

An Agglomeration Set on a Hill: Industry Clusters and the Magnetic Attraction of Foreign Direct Investment

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Motivation

- For the U.S.A., research on agglomeration externalities has emphasized the competitive and productivity benefits of co-location
 - For example, Porter’s cluster mapping project
 - Cluster-based development is the current go-to strategy for growth
 - Attempt to create “something in the air” for firms to grow metabolically
 - Established firms grow and new start-ups can take advantage of a well-developed regional labor force, supply chains and knowledge spillovers
- US-based Research is sparse on regions with strong clusters attracting investment into region

Motivation

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- Do firms from outside the region sense that there is “something in the air”?
- Do firms make a decision to locate in regions in which similar firms are concentrated?
- What is an industry in any case? How do we define industry?
- **Same products**, production process and labor requirements?
- **Similar products**, production process and labor requirements?
- **Complementary**, production process and labor requirements?

Unit of Analysis?

- Related and unrelated variety
- MAR – related variety
- Jacobs – unrelated variety
- Industry clusters as defined by Porter embraces **related variety**
 - Input-output relationships, supply chain, labor force know-how
- For this paper/research, clusters have two meanings:
- Cluster by definition – an industry aggregation category – CMP
- Cluster by concentration: “MAR cluster” signals concentration

Research Question

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- Following Ellison and Glaeser (1997), do location patterns of new investment in plant and equipment follow a random, throw-a-dart approach or reflect decisions to seek the competitive benefits of industrial colocation and concentration?
- Extend the work of Delgado et al. (2014): do agglomeration externalities motivate a firm's decision to move into a region?
- Concentration measured by employment in CMP-defined clusters
- Attraction measured by investment flows: greenfield facilities, plant expansion and developed turn-key facilities (“brownfield”)

Other Investment Considerations

- Investors may consider other criteria as important to a location decision
- Location decisions also driven by:
 - infrastructure
 - workforce characteristics and wages
 - higher education and attainment
 - labor regulations
 - taxes and incentives

Source: International Economic Development Council

Data Sources and Measures

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- The econometric model regresses announced investment on plant and equipment (\$ and employment), both binary and level, on a number of factors that characterize cluster strength
- Employment by industry data from QCEW-complete (BLS&IBRC)
- Employment data are bundled into 70 CMP defined industry clusters
- [fDiMarkets](#) used for P&E investment
 - Built a concordance based on fDimarkets categories, NAICS and CMP

Data Sources and Measures

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- Primary focus is on **traded clusters** (CMP) that are comprised of industries that generally have well-above average LQs
- Shows a level of regional specialization
 - In contrast to local clusters that have LQs of around one, are population driven, and do not signal a high degree of specialization
- Majority of incoming P&E investment is in traded industries
- From 2007 to 2015 there were 30,774 FDI announced projects/events
- 20,632 were in the relevant traded industries

Data Sources Measures

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- The average county has about 27 traded CMP clusters
 - 243,698 county-by-industry CMP cluster observations
- 40 percent of those county-industry clusters are sufficiently concentrated to be considered an MAR cluster, i.e., $LQ > 1.2$
- MAR cluster => specialization that create agglomeration externalities
- County-by-MAR-clusters often have multiple FDI projects or attraction events

Cluster “Balance” or Specialization

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- **“Between” Cluster Evenness**
- Used a common entropy measure – The Shannon Evenness Index (SEI) – to assess the degree to which a region’s CMP clusters are diversified
- **“Within” Cluster Evenness/imbalance**
- At first, applied the SEI to measure balance within cluster, but CMP clusters can range from 1 to 40 industries and the SEI does not describe the nature or magnitude of the imbalance
- Used another “imbalance” measure

Within Cluster Imbalance

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- Use location quotients and sum up the absolute difference between the region's industries and the national LQ (i.e. 1)

$$clst_bal1 = \frac{\sum_{i=1}^{n^{g,cl}} |LQ_i^{g,cl} - 1|}{n^{g,cl}}$$

- A variation of the National Averages Index, a stylized goodness of fit measure
- See Dissart (2003) Regional economic diversity and regional economic stability: research results and agenda. *International Regional Science Review*, 26(4), 423-446
- And Siegel et al. (1995). Regional economic diversity and diversification. *Growth and Change*, 26(2), 261-284

Empirical Strategy

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- OLS
 - Pooled data from all years and regressed announced FDI-related employment on MAR cluster employment and a number of factors that have been reported to contribute to location investment decisions
- Probability Models
 - Logit and negative binomial to assess the frequency of investment counts
 - Many counties – over 3000! – and therefore many zeros, skewing the data
- Pseudo-panel model
 - Built 3 pseudo panels to identify sources of variation
 - Used both fixed effects and random effect methods

OLS Results

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- Hypothesis confirmed: Investment as measured by additional employment attributed to greenfield or expansion FDI is strongly positively associated with total – absolute – cluster employment
- The larger the absolute size of a MAR cluster, the greater the magnetic attraction of FDI related employment
- The marginal effect is higher for non-high-tech clusters in comparison to high-tech clusters
- Presence of relatively weak (CMP) clusters in a region, can have a negative effect on attracting FDI employment
- Interaction term – cluster presence and relative concentration – also points to specialization attracting incoming FDI

OLS Results

- Diversity – between cluster
 - CMP Cluster evenness is negatively associated with an increase in FDI related employment
 - Greater concentration and specialization tend to receive more FDI related employment
- Within cluster evenness/imbalance
 - specialization within a cluster is also positive, as the coefficient for imbalance is positive and statistically significant
 - But, for high-tech, interaction term points to high-tech benefiting from CMP cluster balance

OLS versus Logit

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- The OLS model has weak explanatory power with an R-sq of 0.16
- This result is consistent to the pseudo-R-sq from the logit and negative binomials
- Results for other explanatory variables mostly consistent as well
- Relative to the OLS, significance of the presence of an MAR cluster (*ln_bin*) and the relative concentration of a cluster (*lnlq_clst*) fell away in the logit model
- **Absolute size – employment** – does emerge as increasing the odds of attracting FDI

Negative Binomial

- Results were more congruent with the OLS model in coefficient, sign and significance
- That said, high-tech and cluster employment interaction term significance fell away, as did the high-tech and county between cluster evenness interaction term
- The number of projects and the number of new employees associated with those projects can vary dramatically

Pseudo-Panel Models

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- The within estimator (WE) model shows that the across-time variation of most of the explanatory variables are not significantly associated with FDI employment, with a few exceptions
- **Higher rates of unemployment** (*unempr*) would attract more FDI employment, but so would regions that have increased the number of **highly educated workers**
- The overall fit of the within-estimator model is poor, suggesting time variation is an insignificant element in explaining FDI employment attraction

Pseudo-Panel Models

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- Results of the between estimator (BE) model suggests, as the WE model did, that the variation is better described by the cross-sectional variation across industry clusters
- The over-identifying restriction test signals that the random effects (RE) model might be a better choice over fixed effects
- The aggregated model (panel II) essentially ignores the time dimension and tests the industry and regional characteristics
 - Industry cluster characteristics are stronger than the regional characteristics
 - Panel II BE results are similar to Panel I BE => **cluster effects dominate regional characteristics**

Analysis by Function

- Do the relationships change depending on the function/activity?
- Following Crescenzi et. al. (2013), we classified the industrial activities of fDi Markets data into broad functional areas
- 1) Headquarters
- 2) Manufacturing
- 3) Production
 - Construction Extraction
 - ICT & internet infrastructure
 - Electricity generation
- 4) Innovative activities – R&D, testing
- 5) Services/Sales/Logistics
 - Business services
 - Logistics, distribution & transportation
 - Technical support

Results of Functional Analysis

	All	Headerquarter	Innovative Activities	Manufacturing	Production	Services
"sei_clst" (between cluster evenness)	-0.126 (0.60)	-0.794 (1.83)	-2.030 (2.72)	-1.379* (0.75)	2.290 (3.02)	0.091 (0.76)
"sei_ind" (within cluster evenness)	-0.177*** (0.06)	-0.212 (0.19)	-0.198 (0.21)	-0.285*** (0.07)	-0.043 (0.28)	-0.168 (0.12)
Specialization (Within industry cluster imbalance)	0.096*** (0.02)	0.069 (0.06)	-0.053 (0.08)	-0.105*** (0.03)	0.028 (0.07)	0.075** (0.03)
High-tech clusters	1.472** (0.66)	-0.830 (1.64)	0.673 (2.15)	0.349 (1.02)	0.506 (2.30)	0.569 (0.90)
High-tech clusters & sei_clst	-1.839** (0.85)	0.855 (2.17)	-0.905 (2.82)	-0.515 (1.30)	-0.307 (3.09)	-0.837 (1.17)
MAR cluster; cluster LQ>=1.2	0.145*** (0.04)	-0.045 (0.06)	0.255 (0.08)	-0.020 (0.06)	-0.000 (0.16)	0.167* (0.05)
MAR cluster; cluster LQ>=1.2=1 x clst_conc	0.171*** (0.05)	0.115 (0.09)	0.077 (0.15)	0.282*** (0.06)	-0.147 (0.24)	-0.020 (0.07)

With the exception of within-cluster evenness, the results are consistent for all functions taken together

Other Findings

- Heckman two-step selection model of total FDI employment using all sectors and manufacturing
- Used lagged independent variables for two time periods, 2010 – 2012 and 2013 – 2015
- The IV – university knowledge spillovers – is considered a general criterion for selecting a business location not related to function
- Evidence of selection bias
- Suggests clusters that grow faster in terms of FDI job creation are the ones that are more likely to receive FDIs in the first place
- Corroborates with European literature that investment follows investment

Key Empirical Findings of Pooled Sample

	Total FDI employment	FDI received or not	No. of investment projects
Average cluster employment	0.256***	0.434***	0.319***
Between cluster Shannon	0.609	1.341	0.378
Within cluster imbalance	0.211***	0.224***	0.080***
Being a high-tech cluster	2.202**	2.141***	1.496*
X cluster employment	-0.061***	-0.007	-0.004
X cluster Shannon	-2.107*	-1.444*	-1.765
X cluster imbalance scores	-0.243***	-0.380***	-0.169***
Strong cluster (cluster LQ>1.2)	0.151**	0.025	0.165**
Cluster LQ	-0.123***	-0.017	-0.096***
X strong cluster	0.265***		

Key Empirical Findings of Pooled Sample

	Total FDI employment	FDI received or not	No. of investment projects
Pop. share of less than high school	0.012	-0.125**	-0.046
Pop. share of BA and above	-0.004	0.018***	-0.005
Pop. share of STEM graduates	0.034*	-0.023	0.042***
County total employment	0.049	0.272***	0.128***
Pop. share of prime aged	0.033***	0.020	0.032***
Unemployment rate	0.026**	0.189***	0.023**
Having received VC	-0.667***	-0.642**	-0.744***
VC dollar amount	0.041***	0.046**	0.043***
University KSP/L at 50-mile cutoff	-0.066	0.169***	-0.168***
Mean travel time	0.019**	-0.049***	0.013**
Lane miles per capita	0.001	0.287**	-0.108**
Electricity cost	-0.256**	-0.140	-0.217**
State credit rating scores	0.030	0.151***	0.037*
Observations	5,032	55,635	5,033
Adj./Pseudo R^2	0.159	0.220	0.173

Pseudo Panel Results comparing the dominance of time, cluster and characteristics

		Panel I			Panel II	
	WE	BE	RE		WE	BE
Average cluster employment	0.287	0.149***	0.180***		0.201***	0.191***
Between cluster Shannon	-5.186	-0.309	-0.407		o.m.	-1.521
Within cluster imbalance scores	-0.009	0.122***	0.133***		0.290***	0.118***
Being a high-tech cluster	o.m.	0.667	1.142*		2.990**	-0.275
X cluster employment	-0.333**	-0.037**	-0.047***		-0.098***	-0.170***
X cluster Shannon	-6.376	-0.436	-0.931		-2.749	1.680
X cluster imbalance scores	0.031	-0.145***	-0.159***		-0.383***	-0.262**
Strong cluster (cluster LQ>1.2)	-0.054	0.112**	0.119**		0.077	-0.033
Cluster LQ	-0.136	-0.048*	-0.060**		0.014	-0.041
X strong cluster	-0.037	0.136***	0.154***		0.240**	0.174*

Pseudo Panel Results comparing the dominance of time, cluster and characteristics

		Panel I			Panel II	
	WE	BE	RE		WE	BE
Cost of living index (transp.)	<i>o.m.</i>	-0.005*	-0.002		<i>o.m.</i>	-0.017**
Population share of prime aged	-0.114***	0.030***	0.031***		<i>o.m.</i>	0.027*
Unemployment rate	0.110***	0.024***	0.042***		<i>o.m.</i>	0.074***
Having received VC	-0.106	-0.807***	-0.580***		<i>o.m.</i>	-1.371***
VC dollar amount	0.008	0.050***	0.033***		<i>o.m.</i>	0.087***
Mean travel time	-0.016	0.012***	0.011**		<i>o.m.</i>	-0.003
Lane miles per capita		0.078**	0.092**		<i>o.m.</i>	0.076
Electricity cost	-0.368	-0.185**	-0.220**		<i>o.m.</i>	-0.074
Right to work indicator	<i>o.m.</i>	0.085**	0.099**		<i>o.m.</i>	0.063
Observations	8,171	8,171	8,171		2,434	2,434
Overall R^2	0.001	0.126	0.128		0.089	0.112

Conclusion

- Agglomeration externalities magnetically attract FDI
 - but this driver has limited explanatory power
- Industry specialization seems to trump a “balanced” or diversified regional portfolio of clusters/industries
- The drivers of attracting FDI depends on the investment function (NAICS-based industry activity)
- We corroborate previous research in terms of other decision making drivers and regional characteristics

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