Million Ideas Plants: Do Occasional Inventors Benefit from Local Highly Patenting Companies?

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**This paper does not necessarily reflect the views of the OECD*

Motivations

- Greenstone, Hornbeck and Moretti (2010) [GHM] find a substantial effect of the location of "million dollar" plants (+12% in incumbents' productivity 5 years later)
- Knowledge spillovers are one of the leading mechanisms of agglomeration economics: this paper focuses primarily on this channel, expanding GHMs' findings
- *Million Ideas Plants (stars)* are localized pools of patents sharing the same "star" assignee
- The paper investigates whether the patenting activity of stars has any causal (IV) effect on the number of patents granted to other local inventors (comets) in the same US metropolitan area

Results and contributions

- The effect of stars on comets is overall positive, it is stronger with a time lag, and the spillovers are not confined within narrow technological categories
- The results contributes to filling in two gaps in the literature:
  - it improves our understanding of knowledge spillover and of the mechanisms of urban agglomeration
  - explores the skewness of the distribution of patents across inventors and companies
- Provide evidence for assessing the effectiveness of cluster policies

What we already know

- Long-standing evidence on the local dimension of knowledge spillovers:
  - Jaffe et al (1993): cited-citing patent couple twice as likely to be in the same US metropolitan area than a control couple
  - Carlino et al (2006): higher rate of patents in denser cities
  - Peri (2005): only 20% of knowledge is learned outside the region of origin
- Less evidence on the impact of "stars" on occasional inventors:
- Agrawal et al. (2012): the birth rate of new start-ups is higher in metropolitan areas where large and small labs coexist
- Azoulay et al. (2010) and Waldinger (2010) challenge the existence of localized positive spillovers originating from stars in academic environments

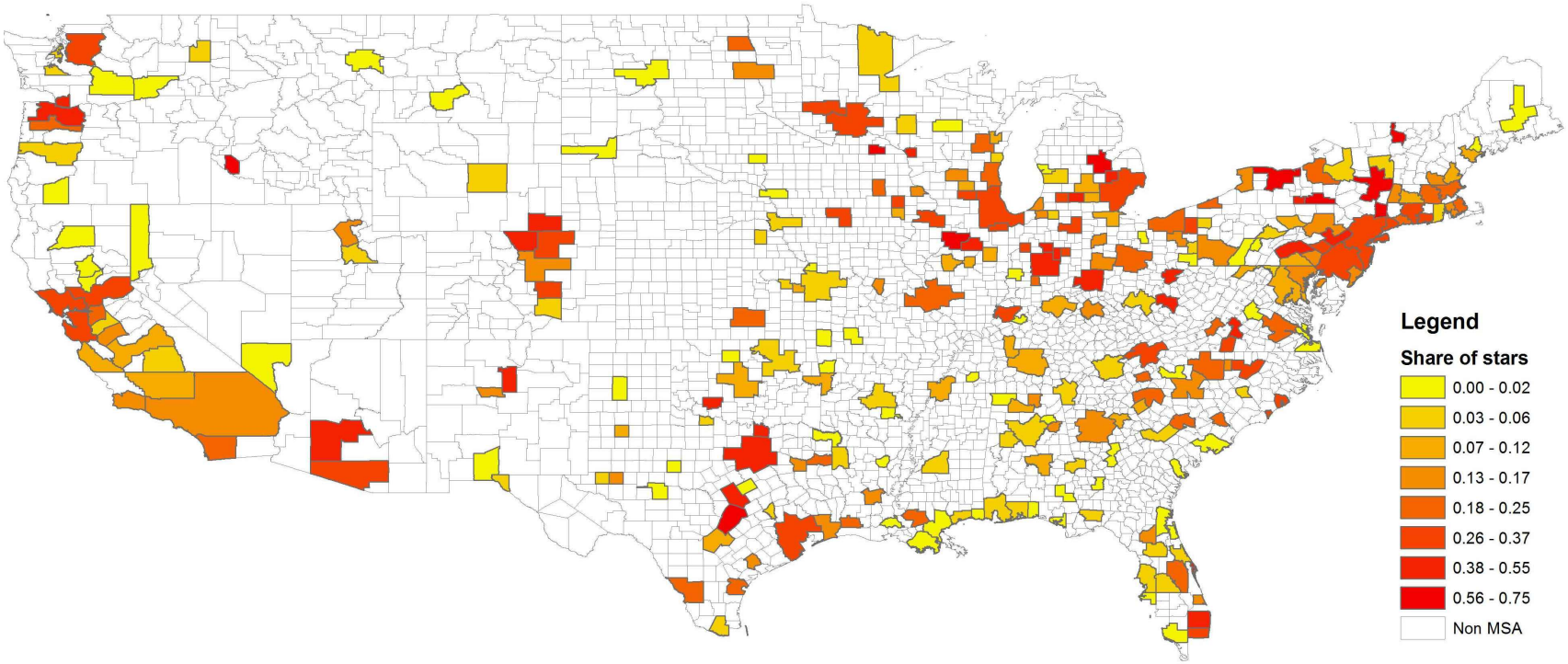
Are comet inventors important?

- Large empirical evidence on the primary role played by young and small firms in innovation (Acs and Audretsch, 1990) and employment growth (Haltiwanger, Jarmin and Miranda, Forthcoming)
- Balasubramanian & Sidavasan (2011): 1st patent has large effects on plant growth
- Comets have more *local* effects than stars
- Growing spatial disparities have spurred policies aimed at enhancing local innovation
  - Is attracting stars effective, or it is just a windfall for large companies?
  - California Dreamin'? Debate on cluster policies (Porter, 1998; Duranton, 2011)

Stars and Comets

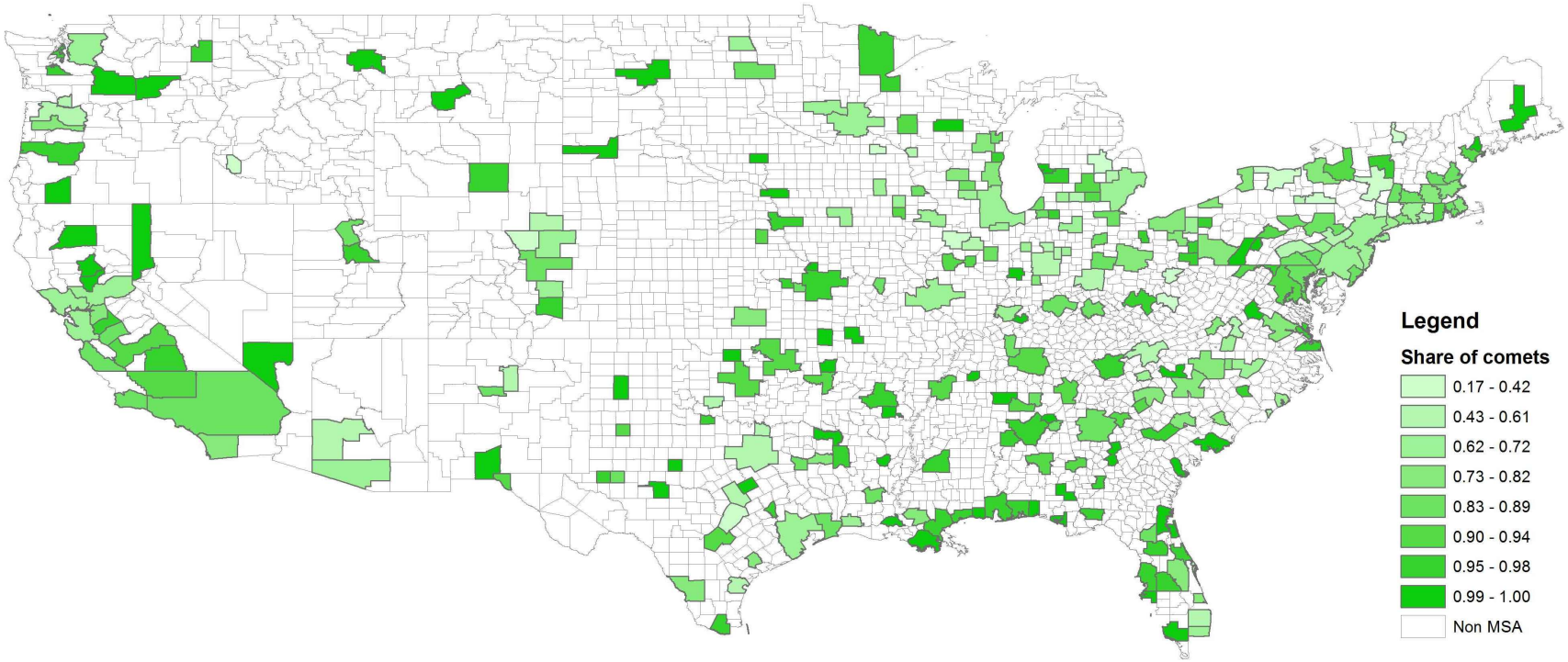
- Data from the NBER patent database: all patents granted by USTPO to US inventors from 1980 to 1999
- analysis at MSA level, focusing on the aggregate *patent count* produced by two groups of applicants: *stars* and *comets*
- The classification into the two groups is based on the total number of patents granted to the applicant over the whole period of analysis
  - stars patents are those assigned to the most inventive companies (top 50) in a given technological category
  - the remaining patents are defined as comets
  - Star patents without citations are excluded
- Five time periods of four years each
- Star patents account for 9% of the total patents granted

Share of star patents by MSA, period 5 (1994-97)



Note: the map shows the share of star patents in the total patents by MSAs in the period 1994-1997.
Source: author's elaboration on NBER Patent database and National Atlas digital maps.

Share of comet patents by MSA, period 5 (1994-97)



Note: the map shows the share of comet patents in the total patents by MSAs in the period 1994-1997.
Source: author's elaboration on NBER Patent database and National Atlas digital maps.

Why should stars affect local comets?

- Positive effects: five main mechanisms
  - Informal knowledge spillovers
  - Externalities through formal interaction and networking
  - Workplace contacts
  - Workplace mobility and spin-off
  - Attraction/display effects
- Positive effects are stronger across technologies and with a time lag?

Why should stars affect local comets?

- Negative effects: general equilibrium in local labour markets (Moretti 2011)
  - A raise in innovation activity in local star plants corresponds to an upward shift in the demand for local scientists
  - This increases nominal wages (at least in the short run) and reduces the number of local comet patents
  - The magnitude of these effects depends on the skill substitutability among star and comet inventors, and on the elasticity of supply of labour
- Negative effects are likely to be stronger
  - in the short term (labour supply is inelastic)
  - within narrowly-defined technological sectors (skill substitutability is higher)

Empirical analysis

- Does the production of star patents in a city affects the production of comet patents in the same city?

$$Comets_t^{ik} = \beta_1 \cdot Stars_t^{ik} + \beta_2 \cdot Stars_{t-1}^{ik} + \beta_2 \cdot Comets_{t-1}^{ik} + \theta_1 \cdot \sum_{j \neq i} Z_t^{jk} + \\ + \theta_2 \cdot \sum_{j \neq i} Z_{t-1}^{jk} + \gamma \cdot Totemp_t^i + \phi^i \delta^k + \delta^k \tau_t + \varepsilon_t^{ik} \quad (1)$$

- where i, k, and t index MSAs, categories, and periods, respectively; stars, comets are the number of patents in the respective groups, Z is a control specific to the MSA/category pair, Totemp is total MSA emp., and δ, τ, ϕ are category, time, and MSA fixed effects
- 3 models: all technologies; 5 categories; 27 subcategories
- All variables are in logs

Instrumental variable: star companies are multilocated

Company	Nr of patents	Nr of MSAs	Nr of States	Share of the 1st MSA
GEN ELECTRIC	12892	20	14	0,49
INT BUSINESS MACHINES	12281	16	16	0,18
EASTMAN KODAK	8828	4	4	0,86
MOTOROLA	8383	7	5	0,35
AT & T	7010	10	10	0,62
E I DU PONT DE NEMOURS	5991	5	5	0,89
XEROX	5918	3	2	0,78
GEN MOTORS	5330	10	4	0,51
DOW CHEM	5197	5	5	0,49
MINNESOTA MINING & MFG	5064	3	3	0,93
MOBIL OIL	4830	4	4	0,56
TEXAS INSTR	4617	5	2	0,74
WESTINGHOUSE ELECTRIC	3663	7	7	0,46
RCA	3548	4	4	0,44
HUGHES AIRCRAFT	3377	3	2	0,91
FORD MOTOR	3135	1	1	1,00
ALLIED SIGNAL	2969	8	8	0,45
HEWLETT PACKARD	2963	7	6	0,42
UNITED TECH	2907	4	2	0,63
UNISYS	2664	11	10	0,16
EXXON RES & ENG	2599	3	3	0,71
ROCKWELL INT	2459	5	5	0,59
AMERICAN CYANAMID	2119	3	3	0,60
MONSANTO	2087	4	4	0,70
CATERPILLAR	1986	2	1	0,81

Note: the table reports the number of different MSAs where at least 100 patents assigned to the company have been developed.

Instrumental variable/1

- The IV is calculated in three steps:
  - 1: share of star inventors active in a given MSA and with a given assignee at time 0 (1980-84)
  - 2: nation-wide average number of star patents per inventor in each period t
  - 3: for each MSA, period, and assignee: sum of 1 weighted by 2

Instrumental variable/2

$$IV_{ikt} = \Sigma_a(StarsInv_{ika1} \cdot AvPat_{iat})/Pat_{ik1} \quad (2)$$

- where i indexes MSAs, t periods, k technological categories, and a the assignees.
- The validity of the IV relies on
  - an exclusion restriction for point 1 (plausible due to MSA f.e.)
  - on an exogeneity assumption for point 2, i.e., given that stars and comets have different assignees, the nation-wide productivity of star assignees has no independent effect on the local productivity of comets.

Results: MSA level (all technologies)

Dep. variable	Number of comets			
Method	OLS	2SLS - F E.		2SLS - F.D.
Stars (t)	0.111**	0.150**		0.079*
Stars (t-1)	0.095***		0.168**	0.158**
Comets (t-1)				0.223
Total MSA empl.	0.243*			-0.077
Period F.E.	YES	YES	YES	YES
Observations	840	840	840	560

Note: robust standard errors clustered at MSA level. The endogenous variable are Stars (t), Stars (t-1), and Comets (t-1). The excluded instruments are IV (t) (col. 2); IV(t-1) (cols. 3); d.IV(t) and d.IV(t-1), IV(t) and Comets (t-2) (col. 4). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Results: MSA-category level

Dep. variable	Number of comets			
Method	OLS	2SLS - F E.		2SLS - F.D.
Stars (t)	-0.001	0.080		-0.025
Stars (t-1)	0.051***		0.233**	0.233***
Comets (t-1)				0.471
Stars oth. cats. (t)	0.089***			0.051
Stars oth. cats. (t-1)	0.059***			-0.023
Total MSA empl.	0.406***			-0.223
MSA*cat f.e.	YES	YES	YES	YES
Cat.*Period f.e.	YES	YES	YES	YES
Observations	7,549	7,549	7,549	4,966

Note: robust standard errors clustered at MSA level. The endogenous variable are Stars (t), Stars (t-1), and Comets (t-1). The excluded instruments are IV (t) (col. 2); IV(t-1) (cols. 3); d.IV(t) and d.IV(t-1), IV(t) and Comets (t-2) (col. 4). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Results: MSA-subcategory level

Dep. variable	Number of comets			
Method	OLS	2SLS - F E.		2SLS - F.D.
Stars (t)	-0.001	0.033		0.052*
Stars (t-1)	0.039***		0.120***	0.123***
Comets (t-1)				0.426***
Stars oth. subcats. (t)	0.058***			0.026
Stars oth. subcats. (t-1)	0.054***			0.007
Total MSA empl.	0.426***			-0.209
MSA*subcat f.e.	YES	YES	YES	YES
Subcat.*Period f.e	YES	YES	YES	YES
Observations	14,235	14,235	14,235	9,387

Note: robust standard errors clustered at MSA level. The endogenous variable are Stars (t), Stars (t-1), and Comets (t-1). The excluded instruments are IV (t) (col. 2); IV(t-1) (cols. 3); d.IV(t) and d.IV(t-1), IV(t) and Comets (t-2) (col. 4). *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Robustness

- Additional robustness tests do not affect the main results:
  - GMM estimation instead of 2SLS
  - The analysis is replicated with two different ranking thresholds, equal to 25 and 75, respectively
  - Forward-citations weighted star patents
  - Test on the assumption that the first author is the project leader

Conclusions

- The theory predicts that an increase in activity of star companies affect the production of comet patents positively through spillovers, and negatively through increased local wages.
- The findings are consistent:
  - positive effects prevail, are stronger with a lag and are not bounded within sectors, providing support for economies of diversity (á la Jacob)
- Why OLS are downward bias? Measurement error, negative selection, LATE.

Policy implications

- The findings have implications for local development policies: overall the “star effect" is positive but...
  - the attraction of stars may impact sectors and time periods which may not be those targeted by the policy
  - stars and comets tend to locate in different places in absence of policy intervention: attracting stars where comets are might not work, as stars in "comets' places" may be less productive (and produce less spillovers)

Thanks for your attention

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