The Global Agglomeration of Multinational Firms

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Figure 1: Geographic distribution of MNC headquarters in transportation equipment (e.g., motor vehicles and equipment, motorcycles and parts, aircrafts and parts, and ship and boat building)
Figure 2: Geographic distribution of MNC subsidiaries in transportation equipment (e.g., motor vehicles and equipment, motorcycles and parts, aircrafts and parts, and ship and boat building)
Do multinationals, known for their global resource and market seeking activities, agglomerate with one another around the world?
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If they do, what motivates their agglomeration?
Potential Forces of Agglomeration

- **First nature** (the FDI literature)
Potential Forces of Agglomeration

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  - Market access
Potential Forces of Agglomeration

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  - *Market access*
    - The common incentives to access markets and avoid trade costs can lead to geographic concentration of MNCs in countries with large markets and high trade costs
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  3. **Other factors**
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  - **Other factors**
    - Natural advantage, institutional factors...
Potential Forces of Agglomeration

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  3. *Knowledge spillovers*
Objective

In this paper we incorporate the two strands of literature and evaluate:

- How the "first nature" fundamentals in FDI and "second nature" agglomeration forces in urban economics jointly explain the worldwide geographic distribution of multinational firms?
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- Do agglomeration forces affect multinational and non-multinational firms differently?
These questions are central to the debates on the determinants and consequences of foreign direct investment:

- Many host countries have long offered lucrative incentives to multinationals in the hope of building and sustaining FDI clusters and extracting benefits from inward FDI;
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- Many host countries have long offered lucrative incentives to multinationals in the hope of building and sustaining FDI clusters and extracting benefits from inward FDI;
- Many home countries also seek to keep multinationals at home and control the outflow of FDI;
- The location interdependence of multinationals can magnify the effect of economic fundamentals and policies on the outward and inward movements of MNCs.
1. The global co-agglomeration patterns of multinational firms
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- We investigate the location interdependence of firms in different industries, also referred to as co-agglomeration;
How We Address the Questions

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   - We construct the agglomeration index in a continuous metric space using the actual distance between each pair of plants;
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2. Spatially continuous index of agglomeration
   - We construct the agglomeration index in a continuous metric space using the actual distance between each pair of plants;
   - The index is independent of the level of geographic aggregation and controls for the overall distribution of firms.
3. Worldwide plant-level dataset
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- We employ a new worldwide plant-level dataset that provides detailed location, ownership and activity information for plants in more than 100 countries;
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Alfaro and Chen (2011)
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4. The role of first-nature incentives and second-nature forces

- We assess the relative importance of first-nature location fundamentals and second-nature forces;
- We also examine how the importance of each factor varies between MNC subsidiaries and their headquarters and domestic counterparts.

2. The trade literature on production linkages and agglomeration incentives

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   • Theoretical: e.g., Venables (1996), Krugman and Venables (1996), Puga and Venables (1997), Markusen and Venables (2000), and Baldwin and Ottaviano (2001)
Presentation Outline

1. Constructing the agglomeration index
2. Constructing the determinants of agglomeration
3. Data
4. Patterns of multinational-firm agglomeration
5. Evaluating the role of first and second natures
   - MNC subsidiaries
   - MNC subsidiary employment
   - MNC headquarters
6. Additional analysis
   - MNC v.s. non-MNC plants
   - Entry patterns of multinational firms
   - Generalized measure of trade costs
Constructing the Agglomeration Index

Issues in constructing the agglomeration indices

Most existing indices tend to equalize agglomeration with activities located in the same administrative or geographic region (measured by number of firms or size of production in the region). Several issues arise with these measures:

1. Dependence on the level and method of geographic disaggregation
Case 1: Underestimating the extent of co-agglomeration between industries A and B

Figure 3: The geographic distribution of industries A and B (each circle represents an establishment; red and blue represent industries A and B, respectively)
Case 2: Overestimating the extent of co-agglomeration between industries A and B (Underestimating the extent of co-agglomeration between industries B and C)

Figure 4: The geographic distribution of industries A, B and C (each circle represents an establishment; red, blue and green represent industries A, B and C, respectively)
Constructing the Agglomeration Index

Issues in constructing the agglomeration indices

2. Can be strongly driven by industrial concentration
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3. Cannot separate general geographic concentration due to location attractiveness from agglomeration
Development in agglomeration indices

1. Ellison and Glaeser (1997): a dartboard approach
Development in agglomeration indices

1. Ellison and Glaeser (1997): a dartboard approach
2. Duranton and Overman (2005): a continuous-space concentration index
Constructing the Agglomeration Index

Step 1: Actual geographic distributions

First, we obtain the latitude and longitude of each plant based on physical location information and compute the great-circle distance for each pair of plants \((N \times (N-1)/2\) with \(N = 32,427\) for MNCs).
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- Then, we obtain the kernel estimator of bilateral distances at any point $\tau$ (i.e., $f_{k\tilde{k}}(\tau)$) for each of the 7,875 ($=126 \times 125/2$) pairwise industries:

$$f_{k\tilde{k}}(\tau) = \frac{1}{n_k n_{\tilde{k}} h} \sum_{i=1}^{n_k} \sum_{j=1}^{n_{\tilde{k}}} K \left( \frac{\tau - \tau_{ij}}{h} \right).$$

(1)
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\[
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\]

(1)

- Alternatively we can treat each worker as the unit of observation:

\[
f_{kk}(\tau) = \frac{1}{h \sum_{i=1}^{n_k} \sum_{j=1}^{n_k} (r_i r_j)} \sum_{i=1}^{n_k} \sum_{j=1}^{n_k} r_i r_j K \left( \frac{\tau - \tau_{ij}}{h} \right).
\]

(2)
Step 2: Counterfactual geographic distributions

We draw, for each industry pair, 1,000 random samples from the entire dataset. Each counterfactual industry has a similar number of observations as the actual data to control for the potential effect of industry size.
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- We then obtain the kernel estimator for each of the 1,000 samples. This gives us 1,000 kernel estimators for each of the 7,875 industry pairs.
- We compute the 95% global confidence band $\tilde{F}_{\tilde{k}}(\tau)$ for various threshold distance (200, 400, 800 and 1600 kilometers).
Step 3: Agglomeration index

Finally, we obtain, for each industry pair $k$ and $\tilde{k}$:

$$agglomeration_{k\tilde{k}}(T) \equiv \sum_{\tau=0}^{T} \max \left( f_{k\tilde{k}}(\tau) - \bar{f}_{k\tilde{k}}(\tau), 0 \right)$$

(3)

or employment-weighted

$$agglomeration_{w_{k\tilde{k}}(T)} \equiv \sum_{\tau=0}^{T} \max \left( f_{k\tilde{k}}^{w}(\tau) - \bar{f}_{k\tilde{k}}^{w}(\tau), 0 \right).$$

(4)

The index measures the extent to which plants in industries $k$ and $\tilde{k}$ agglomerate within the threshold distance $T$ and the statistical significance thereof.
First nature: location fundamentals

To account for the effect of first-nature motives, we estimate an expected geographic agglomeration index based exclusively on market access and comparative advantage factors.
Constructing the Determinants of Agglomeration

First nature: location fundamentals

We proceed in three stages:

- **Step 1:** We estimate an FDI equation following Yeaple (2003) and Alfaro and Charlton (2009):

\[
y_{cck} = \gamma_0 + \gamma_1 \text{marketsize}_{ave}_{cc} + \gamma_2 \text{distance}_{cc} + \gamma_3 \text{skill}_{diff}_{cc} \\
+ \gamma_4 \text{skill}_{diff}_{cc} \times \text{skillintensity}_k + \gamma_5 \text{tariff}_{cck} + \lambda_{ck} + \lambda_{cck} + \epsilon_{ccck}.
\]
First nature: location fundamentals

- **Step 2:** We obtain fitted values of $y_{c\tilde{c}k}$ predicted exclusively by the first-nature location fundamentals, and sum them up for each host region $\tilde{c}$ and industry $k$ to obtain $\hat{y}_{\tilde{c}k}$.
First nature: location fundamentals

- **Step 2:** We obtain fitted values of $y_{\tilde{c}k}$ predicted exclusively by the first-nature location fundamentals, and sum them up for each host region $\tilde{c}$ and industry $k$ to obtain $\hat{y}_{\tilde{c}k}$.

- **Step 3:** We repeat step 1 of Duranton and Overman’s procedure and obtain the geographic agglomeration index predicted by first-nature motives.
Second nature: agglomeration economies

1. Proximity to suppliers and customers
Second nature: agglomeration economies

1. Proximity to suppliers and customers
   - Inter-industry input-output linkage (BEA Benchmark I-O Accounts)
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4. Knowledge spillovers
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4. Knowledge spillovers
   - Industry-pair patent citation intensity (NBER Patent Database)
Data

The WorldBase database

- We employ a worldwide plant-level dataset, WorldBase.
Data

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  - Primary industry information including four-digit SIC code
  - Ownership information including headquarters and global parents
  - Location information of both the plants and headquarters
  - Operational information including sales and employment
The WorldBase database: advantages

- Worldwide coverage
Data

The WorldBase database: advantages

1. Worldwide coverage

   - A significant fraction of agglomeration activities occurs across borders

Table A.1: Distribution of Establishment Pairs by Distance and Different Countries

<table>
<thead>
<tr>
<th></th>
<th>All pairs</th>
<th></th>
<th>Pairs located in two different countries</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pairs (mil)</td>
<td>Ave. dist (km)</td>
<td>Pairs (mil)</td>
<td>Percentage</td>
</tr>
<tr>
<td>dist ≤ 200</td>
<td>28.3</td>
<td>91.6</td>
<td>5.6</td>
<td>0.2</td>
</tr>
<tr>
<td>dist ≤ 400</td>
<td>54.8</td>
<td>194.1</td>
<td>24.5</td>
<td>0.4</td>
</tr>
<tr>
<td>dist ≤ 800</td>
<td>124.2</td>
<td>423.0</td>
<td>85.6</td>
<td>0.7</td>
</tr>
<tr>
<td>dist ≤ 1600</td>
<td>257.1</td>
<td>806.6</td>
<td>198.7</td>
<td>0.8</td>
</tr>
</tbody>
</table>

Notes: Authors’ calculations.
Data

The WorldBase database: advantages

2. Physical address and postal code information
The WorldBase database: advantages

2. Physical address and postal code information

- This enables us to obtain the latitude and longitude of each plant from a geocoding software (Yahoo! Geocoding API), compute between-plant distance, and examine agglomeration in a continuous metric space.
Figure 5: The agglomeration pattern of MNC subsidiaries
Patterns of Multinational-Firm Agglomeration

- Jewelry, silverware
- Misc. fabricated metal product
- Watches, clocks, watch cases
- Misc. wood product
Patterns of Multinational-Firm Agglomeration

- Fabricated structural metal product
- Jewelry, silverware
- Household furniture
- Watches, clocks, watch cases
- Misc. fabricated metal product
- Misc. wood product
Patterns of Multinational-Firm Agglomeration

Newspaper

Printing trade services

Partition fixtures

Wood building, mobile home

Paperboard Mills

Paperboard containers
Patterns of Multinational-Firm Agglomeration

Sawmills, planing mills

Public building furniture

Partition fixtures

Wood building, mobile home

Newspaper

Printing trade services

Paperboard Mills

Paperboard containers
Patterns of Multinational-Firm Agglomeration

Figure 6: The agglomeration pattern of MNC headquarters

Alfaro and Chen
Evaluating the Role of First and Second Natures

$$\text{agglomeration}_{k\tilde{k}}(T) = \alpha_k + \beta_1 \text{firstnature}_{k\tilde{k}} + \beta_2 \text{iOlinkage}_{k\tilde{k}}$$
$$+ \beta_3 \text{labor}_{k\tilde{k}} + \beta_4 \text{capital}_{k\tilde{k}} + \beta_5 \text{knowledge}_{k\tilde{k}} + \varepsilon_{k\tilde{k}},$$
(5)
### Table 3: Agglomeration Economies and MNC Subsidiary Agglomeration

<table>
<thead>
<tr>
<th></th>
<th>T= 200 km</th>
<th>T= 400 km</th>
<th>T= 800 km</th>
<th>T= 1600 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO Linkages</td>
<td>0.265*</td>
<td>0.573*</td>
<td>1.331**</td>
<td>2.596**</td>
</tr>
<tr>
<td></td>
<td>(0.147)</td>
<td>(0.306)</td>
<td>(0.656)</td>
<td>(1.296)</td>
</tr>
<tr>
<td>Capital</td>
<td>0.038***</td>
<td>0.093***</td>
<td>0.241***</td>
<td>0.506***</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.032)</td>
<td>(0.066)</td>
<td>(0.139)</td>
</tr>
<tr>
<td>Labor</td>
<td>-0.002</td>
<td>-0.015</td>
<td>-0.079</td>
<td>-0.231</td>
</tr>
<tr>
<td></td>
<td>(0.016)</td>
<td>(0.035)</td>
<td>(0.068)</td>
<td>(0.160)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.609**</td>
<td>1.178**</td>
<td>2.521**</td>
<td>4.395**</td>
</tr>
<tr>
<td></td>
<td>(0.293)</td>
<td>(0.546)</td>
<td>(1.117)</td>
<td>(2.371)</td>
</tr>
<tr>
<td>First Nature</td>
<td>0.018</td>
<td>0.019</td>
<td>0.020</td>
<td>0.021*</td>
</tr>
<tr>
<td></td>
<td>(0.025)</td>
<td>(0.019)</td>
<td>(0.022)</td>
<td>(0.012)</td>
</tr>
<tr>
<td># Obs.</td>
<td>7875</td>
<td>7875</td>
<td>7875</td>
<td>7875</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.571</td>
<td>0.600</td>
<td>0.627</td>
<td>0.631</td>
</tr>
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</table>

### Beta Coefficients

<p>| |</p>
<table>
<thead>
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<tbody>
<tr>
<td>IO Linkages</td>
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</tr>
<tr>
<td>Labor</td>
</tr>
<tr>
<td>Knowledge</td>
</tr>
<tr>
<td>First Nature</td>
</tr>
</tbody>
</table>

**Notes:** Bootstrapped standard errors in parentheses. ***, p < 0.01; **, p < 0.05; *, p < 0.1. All regressions control for industry and country fixed effects.
Table 5: Agglomeration Economies and MNC Subsidiary Employment Agglomeration

<table>
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<th>T= 800 km</th>
<th>T= 1600 km</th>
</tr>
</thead>
<tbody>
<tr>
<td>IO Linkages</td>
<td>-0.145</td>
<td>-0.256</td>
<td>-0.272</td>
<td>-0.750</td>
</tr>
<tr>
<td></td>
<td>(0.209)</td>
<td>(0.403)</td>
<td>(0.683)</td>
<td>(1.160)</td>
</tr>
<tr>
<td>Capital</td>
<td>0.041*</td>
<td>0.109**</td>
<td>0.315***</td>
<td>0.557***</td>
</tr>
<tr>
<td></td>
<td>(0.023)</td>
<td>(0.044)</td>
<td>(0.089)</td>
<td>(0.144)</td>
</tr>
<tr>
<td>Labor</td>
<td>0.048*</td>
<td>0.088*</td>
<td>0.120</td>
<td>0.128</td>
</tr>
<tr>
<td></td>
<td>(0.026)</td>
<td>(0.048)</td>
<td>(0.104)</td>
<td>(0.162)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>2.262***</td>
<td>3.957***</td>
<td>6.243***</td>
<td>9.333***</td>
</tr>
<tr>
<td></td>
<td>(0.516)</td>
<td>(0.867)</td>
<td>(1.613)</td>
<td>(2.356)</td>
</tr>
<tr>
<td>First Nature</td>
<td>0.0004***</td>
<td>0.0004***</td>
<td>0.0004***</td>
<td>0.0004**</td>
</tr>
<tr>
<td></td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0002)</td>
</tr>
<tr>
<td># Obs.</td>
<td>7875</td>
<td>7875</td>
<td>7875</td>
<td>7875</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.327</td>
<td>0.327</td>
<td>0.363</td>
<td>0.402</td>
</tr>
</tbody>
</table>

Beta Coefficients

<p>| | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IO Linkages</td>
<td>-0.007</td>
<td>-0.006</td>
<td>-0.003</td>
<td>-0.005</td>
</tr>
<tr>
<td>Capital</td>
<td>0.033</td>
<td>0.045</td>
<td>0.066</td>
<td>0.065</td>
</tr>
<tr>
<td>Labor</td>
<td>0.042</td>
<td>0.039</td>
<td>0.027</td>
<td>0.016</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.100</td>
<td>0.091</td>
<td>0.073</td>
<td>0.061</td>
</tr>
<tr>
<td>First Nature</td>
<td>0.315</td>
<td>0.349</td>
<td>0.390</td>
<td>0.435</td>
</tr>
</tbody>
</table>

Notes: Bootstrapped standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. All regressions...
### Table 6: Agglomeration Economies and MNC Headquarters Agglomeration

<table>
<thead>
<tr>
<th></th>
<th>T= 200 km</th>
<th>T= 400 km</th>
<th>T= 800 km</th>
<th>T= 1600 km</th>
</tr>
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<tbody>
<tr>
<td>IO Linkages</td>
<td>0.090</td>
<td>0.156</td>
<td>0.127</td>
<td>0.457</td>
</tr>
<tr>
<td></td>
<td>(0.174)</td>
<td>(0.406)</td>
<td>(0.815)</td>
<td>(1.254)</td>
</tr>
<tr>
<td>Capital</td>
<td>0.026</td>
<td>0.084**</td>
<td>0.261***</td>
<td>0.459***</td>
</tr>
<tr>
<td></td>
<td>(0.019)</td>
<td>(0.040)</td>
<td>(0.088)</td>
<td>(0.164)</td>
</tr>
<tr>
<td>Labor</td>
<td>0.043**</td>
<td>0.064</td>
<td>0.019</td>
<td>-0.085</td>
</tr>
<tr>
<td></td>
<td>(0.021)</td>
<td>(0.044)</td>
<td>(0.104)</td>
<td>(0.180)</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.793***</td>
<td>1.727***</td>
<td>3.870***</td>
<td>6.935***</td>
</tr>
<tr>
<td></td>
<td>(0.241)</td>
<td>(0.477)</td>
<td>(1.153)</td>
<td>(1.735)</td>
</tr>
<tr>
<td>First Nature</td>
<td>0.022**</td>
<td>0.023***</td>
<td>0.024*</td>
<td>0.019</td>
</tr>
<tr>
<td></td>
<td>(0.009)</td>
<td>(0.009)</td>
<td>(0.013)</td>
<td>(0.018)</td>
</tr>
<tr>
<td># Obs.</td>
<td>7875</td>
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<tr>
<td>$R^2$</td>
<td>0.639</td>
<td>0.65</td>
<td>0.664</td>
<td>0.667</td>
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</table>

#### Beta Coefficients

<p>| | | | | |</p>
<table>
<thead>
<tr>
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<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>IO Linkages</td>
<td>0.003</td>
<td>0.003</td>
<td>0.001</td>
<td>0.002</td>
</tr>
<tr>
<td>Capital</td>
<td>0.017</td>
<td>0.024</td>
<td>0.032</td>
<td>0.033</td>
</tr>
<tr>
<td>Labor</td>
<td>0.030</td>
<td>0.020</td>
<td>0.003</td>
<td>-0.007</td>
</tr>
<tr>
<td>Knowledge</td>
<td>0.028</td>
<td>0.027</td>
<td>0.027</td>
<td>0.028</td>
</tr>
<tr>
<td>First Nature</td>
<td>0.212</td>
<td>0.212</td>
<td>0.208</td>
<td>0.213</td>
</tr>
</tbody>
</table>

*Note: Bootstrapped standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$. All regressions.*
Additional Analysis

- MNC v.s. non-MNC plants
Additional Analysis

- MNC v.s. non-MNC plants
- Entry patterns of MNCs
Additional Analysis

- MNC v.s. non-MNC plants
- Entry patterns of MNCs
- The agglomeration between MNC and domestic plants
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- Entry patterns of MNCs
- The agglomeration between MNC and domestic plants
- Generalized measure of trade costs
Multinationals’ agglomeration goes above and beyond first-nature driven geographic concentration
Conclusion

- Multinationals’ agglomeration goes above and beyond first-nature driven geographic concentration.
- Second-nature forces including knowledge spillovers, capital-market externalities, and vertical production linkages play a significant role.
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- In comparison to domestic plants, knowledge spillovers and capital market externalities exert a stronger effect on the clustering of multinational firms while labor market pooling has a weaker impact
- These results suggest that more consideration should be given to the interdependence of multinational firms especially in policy making aimed at influencing the flow of FDI