Economic Geography

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International Trade II, Chapter 5

This Lecture

- Stylized facts about agglomeration of economic activity
- Testing sources of agglomeration:
  - Direct estimation
  - Estimation from spatial equilibrium

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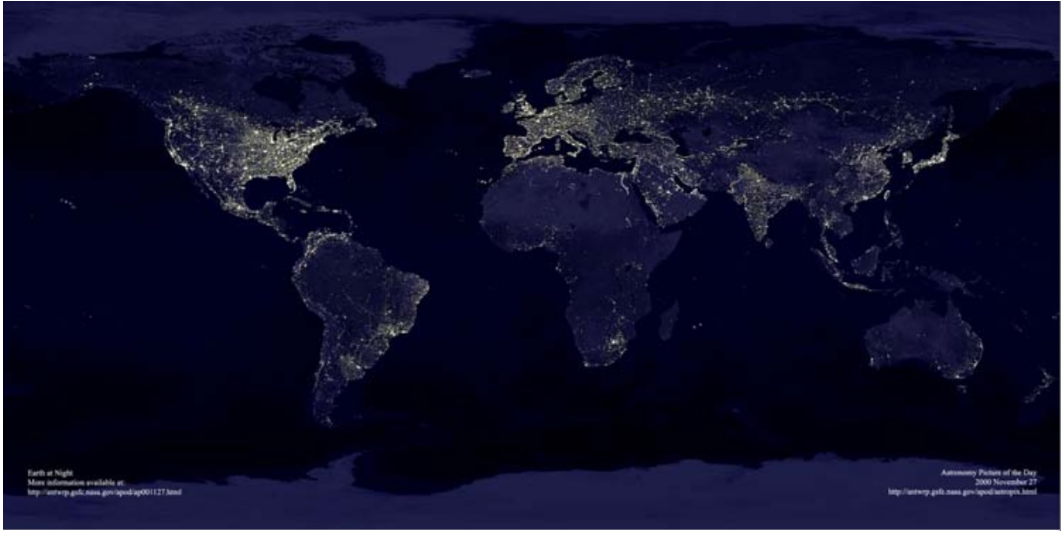
The Earth at Night



Urban Development in Satellite Images

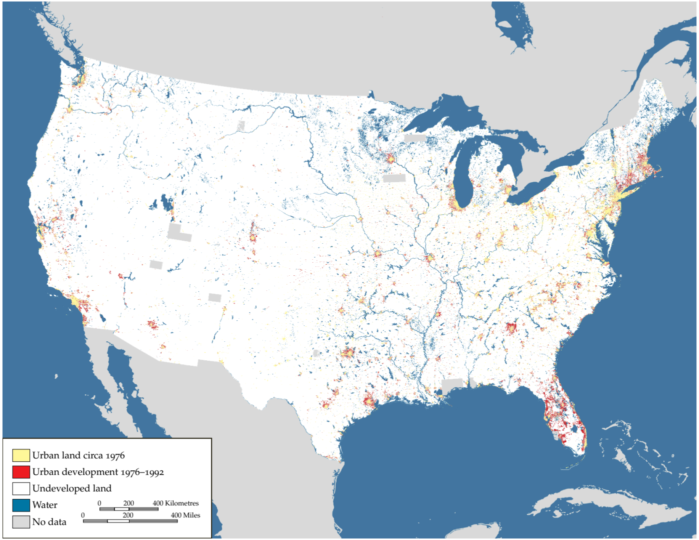
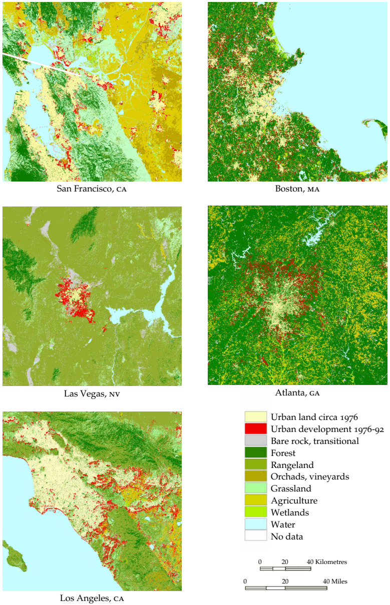


Figure 1. Urban development 1976–92 in the continental US

Urban Sprawl



Geographic Concentration of Industry: Ellison and Glaeser

- EG (1997) asks: Just how concentrated is economic activity within any given industry in the US?
- Key point: What is the right null hypothesis?
  - If output within an industry is highly concentrated in a small number of plants, then that industry will look very concentrated spatially, simply by nature of the small number of plants.
- EG develops an index (denoted γ and now known as 'the EG index') of localization that considers as its null hypothesis the random location of plants within an industry.
  - We don't have time to go into the definition of γ, but see the paper for that.
  - See also Duranton and Overman (ReStud, 2005) on an axiomatic approach to generalizing the EG index to correct for the lumpiness of 'locations' in the data.

EG (1997): Results

For industries that we might expect to be highly localized:

- Autos: $\gamma = 0.127$
- Auto parts: $\gamma = 0.089$
- Carpets (Dalton, GA): $\gamma = 0.378$
- Electronics (Silicon Valley): $\gamma = 0.059$ to 0.142

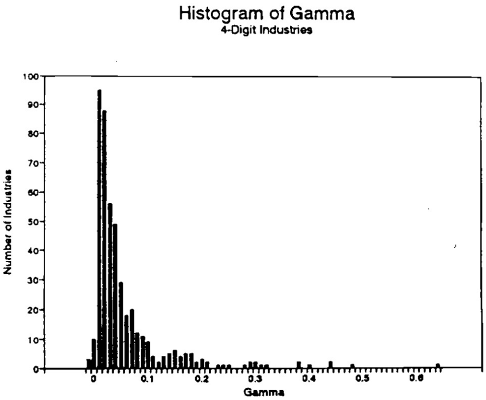
For industries that we might not expect to be highly localized:

- Bottled/canned soft drinks: $\gamma = 0.005$
- Newspaper: $\gamma = 0.002$
- Concrete: $\gamma = 0.012$
- Ice: $\gamma = 0.012$

EG (1997): Results (Continued)

- Virtually every industry exhibits excess concentration.
- Large heterogeneity.
- It is more common for industries to be only very slightly concentrated ($\gamma < 0.05$).

Figure 1: Histogram of γ



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- **Testing sources of agglomeration:**
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Why is Output so Agglomerated?

Three broad explanations:

1. Some production input is exogenously agglomerated:
   - Natural resources (e.g., the wine industry)
   - Institutions
2. Some consumption amenity is exogenously or endogenously agglomerated:
   - Non-tradable amenities, like nice places to live
   - People like to live near each other
   - Non-tradable amenities that are endogenously provided with increasing returns to scale (e.g., opera houses)
3. Some production input agglomerates endogenously:
   - Positive externalities (spillovers) that depend on proximity, e.g., Silicon Valley, Detroit, etc.
   - This is what is usually meant by the term, ‘agglomeration economies’
   - This source of agglomeration has attracted the greatest interest among economists.

What are Sources of Possible Agglomeration Economies?

The literature on this is enormous:

- Began with Marshall (1890)
- Recent surveys by Duranton and Puga (2004, Handbook of Urban and Regional Econ)

Typically, three forces for potential agglomeration economies:

1. Thick input markets (reduce search costs and idiosyncratic risk)
2. Increasing returns to scale combined with trade costs (on inputs or outputs)
3. Knowledge spillovers

Empirical Work on the Causes of Agglomeration

Recent surveys include:

- Redding (2010, J Reg. Sci. survey)
- Rosenthal and Strange (2004, Handbook of Urban and Regional Econ)
- Head and Mayer (2004, Handbook of Urban and Regional Econ)
- Overman, Redding and Venables (2004, Handbook of International Trade)
- Combes et al. textbook, Economic Geography

Broadly, two approaches:

1. Estimating agglomeration economies directly
2. Estimating from the extent of agglomeration in observed spatial equilibrium

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Estimating Agglomeration Economies Directly

- A large literature argues that if agglomeration economies exist, production units should be more productive when surrounded by other producers.
- Krugman model gives rise to agglomeration: backward and forward linkages leads to lower cost of production
- Two modern examples:
  - Henderson (2003, JUE) on across-firm (within-location) externalities
  - Moretti (2004, AER) on local (within-city) human capital externalities
- A central challenge with this approach is an analogy to the challenge that faces the 'peer effects' literature (e.g. Manski, 1993): does one unit actually affect a proximate unit, or are proximate units just similar on unobservable dimensions?
- Greenstone, Hornbeck and Moretti (JPE, 2010) consider a natural experiment approach to this question.

Greenstone, Hornbeck and Moretti (2010)

Preview in one page

- Effect of ‘million dollar plants’ (huge industrial plants) have on incumbent firms of the same region.

- Example (from paper):
  - BMW did a worldwide search for a new plant location in 1991. 2 finalists: Omaha, NE, and Greenville-Spartanburg, SC. BMW chose Greenville-Spartanburg.

- Why? BMW stated:
  - Low costs of production: low union density, supply of quality workers, numerous global firms in the area (including 58 German companies), good transport infrastructure, and access to key local services.
  - A subsidy of $115 million was received from the local government.

- GHM obtained a list of the winner and loser counties for 82 MDP openings and compared winners to losers (rather than comparing winners to all 3,000 other counties, or to counties that look similar on observables).

Greenstone, Hornbeck and Moretti (2010)

Research question

The magnitude of the agglomeration spillover, and the mechanism

1. How does the opening of a large manufacturing plant affect the Total Factor Productivity (TFP) of incumbent plants in the same country?
2. Is there any evidence in favor of the proposed mechanisms?
3. Is the spillover reflected in higher local factor prices?

Greenstone, Hornbeck and Moretti (2010)

Data

1. Site Selection's "Million Dollar Plant" articles
   - 82 announcements of plant winners and losers
2. Standard Statistical Establishment List (SSEL)
   - Match MDP openings to plant-level data
   - 47 usable matches in manufacturing industries
3. Annual Survey of Manufacturers (ASM)
   - Plant-level data on inputs/outputs
   - Construct capital stocks using the permanent inventory method

Greenstone, Hornbeck and Moretti (2010)

Research design

- Plants choose locations based on the NPV of expected profits, which may be correlated in unobserved ways with other plants' changes in TFP.

"Million Dollar Plant" Research Design:

- Rely on reported location rankings by profit-maximizing firms to identify the counterfactual

Typical selection process for new plant location:

- Start with a list of 100-200 sites
- Short list: 10-20 sites
- Finalists: 2 sites
- Winner: 1 site

Greenstone, Hornbeck and Moretti (2010)

Research design: Greenville BMW case study

The Decision Process

1. In 1990, BMW announces consideration of 250 sites
2. 20 counties are semifinalists
3. 2 finalists: Greenville, SC and Omaha, NE
4. In 1992, BMW announces Greenville, SC as the winner

Rationale for Decision

1. Subsidy worth $115 million
2. Low union density
3. Supply of qualified workers
4. 58 German companies in the area
5. Good transportation infrastructure

Greenstone, Hornbeck and Moretti (2010)

Research design: Greenville BMW case study

Ex-ante Anticipated Effects

1. Expected 5-year economic impact of $2 billion
2. 2,000 direct jobs
3. Another 2,000 jobs in related industries

   Example: Magna Int'l built a new plant to produce roofs, side panels, and doors for BMW

Greenstone, Hornbeck and Moretti (2010)

Research design: identification assumption

Identification assumption: conditional on being in the final pairing, incumbents' TFP would have evolved identically in the winning and losing counties.

In practice, we need this assumption to hold after conditioning on:

- Plant fixed effects
- Industry by year fixed effects
- Differences in pre-existing trends

Greenstone, Hornbeck and Moretti (2010)

Specification (Baseline)

$$
\begin{aligned}
\ln(Y_{pijt}) = {} & \beta_1 \ln(L_{pijt}) + \beta_2 \ln(K^B_{pijt}) + \beta_3 \ln(K^E_{pijt}) + \beta_4 \ln(M_{pijt}) \\
& + \delta \mathbf{1}(\text{Winner})_{pj} + \psi \text{Trend}_{jt} + \Omega[\text{Trend}_{jt} \times \mathbf{1}(\text{Winner})_{pj}] \\
& + \kappa \mathbf{1}(\tau \geq 0)_{jt} + \gamma[\text{trend}_{jt} \times \mathbf{1}(\tau \geq 0)_{jt}] \\
& + \theta_1[\mathbf{1}(\text{Winner})_{pj} \times \mathbf{1}(\tau \geq 0)_{jt}] \\
& + \theta_2[\text{Trend}_{jt} \times \mathbf{1}(\text{Winner})_{pj} \times \mathbf{1}(\tau \geq 0)_{jt}] \\
& + \alpha_p + \mu_{it} + \lambda_j + \varepsilon_{pijt}
\end{aligned}
$$

- p : plant, i : industry, j : case (λ_j instead of λ_p, typo in paper)
- $\ln(K^B_{pijt})$ and $\ln(K^E_{pijt})$ are building and equipment capital, respectively
- Paper discusses a long array of robustness and sensitivity analyses (including estimation using Olley-Pakes methodology)

Greenstone, Hornbeck and Moretti (2010)

TABLE 3

County and Plant Characteristics by Winner Status, 1 Year Prior to a Million Dollar Plant Opening

	All Plants					Within Same Industry (Two-Digit SIC)				
	Winning Counties (1)	Losing Counties (2)	All U.S. Counties (3)	*t*-Statistic (Col. 1 − Col. 2) (4)	*t*-Statistic (Col. 1 − Col. 3) (5)	Winning Counties (6)	Losing Counties (7)	All U.S. Counties (8)	*t*-Statistic (Col. 6 − Col. 7) (9)	*t*-Statistic (Col. 6 − Col. 8) (10)
	A. County Characteristics									
No. of counties	47	73				16	19			
Total per capita earnings ($)	17,418	20,628	11,259	**−2.05**	**5.79**	20,230	20,528	11,378	−.11	**4.62**
% change, over last 6 years	.074	.096	.037	−.81	1.67	.076	.089	.057	−.28	.57
Population	322,745	447,876	82,381	−1.61	**4.33**	357,955	504,342	83,430	−1.17	**3.26**
% change, over last 6 years	.102	.051	.036	**2.06**	**3.22**	.070	.032	.031	1.18	1.63
Employment-population ratio	.535	.579	.461	−1.41	**3.49**	.602	.569	.467	.64	**3.63**
Change, over last 6 years	.041	.047	.023	−.68	**2.54**	.045	.038	.028	.39	1.57
Manufacturing labor share	.314	.251	.252	**2.35**	**3.12**	.296	.227	.251	1.60	1.17
Change, over last 6 years	−.014	−.031	−.008	1.52	−.64	−.030	−.040	−.007	.87	**−3.17**
	B. Plant Characteristics									
No. of sample plants	18.8	25.6	7.98	−1.35	**3.02**	2.75	3.92	2.38	−1.14	.70
Output ($1,000s)	190,039	181,454	123,187	.25	**2.14**	217,950	178,958	132,571	.41	1.25
% change, over last 6 years	.082	.082	.118	.01	−.97	−.061	.177	.182	−1.23	**−3.38**
Hours of labor (1,000s)	1,508	1,168	877	1.52	**2.43**	1,738	1,198	1,050	.92	1.33
% change, over last 6 years	.122	.081	.115	.81	.14	.160	.023	.144	.85	.13

Note.—For each case to be weighted equally, counties are weighted by the inverse of their number per case. Similarly, plants are weighted by the inverse of their number per county multiplied by the inverse of the number of counties per case. The sample includes all plants reporting data in the ASM for each year between the MDP opening and 8 years prior. Excluded are all plants owned by the firm opening an MDP. Also excluded are all plants from two uncommon two-digit SIC values so that subsequently estimated clustered variance matrices would always be positive definite. The sample of all U.S. counties excludes winning counties and counties with no manufacturing plant reporting data in the ASM for 9 consecutive years. These other U.S. counties are given equal weight within years and are weighted across years to represent the years of MDP openings. Reported *t*-statistics are calculated from standard errors clustered at the county level. *t*-statistics greater than 2 are reported in bold. All monetary amounts are in 2006 U.S. dollars.

Greenstone, Hornbeck and Moretti (2010)

Statistically equivalent trend, 7 years before the MDP opened

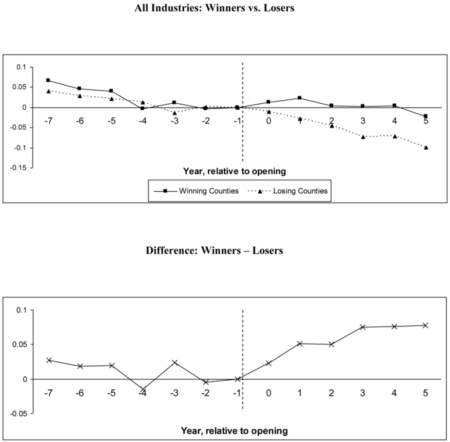

FIG. 1.—All incumbent plants' productivity in winning versus losing counties, relative to the year of an MDP opening. These figures accompany table 4.

Greenstone, Hornbeck and Moretti (2010)

After the MDP opened, incumbent plants in winning counties experienced a sharp relative increase in TFP

TABLE 4
INCUMBENT PLANT PRODUCTIVITY, RELATIVE TO THE YEAR OF AN MDP OPENING

Event Year	In Winning Counties (1)	In Losing Counties (2)	Difference Col. 1 − Col. 2 (3)
$\tau = -7$	.067	.040	.027
	(.058)	(.053)	(.032)
$\tau = -6$	.047	.028	.018
	(.044)	(.046)	(.023)
$\tau = -5$	.041	.021	.020
	(.036)	(.040)	(.025)
$\tau = -4$	−.003	.012	−.015
	(.030)	(.030)	(.024)
$\tau = -3$	.011	−.013	.024
	(.022)	(.022)	(.021)
$\tau = -2$	−.003	.001	−.005
	(.027)	(.011)	(.028)
$\tau = -1$	0	0	0
$\tau = 0$	.013	−.010	.023
	(.018)	(.011)	(.019)
$\tau = 1$	.023	−.028	.051**
	(.026)	(.024)	(.023)
$\tau = 2$	.004	−.046	.050
	(.036)	(.046)	(.033)
$\tau = 3$	.003	−.073	.076*
	(.047)	(.057)	(.043)
$\tau = 4$	.004	−.072	.076**
	(.053)	(.062)	(.033)
$\tau = 5$	−.023	−.100	.077**
	(.069)	(.067)	(.035)
R^2	.9861		
Observations	28,732		

NOTE.—Standard errors are clustered at the county level. Columns 1 and 2 report coefficients from the same regression: the natural log of output is regressed on the natural log of inputs (all worker hours, building

Greenstone, Hornbeck and Moretti (2010)

TABLE 5

CHANGES IN INCUMBENT PLANT PRODUCTIVITY FOLLOWING AN MDP OPENING

	ALL COUNTIES: MDP WINNERS − MDP LOSERS		MDP COUNTIES: MDP WINNERS − MDP LOSERS		ALL COUNTIES: RANDOM WINNERS
	(1)	(2)	(3)	(4)	(5)
			A. Model 1		
Mean shift	.0442*	.0435*	.0524**	.0477**	− 0.0496***
	(.0233)	(.0235)	(.0225)	(.0231)	(.0174)
				[$170 m]	
R^2	.9811	.9812	.9812	.9860	~0.98
Observations (plant by year)	418,064	418,064	50,842	28,732	~400,000
			B. Model 2		
Effect after 5 years	.1301**	.1324**	.1355***	.1203**	−.0296
	(.0533)	(.0529)	(.0477)	(.0517)	(.0434)
				[$429 m]	
Level change	.0277	.0251	.0255	.0290	.0073
	(.0241)	(.0221)	(.0186)	(.0210)	(.0223)
Trend break	.0171*	.0179**	.0183**	.0152*	− 0.0062
	(.0091)	(.0088)	(.0078)	(.0079)	(.0063)
Pre-trend	−.0057	−.0058	−.0048	−.0044	−.0048
	(.0046)	(.0046)	(.0046)	(.0044)	(.0040)
R^2	.9811	.9812	.9813	.9861	~.98
Observations (plant by year)	418,064	418,064	50,842	28,732	~400,000
Plant and industry by year fixed effects	Yes	Yes	Yes	Yes	Yes
Case fixed effects	No	Yes	Yes	Yes	NA
Years included	All	All	All	$-7 \leq \tau \leq 5$	All

NOTE.—The table reports results from fitting several versions of eq. (8). Specifically, entries are from a regression of the natural log of output on the natural log of inputs, year by two-digit SIC fixed effects, plant fixed effects, and case fixed effects. In model 1, two additional dummy variables are included for whether the plant is in a winning county 7 to 1 years before the MDP opening or 0 to 5 years after. The reported mean shift indicates the difference in these two coefficients, i.e., the average change in TFP following the opening. In model 2, the same two dummy variables are included along with pre- and post-trend variables. The shift in level and trend are reported, along with the pre-trend and the total effect evaluated after 5 years. In cols. 1, 2, and 5, the sample is composed of all manufacturing plants in the ASM that report data for 14 consecutive years, excluding all plants owned by the MDP firm. In these models, additional control variables are included for the event years outside the range from $\tau = -7$ through $\tau = 5$ (i.e., −20 to −8 and 6 to 17). Column 2 adds the case fixed effects that equal one during the period that τ ranges from −7 through 5. In cols. 3 and 4, the sample is restricted to include only plants in counties that won or lost an MDP. This forces the industry by year fixed effects to be estimated solely from plants in these counties. For col. 4, the sample is restricted further to include only plant by year observations within the period of interest (where τ ranges from −7 to 5). This forces the industry by year fixed effects to be estimated solely on plant by year observations that identify the parameters of interest. In col. 5, a set of 47 plant openings in the entire country were randomly chosen from the ASM

Greenstone, Hornbeck and Moretti (2010)

TABLE 6
CHANGES IN INCUMBENT PLANT OUTPUT AND INPUTS FOLLOWING AN MDP OPENING

	Output (1)	Worker Hours (2)	Machinery Capital (3)	Building Capital (4)	Materials (5)
Model 1: mean shift	.1200***	.0789**	.0401	.1327*	.0911***
	(.0354)	(.0357)	(.0348)	(.0691)	(.0302)
Model 2: after 5 years	.0826*	.0562	−.0089	−.0077	.0509
	(.0478)	(.0469)	(.0300)	(.0375)	(.0541)

NOTE.—The table reports results from fitting versions of eq. (8) for each of the indicated outcome variables (in logs). See the text for more details. Standard errors clustered at the county level are reported in parentheses.

* Significant at the 10 percent level.
** Significant at the 5 percent level.
*** Significant at the 1 percent level.

Greenstone, Hornbeck and Moretti (2010)

TABLE 7

Changes in Incumbent Plant Productivity Following an MDP Opening for Incumbent Plants in the MDP's Two-Digit Industry and All Other Industries

	All Industries (1)	MDP's Two-Digit Industry (2)	All Other Two-Digit Industries (3)
		A. Model 1	
Mean shift	.0477**	.1700**	.0326
	(.0231)	(.0743)	(.0253)
	[$170 m]	[$102 m]	[$104 m]
R^2	.9860	.9861	
Observations	28,732	28,732	
		B. Model 2	
Effect after 5 years	.1203**	.3289	.0889*
	(.0517)	(.2684)	(.0504)
	[$429 m]	[$197 m]	[$283 m]
Level change	.0290	.2814***	.0004
	(.0210)	(.0895)	(.0171)
Trend break	.0152*	.0079	.0147*
	(.0079)	(.0344)	(.0081)
Pre-trend	−.0044	−.0174	−.0026
	(.0044)	(.0265)	(.0036)
R^2	.9861	.9862	
Observations	28,732	28,732	

Note.—The table reports results from fitting versions of eq. (8). As a basis for comparison, col. 1 reports estimates from the baseline specification for incumbent plants in all industries (baseline estimates for incumbent plants in all industries, col. 4 of table 5). Columns 2 and 3 report estimates from a single regression, which fully interacts the winner/loser and pre/post variables with indicators for whether the incumbent plant is in the same two-digit industry as the MDP or a different industry. Reported in parentheses are standard errors clustered at the county level. The numbers in brackets are the value (2006 U.S. dollars) from the estimated increase in productivity: the percentage increase is multiplied by the total value of output for the affected incumbent plants in the winning counties.

* Significant at the 10 percent level.

** Significant at the 5 percent level.

*** Significant at the 1 percent level.

Greenstone, Hornbeck and Moretti (2010)

Do not find spillovers associated with input-output links.

TABLE 8

CHANGES IN INCUMBENT PLANT PRODUCTIVITY FOLLOWING AN MDP OPENING, BY MEASURES OF ECONOMIC DISTANCE BETWEEN THE MDP'S INDUSTRY AND INCUMBENT PLANT'S INDUSTRY

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
CPS worker transitions	.0701***						.0374
	(.0237)						(.0260)
Citation pattern		.0545***					.0256
		(.0192)					(.0208)
Technology input			.0320*				.0501
			(.0173)				(.0421)
Technology output				.0596***			.0004
				(.0216)			(.0434)
Manufacturing input					.0060		−.0473
					(.0123)		(.0289)
Manufacturing output						.0150	−.0145
						(.0196)	(.0230)
R^2	.9852	.9852	.9851	.9852	.9851	.9852	.9853
Observations	23,397	23,397	23,397	23,397	23,397	23,397	23,397

NOTE.—The table reports results from fitting versions of eq. (9), which is modified from eq. (8). Building on the model 1 specification in col. 4 of table 5, each column adds interaction terms between winner/loser and pre/post status with the indicated measures of how an incumbent plant's industry is linked to its associated MDP's industry (a continuous version of results in table 7). These industry linkage measures are defined and described in table 2, and here the measures are normalized to have a mean of zero and a standard deviation of one. The sample of plants is that in col. 4 of table 5, but it is restricted to plants that have industry linkage data for each measure. For assigning this linkage measure, the incumbent plant's industry is held fixed at its industry the year prior to the MDP opening. Whenever a plant is a winner or loser more than once, it receives an additive dummy variable and interaction term for each occurrence. Reported in parentheses are standard errors clustered at the county level.

Greenstone, Hornbeck and Moretti (2010)

Evidence of wage growth in treated counties.

TABLE 9

Changes in Counties' Number of Plants, Total Output, and Skill-Adjusted Wages Following an MDP Opening

	A. Census of Manufactures		B. Census of Population
	Dependent Variable: Log(Plants) (1)	Dependent Variable: Log(Total Output) (2)	Dependent Variable: Log(Wage) (3)
Difference-in-difference	.1255**	.1454	.0268*
	(.0550)	(.0900)	(.0139)
R^2	.9984	.9931	.3623
Observations	209	209	1,057,999

Note.—The table reports results from fitting three regressions. In panel A, the dependent variables are the log of number of establishments and the log of total manufacturing output in the county, based on data from the Census of Manufactures. Controls include county, year, and case fixed effects. Reported are the county-level difference-in-difference estimates for receiving an MDP opening. Because data are available every 5 years, depending on the census year relative to the MDP opening, the sample years are defined to be 1–5 years before the MDP opening and 4–8 years after the MDP opening. Thus, each MDP opening is associated with one earlier date and one later date. The col. 1 model is weighted by the number of plants in the county in years −6 to −10, and the col. 2 model is weighted by the county's total manufacturing output in years −6 to −10. In panel B, the dependent variable is log wage and controls include dummies for age by year, age squared by year, education by year, sex by race by Hispanic by citizen, and case fixed effects. Reported is the county-level difference-in-difference estimate for receiving an MDP opening. Because data are available every 10 years, the sample years are defined to be 1–10 years before the MDP opening and 3–12 years after the MDP opening. As in panel A, each MDP opening is associated with one earlier date and one later date. The sample is restricted to individuals who worked more than 26 weeks in the previous year, usually work more than 20 hours per week, are not in school, are at work, and work for wages in the private sector. The number of observations reported refers to unique individuals: some Integrated Public Use Microdata Series county groups include more than one Federal Information Processing Standard (FIPS), so all individuals in a county group were matched to each potential FIPS. The same individual may then appear in more than one FIPS, and observations are weighted to give each unique individual the same weight. Reported in parentheses are standard errors clustered at the county level.

Greenstone, Hornbeck and Moretti (2010)

Other threats to validity

Increases in public investment

- No change in government construction or total capital expenditures.

Increases in output prices

- No evidence for more local or more concentrated industries experiencing larger effects (some evidence for the opposite).

Increases in capital utilization

- No change in the ratio of energy usage to capital stock.

Differential attrition of sample plants

- 28% of winning plants attrit by year 5.
- 32% of losing plants attrit by year 5.
- These attriting plants are on similar pre-opening TFP trends.

Greenstone, Hornbeck and Moretti (2010)

Summary of results

The MDP opening is associated with a 12% increase in incumbent plants' Total Factor Productivity (TFP), 5 years later and across all industries.

- A $430 million increase in output, holding inputs constant.
- The estimates appear robust to alternative specifications: large increase in output, smaller increases in inputs.

Assessment of the Research Design:

- Measured county and plant characteristics were similar before the MDP opening, in both levels and trends.
- Pre-trends in TFP are similar for incumbent plants.

Greenstone, Hornbeck and Moretti (2010)

Summary of results

Do increases in TFP vary with economic distance?

- Larger for incumbents in the same 2-digit SIC.
- Larger for plants that share labor and technology pools.
- Similar for plants that share customer or supplier links.

Implications for incumbents' profits:

- A 2.7% increase in skill-adjusted wages.
- Though, there is some evidence of increased entry.

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