendra Sharma, *University of San Francisco*

Miao Wang, *Marquette University*

M. C. Sunny Wong, *University of San Francisco*

November 2010



Motivations

- Most FDI is received by developed countries (DCs) while the share of FDI in less developed countries (LDCs) is increasing.
- Among all LDCs, China is the largest FDI recipient.
- Moving to a multilateral framework from the traditional bilateral framework using spatial econometric techniques.



Our study

- Would FDI in one province be substitute or complement to those FDI in other provinces?
- Spatial Analysis: Spatial Autoregression Model
 - We investigate the interdependence of FDI in different provinces in China
- Both aggregate and industry-level of FDI in China between 1999 and 2007
 - Aggregate Level: 31 Provinces, 1999-2007
 - Industry Level: 31 Provinces, 2001-2006



Results

- Strong spatial interdependence among provinces in China in terms of their receiving FDI
 - Provincial Level: Neighboring provinces tend to become competitors for FDI
 - Industry Level: Stronger evidence for vertical or complex vertical FDI

Previous Literature

- Horizontal FDI (Markusen 1984)
 - Avoid trade costs, Access to foreign markets
- Vertical FDI (Helpman 1984)
 - Differences in factor prices (cost advantages)
- Knowledge-Capital Model (Markusen and Maskus 2001, 2002)
 - Horizontal + Vertical FDI



Previous Literature

- Spatial Analysis is a more systematic and flexible approach to test the relevance of the “third country” effect
 - Baltagi *et al.* (2007, 2008), Blonigen *et al.* (2007), Coughlin and Segev (2000), and Garretsen and Peeters (2009), and Ledyeva (2009).

Model

- $FDI_{it} = \beta_0 + \beta_1 HostVariables_{it} + \beta_2 SurroundingMktPotential_t + \rho \cdot W \cdot FDI_t + \varepsilon_{it}$
- where i and t are province and year subscripts
- FDI: inward FDI received by province i in year t
- *Host variables* represent characteristics of host province, including gross provincial product (GPP), provincial population, labor cost, labor quality, infrastructure, policy package, coastal dummies.
- Surrounding market potential: weighted average of GPP of all $k \neq i$ province
- $W \cdot FDI$ is the “spatial lag” term: weighted average of FDI received by all $k \neq i$ province, with W as the weight matrix.

$$FDI_{ijt} = \beta_0 + \beta_1 HostVariables_{it} + \beta_2 SurroundingMktPotential_t + \rho \cdot W \cdot FDI_{jt} + \varepsilon_{ijt}$$

- Where i, j, t are province, industry and year subscripts

Construction of Weight Matrix

- Provinces 1, 2, and 3; over two years, 1983 and 1984.

- $$W_{1983} = \begin{bmatrix} 0 & w_{1983}(d_{12}) & w_{1983}(d_{13}) \\ w_{1983}(d_{21}) & 0 & w_{1983}(d_{23}) \\ w_{1983}(d_{31}) & w_{1983}(d_{32}) & 0 \end{bmatrix}$$

- $$W_{1984} = \begin{bmatrix} 0 & w_{1984}(d_{12}) & w_{1984}(d_{13}) \\ w_{1984}(d_{21}) & 0 & w_{1984}(d_{23}) \\ w_{1984}(d_{31}) & w_{1984}(d_{32}) & 0 \end{bmatrix}$$

- $W_{1983} = W_{1984}$ since distance is time-invariant

- $$W = \begin{bmatrix} W_{1983} & 0 \\ 0 & W_{1984} \end{bmatrix}$$

Model

$$FDI_{it} = \beta_0 + \beta_1 HostVariables_{it} + \beta_2 Surrounding$$

$$MarketPotential + \rho \times W \times FDI_t + \varepsilon_{it}$$

| Motives of FDI | Sign of spatial lag | Sign of surrounding market potential |
|-------------------------|---------------------|--------------------------------------|
| Horizontal | 0 | 0 |
| Vertical | - | 0 |
| Regional Trade Platform | - | + |
| Complex Vertical | + | 0/+ |



Model

- Sample: FDI in 31 provinces, autonomous regions, and municipalities in China over the period of 1999-2007 (aggregate provincial FDI) and 2001-2006 (industry-level FDI in different provinces)
- Data are from different issues of China Statistical Yearbook and China Industry Economy Statistics Yearbook

Table 3. Provincial FDI Regressions – Ordinary Least Squares and Spatial Estimations

| | Ordinary Least Squares | | | | Spatial Autoregression | | |
|------------------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|------------------------|
| | 3.1 | 3.2 | 3.3 | 3.4 | 3.5 | 3.6 | 3.7 |
| Population | -1.61149*** [0.147] | -1.68101*** [0.136] | -0.98504*** [0.155] | -0.74214*** [0.169] | -1.76985*** [0.138] | -1.07344*** [0.155] | -0.82033*** [0.171] |
| Wage | -0.92236*** [0.195] | -1.15398*** [0.219] | -1.44832*** [0.169] | -1.24717*** [0.166] | -1.16761*** [0.213] | -1.45976*** [0.164] | -1.26406*** [0.161] |
| Labor Quality | -0.24358 [0.250] | -0.25268 [0.254] | 1.09418*** [0.266] | 0.97836*** [0.259] | -0.24738 [0.246] | 1.09210*** [0.260] | 0.98138*** [0.254] |
| Infrastructure | 0.15402*** [0.054] | 0.09525* [0.056] | 0.06932* [0.037] | 0.03473 [0.034] | 0.08306 [0.056] | 0.05783 [0.038] | 0.0272 [0.034] |
| GPP | 2.40544*** [0.137] | 2.43820*** [0.126] | 1.43279*** [0.159] | 1.27725*** [0.168] | 2.53213*** [0.132] | 1.52767*** [0.160] | 1.35697*** [0.171] |
| Surrounding Market Potential | | 0.30382 [0.186] | 0.70166*** [0.143] | 0.69433*** [0.132] | 0.51312** [0.211] | 0.89913*** [0.160] | 0.84762*** [0.145] |
| Policy | | | 0.28485*** [0.026] | 0.20229*** [0.029] | | 0.28334*** [0.025] | 0.20441*** [0.029] |
| Coastal Dummy | | | | 0.58729*** [0.126] | | | 0.56385*** [0.125] |
| W _X FDI | | | | | -0.29751** [0.142] | -0.28368** [0.126] | -0.21979* [0.120] |
| Constant | 4.71328** [2.144] | 6.13819*** [2.190] | 10.36602*** [1.700] | 7.93482*** [1.680] | 6.52040*** [2.116] | 10.70808*** [1.657] | 8.29689*** [1.637] |
| Observations | 279 | 279 | 279 | 279 | 279 | 279 | 279 |
| R-squared / Variance Ratio | 0.81640 | 0.8197 | 0.8732 | 0.8824 | 0.821 | 0.875 | 0.883 |
| Robust standard errors in brackets | | | | | | | |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | | | | |

- 
- Surrounding Market Potential = Positive
 - Spatial Lag of FDI = Negative
 - Implication:
 - A dominant regional trade platform motivation for MNCs in China
 - MNCs choose one province as the host province and products produced in this host province will be sold to other surrounding provinces

Table 4. Spatial FDI Regressions by Factor Intensity

| | Labor Intensive Industry | | Capital Intensive Industry | | Human Capital Intensive Industry | |
|------------------------------------|--------------------------|------------------------|----------------------------|-----------------------|----------------------------------|------------------------|
| | 4.1 | 4.2 | 4.3 | 4.4 | 4.5 | 4.6 |
| Population | -1.60766*** [0.195] | -0.41190*** [0.157] | -0.62471*** [0.183] | 0.34268** [0.156] | -1.35511*** [0.286] | -0.19293 [0.190] |
| Wage | -0.37646 [0.244] | -0.60980*** [0.190] | 0.49733* [0.266] | 0.07645 [0.210] | 0.21487 [0.348] | -0.44622** [0.211] |
| Labor Quality | -0.24977 [0.296] | 1.19368*** [0.227] | 1.16130*** [0.357] | 2.75029*** [0.308] | 1.09124*** [0.375] | 3.37015*** [0.262] |
| Infrastructure | 0.05396 [0.069] | -0.06460** [0.033] | 0.22012*** [0.078] | 0.13715*** [0.040] | 0.0505 [0.088] | -0.07188* [0.039] |
| GPP | 2.40087*** [0.177] | 0.99242*** [0.149] | 1.29598*** [0.169] | 0.02793 [0.156] | 2.19838*** [0.268] | 0.60676*** [0.192] |
| Surrounding Market Potential | -0.16947 [0.224] | 0.21533 [0.137] | 0.36663 [0.247] | 0.74570*** [0.194] | 0.65700** [0.264] | 1.42360*** [0.151] |
| Policy | | 0.18016*** [0.025] | | 0.26229*** [0.025] | | 0.38466*** [0.032] |
| Coastal Dummy | | 1.06073*** [0.113] | | 0.47126*** [0.137] | | 0.48173*** [0.144] |
| W x FDI | 0.22668 [0.168] | 0.29046** [0.125] | -0.45818** [0.208] | -0.36147** [0.181] | -0.52962** [0.229] | -0.74811*** [0.185] |
| Constant | -0.62674 [2.581] | 2.81133 [2.017] | -8.10956*** [2.981] | -2.38867 [2.411] | -7.03716** [3.529] | 1.75969 [2.312] |
| Observations | 186 | 186 | 186 | 186 | 186 | 186 |
| Variance Ratio | 0.808 | 0.911 | 0.788 | 0.876 | 0.807 | 0.916 |
| Robust standard errors in brackets | | | | | | |
| *** p<0.01, ** p<0.05, * p<0.1 | | | | | | |


- 
- Labor Intensive Industry
 - SMP = insignificant, Spatial Lag = Positive
 - Implication: Complex Vertical
 - Vertical chain of production across different provinces to take advantage of different comparative adv. in other provinces
 - Physical / Human Capital Intensive Industry
 - SMP = Positive, Spatial Lag = Negative
 - Implication: Regional Trade Platform
 - FDI in different provinces serves as substitutes
 - Products produced shipped to surrounding regions

Table 5. Industrial FDI Spatial Regressions

| | Industry 01 | Industry 02 | Industry 03 | Industry 04 | Industry 05 | Industry 06 |
|------------------------------|---------------------------|----------------------------|-------------------------|--------------------------------|-----------------------|-------------------------|
| Industry | Coal | Nonferrous Metal | Food Processing | Food Production | Beverage | Textile |
| GPP | 0.56496** [0.229] | 0.08348 [0.085] | 0.88952*** [0.180] | 1.44268*** [0.178] | 0.33052* [0.181] | 1.12615*** [0.220] |
| Surrounding Market Potential | 0.64166*** [0.232] | 0.11402 [0.085] | -0.14983 [0.106] | 0.03757 [0.148] | -0.14416 [0.162] | 0.84320*** [0.171] |
| W x FDI | -0.17158 [0.206] | -0.16186 [0.201] | 0.37779*** [0.147] | -0.70753*** [0.196] | -0.45490* [0.254] | 0.14297 [0.159] |
| Observations | 58 | 56 | 175 | 165 | 174 | 155 |
| Variance Ratio | 0.368 | 0.439 | 0.804 | 0.828 | 0.722 | 0.888 |
| | Industry 07 | Industry 08 | Industry 09 | Industry 10 | Industry 11 | Industry 12 |
| Industry | Paper | Petrol Processing | Raw Chemical | Medical | Chemical Fiber | Nonmetal Mineral |
| GPP | 0.38365 [0.247] | 0.14140 [0.293] | -0.46186** [0.220] | 0.36175*** [0.123] | 0.13267 [0.449] | 0.46282** [0.207] |
| Surrounding Market Potential | 0.14119 [0.230] | -0.21474 [0.174] | 0.23348 [0.210] | 0.50777*** [0.129] | 0.44678* [0.241] | 0.67914*** [0.158] |
| W x FDI | -0.07732 [0.202] | -1.34435*** [0.236] | -0.00560 [0.196] | -0.24593 [0.174] | -0.12093 [0.241] | -0.72283*** [0.208] |
| Observations | 143 | 114 | 173 | 174 | 83 | 172 |
| Variance Ratio | 0.756 | 0.475 | 0.838 | 0.812 | 0.682 | 0.805 |
| | Industry 13 | Industry 14 | Industry 15 | Industry 16 | Industry 17 | Industry 18 |
| Industry | Smelting Ferrous | Smelting Nonferrous | Metal Production | Ordinary Machinery | Special Eq. | Transportation |
| GPP | 0.25154 [0.287] | 0.67498*** [0.187] | 0.43417** [0.179] | 0.33728** [0.147] | -0.12785 [0.180] | 0.52723* [0.311] |
| Surrounding Market Potential | 1.28824*** [0.247] | 0.40764* [0.218] | 0.16679 [0.106] | 0.45721*** [0.130] | 0.53691*** [0.145] | 0.54805* [0.311] |
| W x FDI | -0.11228 [0.217] | -0.39336 [0.281] | -0.11700 [0.150] | -0.37532** [0.156] | 0.10016 [0.158] | -0.77635*** [0.295] |
| Observations | 135 | 155 | 146 | 158 | 155 | 161 |
| Variance Ratio | 0.688 | 0.594 | 0.907 | 0.898 | 0.817 | 0.649 |
| | Industry 19 | Industry 20 | Industry 21 | Industry 22 | | |
| Industry | Electric Machinery | Communication Eq. | Instruments | Electricity and Heating | | |
| GPP | 0.39831** [0.200] | 0.81163*** [0.260] | -0.07908 [0.143] | 1.12384*** [0.332] | | |
| Surrounding Market Potential | 0.48204*** [0.177] | 0.61376** [0.251] | 0.22480** [0.113] | 0.21332 [0.202] | | |
| W x FDI | -0.13914 [0.185] | -1.01686*** [0.170] | -0.30459** [0.136] | 0.03902 [0.233] | | |
| Observations | 163 | 151 | 133 | 136 | | |
| Variance Ratio | 0.844 | 0.843 | 0.884 | 0.643 | | |



Conclusions

- Spatial interdependence is significant
- The estimated results based on aggregated data are compatible with the regional trade platform motive.
- The disaggregated industry-level FDI data present more heterogeneity