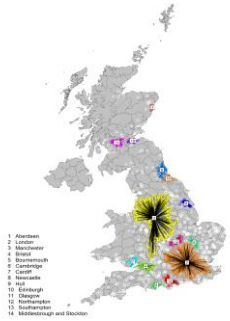
Impact of Clustering on Manufacturing Total Factor Productivity (TFP), Great Britain, 1984-2014



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'New Industrial Strategy'

- International return of industrial policy focused on meso-level and decentralised support networks
- UK variant of this includes:
  - tackle local barriers to raise productivity, build most dynamic local economies, and ensure more sectorally and spatially balanced growth
- But: still sectoral and science focus
  - place 'pillar' appears relatively weak
  - aim to use clusters and centres to connect local institutions with sectoral and innovation support

"We will prioritise areas with potential to drive wider regional growth, focusing on clusters of expertise and centres of economic activity" (HM Government, 2018, p 221)

Place and 'New Industrial Strategy'

- Unclear intersection of Sector deals with place – is this through local industrial strategies?
  - i.e., Combined Authorities and LEPs leading to competitive funding of clusters?
- Questionable assumptions about geography –
- *"The most knowledge-intensive jobs, industries and research are increasingly concentrated in particular economic clusters"* (2018, p. 227)
- "*Every part of the UK has strong clusters and particular strengths*" (2017, 199)
- Is rediscovery of clusters based on:
  - Desire to reconcile sector focus with 'place', or
  - on evidence of their benefits?

Main motivation

- It is generally assumed that spatial clustering positively impacts on a plant's performance, leading to higher productivity.

"Clustering is viewed as beneficial to firms (particularly to small firms) because they can access a shared pool of expertise and labour, suppliers, and information or contacts." (HC BP7682, 4 April 2018)

- Here we use a cluster index for each 4-digit SIC and find that such Marshallian spillovers are by no means universal, and in many cases only benefit larger plants (with sufficient absorptive capacity).

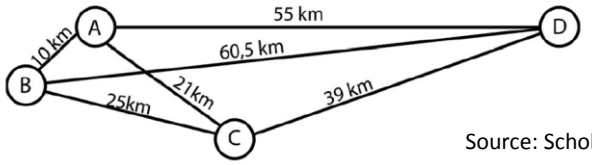
Measuring clustering

- Use a Distance index
  - based on mapping the location of every plant to every other plant in an industry
- Obtained by calculating the distance in kilometres between all pairs of (weighted by employment) plants in each 4-digit SIC80, using the plant's postcode district (first 4-digits of the UK postcode) and the following formula:

$$D_i = \frac{1}{J-1}\sum_{j=1, j\neq i}^{J}\left(e^{-0.05(d_{i,j})} \times \frac{E_j}{\sum_{k=1,k\neq i} E_k}\right)$$

  - where D_i is the sum of inverted distances from plant *i* to all other plants in the same 4-digit industry;
  - *J* is the number of observations;
  - $d_{i,j}$ is the distance between plant *i* and *j*;
  - E_j is the number of employees in plant *j*; and
  - $\sum_{k=1,k\neq i} E_k$ is the total employment in all other plants, except plant *i*, in the observed industry.

Simple example



Source: Scholl and Brenner (2016)

- Consider 4 plants (A-D). For plant *A* a simple version of D_i value is:

$$\frac{1}{3}\cdot\left(\frac{1}{10\,\text{km}}+\frac{1}{21\,\text{km}}+\frac{1}{55\,\text{km}}\right)=0.055\left[\frac{1}{\text{km}}\right]$$

- The values for plants *B, C, D* are: 0.052, 0.052 and 0.02, respectively.
- The higher is D_i value, the more a plant is located in spatial proximity to other plants in the same industry.

Clustering in GB manufacturing 2012-2014

Table 1 (weighted) means and coefficient of variation of D_{iy} 2012-14

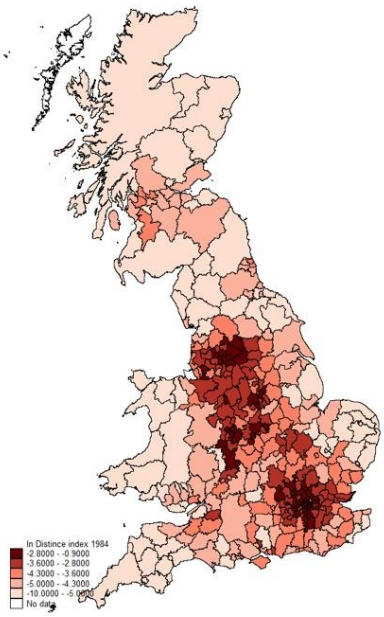
Industry (SIC80)	means	cv	Observations*	No. of unique firms*
Office machinery & data processing (SIC33)	0.128	4.967	1,341	309
Electrical and electronic engineering (SIC34)	0.187	5.288	2,131	1,053
Motor Vehicles and parts (SIC35)	0.047	3.494	854	365
Instrumental engineering (SIC37)	0.047	2.157	1,108	483
Pharmaceuticals (SIC2570)	0.057	2.636	390	123
Aerospace (SIC3640)	0.079	2.986	772	170
Metal manufacturing (SIC22)	0.079	2.270	691	326
Extraction of minerals nes (SIC23)	0.126	1.868	29	11
Non-metallic mineral products (SIC24)	0.044	4.861	4,315	674
Chemicals (SIC25 ex. 2570)	0.055	2.782	2,355	789
Metal good nes (SIC31)	0.074	2.875	1,670	918
Mechanical engineering (SIC32)	0.039	2.075	5,779	2,651
Other transport equipment SIC36 (ex. 3640)	0.074	3.665	781	283
Food products (SIC41)	0.049	3.051	2,928	683
Drinks & Tobacco (SIC42)	0.078	3.173	2,003	601
Textiles (SIC43)	0.122	2.254	648	401
Leather & Leather goods (SIC44)	0.132	2.790	67	46
Footwear & Clothing (SIC45)	0.100	3.518	720	424
Timber & Furniture (SIC46)	0.038	2.134	1,728	1,022
Paper & Printing (SIC47)	0.104	5.327	4,315	1,562
Rubber & Plastics (SIC48)	0.040	1.993	1,652	681
Other manufacturing (SIC49)	0.272	4.753	636	478
All manufacturing	0.083	5.750	36,927	14,053

*Unweighted counts

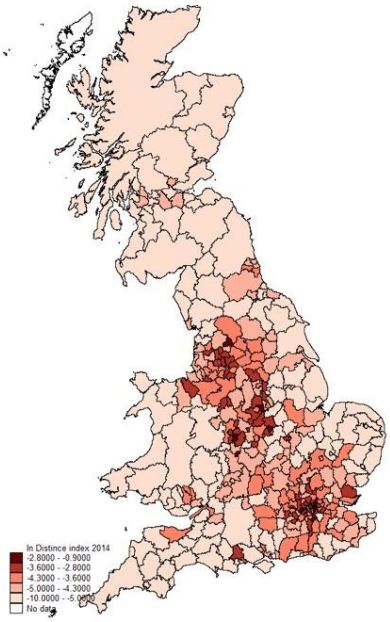
Source: see Table A.1 and text

Figure 1: Average *ln* Distance index by local authority, 1984 and 2014: all manufacturing plants

1984



2014



Data used in this project

Table A.1 Definitions of variables used (weighted) – manufacturing sector, 1984-2014

Variable	Definition	Mean	Std. Dev.	Source
ln gross output	*ln* real gross output (£m 2000 prices)	-0.394	1.790	ARD
ln Intermediate Inputs	*ln* intermediate inputs (gross output - GVA) (£m 2000 prices)	-1.148	1.998	ARD
ln Employment	*ln* numbers employed in plant	2.386	1.534	ARD
ln Capital	*ln* plant and machinery capital stock (£m 1995 prices) plus real value hires. Source: Harris and Drinkwater (2000, updated)	4.619	2.379	ARD
ln Distance	*ln* distance index (see text for details)	-4.033	2.059	BSD
ln Distance × employment	*ln* distance index × employment	-8.140	5.694	BSD/ARD
ln Age	*ln* number of years since year of opening	1.747	1.045	ARD
Single-Plant Enterprise	Dummy coded 1 if plant comprises a single-plant enterprise	0.341	0.474	ARD
Multi-Region Enterprise	Dummy coded 1 if plant belongs to an enterprise operating plants in more than one UK region	0.501	0.500	ARD
Multi-SIC Enterprise	Dummy coded 1 if enterprise has more than one 4-digit SIC80 across plants it owns	0.382	0.486	ARD
USA	Dummy coded 1 if plant is US-owned	0.047	0.211	ARD
EU	Dummy coded 1 if plant is EU-owned	0.067	0.251	ARD
OFO	Dummy coded 1 if plant is other foreign-owned	0.023	0.149	ARD
Diversification	*ln* proportion of the 206 4-digit SIC80 industries in each LA in which plant is located - Jacobian spillovers	-0.499	0.395	ARD
ln Herfindahl Index	*ln* Herfindahl index of industry concentration (3-digit level)	-2.886	0.994	ARD
Cities	Dummy coded 1 if plant is located in major city (defined by NUTS3 code)*	0.137	0.344	ARD
Unweighted N		631,788		

* These are London, Manchester, Birmingham, Glasgow, Edinburgh, Cardiff, Tyneside, Liverpool, Bristol, Nottingham, Leicester and Coventry

Estimates of TFP

- Estimate:

Gross output, employment, Capital stock, Time trend

$$y_{it} = a_i + a_E e_{it} + a_M m_{it} + a_K k_{it} + a_X X_{it} + a_T t + e_{it}$$

Intermediate inputs, Other factors, Other (random) effects

- To obtain:

Output minus, Factor inputs

$$\ln \hat{TFP}_{it} = y_{it} - \hat{a}_E e_{it} - \hat{a}_M m_{it} - \hat{a}_K k_{it} = \hat{a}_i + \hat{a}_X X_{it} + \hat{a}_T t + \hat{e}_{it}$$

- Use system-GMM
  - Fixed effects, endogeneity, dynamics
    - Note the following are treated as endogenous
      - Output, Factor inputs (e_{it}, m_{it}, k_{it}), *ln* distance, and foreign-ownership.

Reconciling TFP with Labour Productivity (LP)

- Note:

$$\Delta(y-e)_{it} = (\hat{\alpha}_E - 1)\Delta e_{it} + \hat{\alpha}_M \Delta m_{it} + \hat{\alpha}_K \Delta k_{it} + \Delta ln\widehat{TFP}_{it}$$

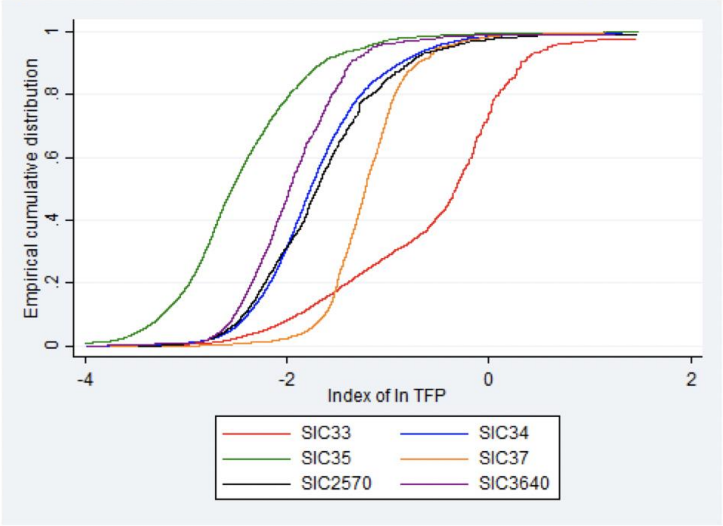
- changes in labour productivity (log output, *y*, minus log employment, *e*) are:
  - negatively related to increases in employment [since $(\hat{\alpha}_E - 1)) < 0$, where $\hat{\alpha}_E$ is the output-elasticity of output with respect to labour], and
  - positively related to increases in intermediate inputs (*m*), capital stock (*k*) and TFP.
- Thus LP is determined by:
  - Changes in factor mixes (e.g., over time labour is substituted by capital and/or intermediate inputs as mechanization and/or supply-chains become more important)
  - Longer-run improvements in efficient and technical change (i.e. TFP)

Table 1: Long-run (weighted) parameter estimates of production function using System-GMM (1980 SIC), 1984-2014

VARIABLES	SIC33	SIC34	SIC35	SIC37	SIC2570	SIC3640
ln Intermediate Inputs	0.765***	0.322***	0.309***	0.524***	0.685***	0.351***
ln Employment	0.186***	0.605***	0.751***	0.465***	0.219***	0.665***
ln Capital	0.293***	0.216***	0.136***	0.079**	0.262***	0.110***
Time trend	0.057***	0.022***	0.021***	0.005***	0.001	0.009***
ln Age	-0.369***	-0.213	-0.170***	-0.038	-0.319***	-0.082
Single-Plant Enterprise	-0.047	0.013	-0.057***	0.124***	0.051	-0.072
Multi-Region Enterprise	-0.014	0.134***	0.035	0.103***	-0.093***	0.029
Multi-SIC Enterprise	-0.018	-0.096***	-0.050***	0.028*	0.010	-0.059*
USA	0.132**	0.061	0.128***	0.080**	0.022	0.142**
EU	-0.006	0.128*	0.203***	0.142***	0.030	-0.039
OFO	-0.245***	0.106	-0.012	0.148***	-0.368***	-0.066
ln Distance	0.035***	-0.043	-0.122***	-0.037**	-0.111***	-0.046
ln Distance × employment	0.028***	0.045***	0.036***	0.024***	0.041***	0.020
urbanisation	-0.029	-0.100	0.046	-0.061	-0.228**	-0.053
Cities	0.049	0.028	0.018	0.047	-0.008	-0.011
ln Herfindahl Index	-0.058	-0.018	0.084***	-0.075***	0.089***	0.104***
North-East	0.021	-0.091**	-0.111***	-0.064	0.006	0.066
Yorkshire-Humberside	0.013	-0.061	-0.051	0.025	0.093*	-0.105**
North-West	0.045	-0.136	0.012	-0.016	0.169***	0.023
West Midlands	0.207**	-0.005	-0.090*	-0.094*	0.122*	0.013
East Midlands	0.091	-0.047	-0.064*	-0.070**	0.086*	-0.078
South-West	0.202***	0.085	-0.036	0.018	0.055	-0.025
East	0.234***	0.027	-0.014	0.002	0.139**	-0.055
London	0.080	-0.048	-0.064	-0.013	0.096	-0.068
Scotland	-0.023	-0.065*	-0.120***	-0.001	0.305***	-0.047
Wales	0.203***	0.025	-0.035	-0.04	0.141***	-0.114
Unweighted Observations	2,117	27,197	10,636	6,451	3,871	4,434
Unweighted Number of firms	423	4,301	1,590	1,283	470	500
AR(1) z-statistic	-3.818***	-6.279	-7.624***	-2.637***	-4.665***	-7.472***
AR(2) z-statistic	0.240	0.89	0.218	0.964	-0.272	0.895
Hansen test	75.71	28.32	31.68	50.63	69.78	41.75
Hansen test p-value	0.131	0.395	0.135	0.144	0.260	0.141

*** p<0.01, ** p<0.05, * p<0.1

Figure 3: Cumulative distribution of *ln* TFP for plants in certain sectors



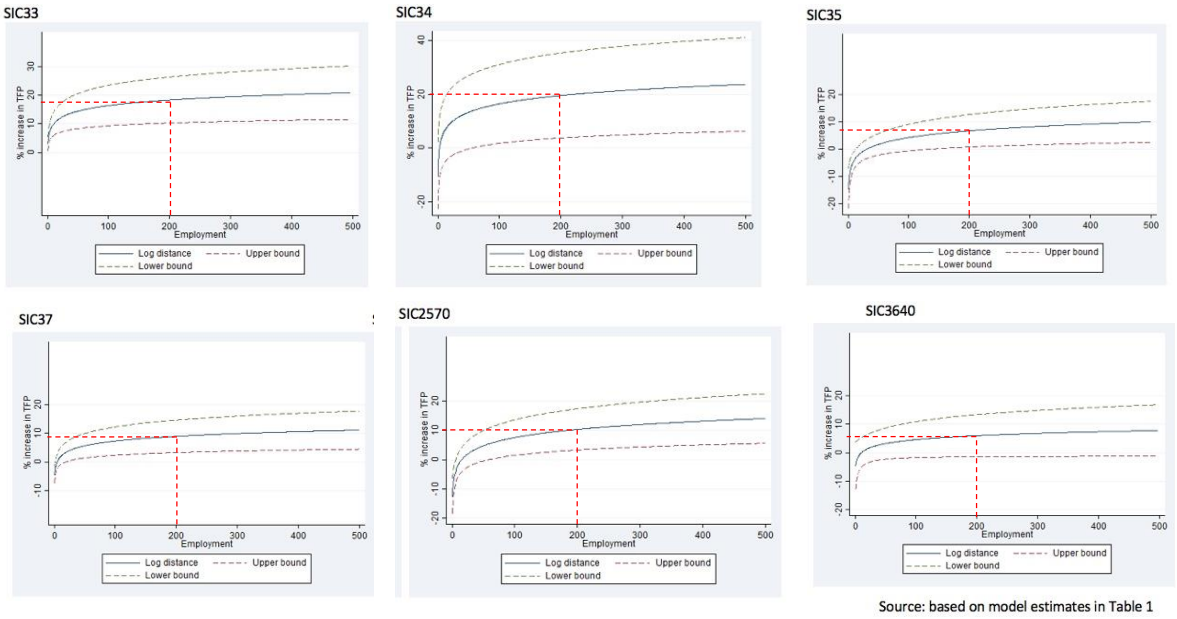
Impact of distance (clustering) on TFP by size of plant

Table 2: Long-run (weighted) parameter estimates of production function using System-GMM (1980 SIC), 1984-2014

VARIABLES	SIC33	SIC34	SIC35	SIC37	SIC2570	SIC3640	SIC22	SIC23	SIC24	SIC25ex2570	SIC31
Distance 5 employees	0.081***	0.030	-0.065***	0.002	-0.046*	-0.014	0.091***	-0.054	0.042	0.176***	0.128
Distance 10 employees	0.100***	0.061	-0.040**	0.018	-0.018	0.000	0.077***	-0.029	0.053	0.166***	0.144
Distance 50 employees	0.145***	0.133	0.018	0.057**	0.048	0.032	0.045*	0.026	0.078*	0.140**	0.183
Distance 200 employees	0.184***	0.195**	0.067*	0.090***	0.104***	0.060	0.018	0.075	0.099*	0.119*	0.217

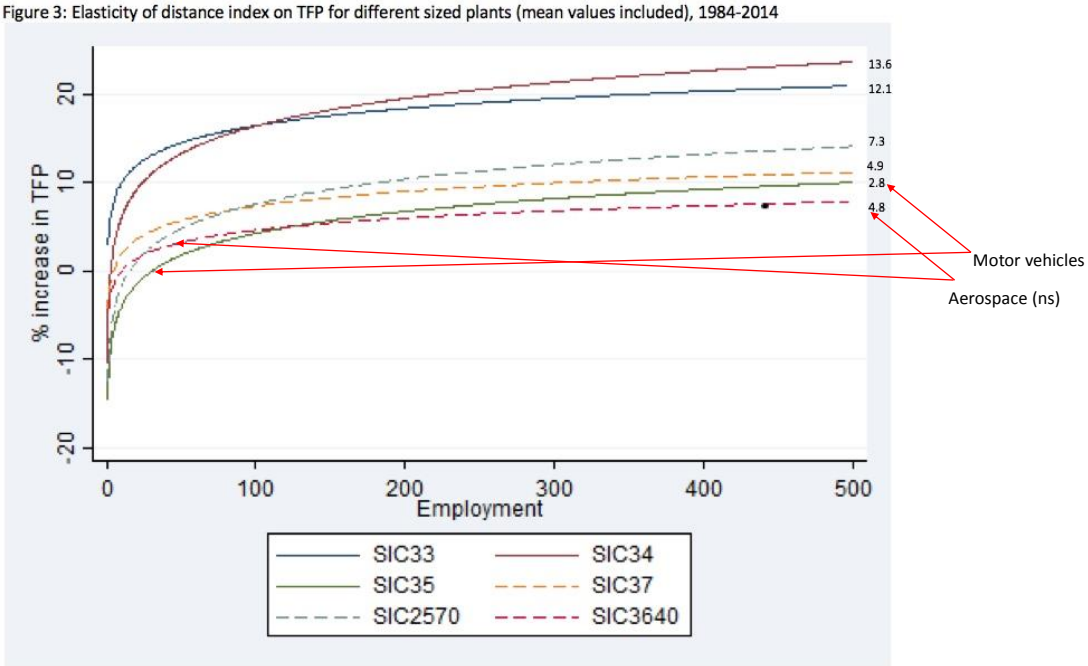
VARIABLES	SIC32	SIC36ex3640	SIC41	SIC42	SIC43	SIC44	SIC45	SIC46	SIC47	SIC48	SIC49
Distance 5 employees	0.007	0.203***	-0.021	0.041	0.055	0.018	0.069**	-0.043**	0.081***	0.088*	-0.168***
Distance 10 employees	0.017	0.181***	-0.011	0.045	0.042	0.047***	0.068**	-0.026	0.081***	0.078*	-0.128***
Distance 50 employees	0.039	0.132***	0.013	0.053*	0.012	0.114***	0.067	0.015	0.082***	0.057	-0.037
Distance 200 employees	0.059*	0.089	0.033	0.061	-0.014	0.172***	0.066	0.049	0.082**	0.039	0.042

Figure 2: Elasticity of distance index on TFP for different sized plants for selected industries, 1984-2014



Source: based on model estimates in Table 1

Figure 3: Elasticity of distance index on TFP for different sized plants (mean values included), 1984-2014



Source: Figure 1

Summary and conclusions

- It is generally assumed that spatial clustering positively impacts on a plant's performance, leading to higher productivity.

Clustering is viewed as beneficial to firms (particularly to small firms) because they can access a shared pool of expertise and labour, suppliers, and information or contacts. (HC BP7682, 4 April 2018)

- This approach uses a cluster index for each 4-digit SIC and finds that such Marshallian spillovers are by no means universal, and in many cases only benefit larger plants (with sufficient absorptive capacity).
- We also find other 'place' factors impact on TFP, especially the impact of being located in different regions, which are often larger than narrowly defined spatial clustering
- We find no evidence for our 6 key sectors, after controlling for other effects, that being located in a major city lead to a positive TFP impact.