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Abstract

This paper takes a different perspective toward the escape entry incentive of incumbent firms to innovate. New entrants spawned from incumbents are not necessarily a threat; they can complement incumbents' production by commercializing knowledge incumbents are not willing or able to exploit. Accordingly, incumbent innovation determines exploitable knowledge externalities for spinoffs while, at the same time, spinoffs are expected to influence incumbent innovation. To overcome this problem of endogeneity, we apply an IV approach to analyze a rich industry-level dataset (1987–2000) for Germany. We find evidence that entry by spinoffs does, indeed, have a positive impact on incumbent innovation.

JEL-classification: O3, L16, M13

Keywords: Innovation, Entry, Spinoff

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1. Introduction

New firm entry has a definite impact on incumbent firms. Schumpeter describes this effect as a process of creative destruction where the new replaces the old, thereby stimulating dynamics and change. Along this line, Aghion *et al.* (2008) describe the incentive of firms to innovate as an escape entry strategy. If an incumbent firm is less technologically advanced, the entrant will replace the incumbent; however, if the incumbent is also employing leading-edge technology, it can use its reputation advantage and block entry. Therefore, an incumbent perched on the border of leading-edge technology has a strong incentive to innovate and keep pace with technological progress as doing so can prevent entry and competition (Aghion *et al.* 2004).

In contrast to Schumpeter's idea of creative destruction, one could also imagine the case where new entrants do not replace incumbents but, instead, complement their production. Along this line, Klepper and Thompson (2006) develop a theory where employees working for incumbents choose to start their own venture, a spinoff, when they disagree with management decisions on which projects should be pursued. In this way, spinoffs exploit unused, knowledge and thus contribute to the industry's overall efficiency in knowledge commercialization. Depending on the spinoff's success, this mechanism could take the Schumpeterian route and creatively destroy incumbents that failed, or refused, to see an idea for what it was worth. However, it might also open up new opportunities for incumbents in case of a complementary innovation.

Combining Aghion's *et al.* (2008) escape entry argument with Klepper and Thompson's (2006) findings on spinoffs, this paper aims to identify the effect of endogenous domestic entry, that is, spinoffs on incumbent incentive to innovate, employing an instrumental variable (IV) approach that exploits the fact that spinoffs are likely to locate in proximity to their parents. Section 2 provides a detailed explanation of our strategy for overcoming the problem of endogenous entry in the empirical analysis that follows in Section 3, which is based on a rich industry-level dataset (1987–2000) for West Germany. In Section 4, we discuss our empirical method and present results that show a positive impact of spinoff entry on incumbent innovation. Section 5 concludes with some implications and limitations of our analysis.

2. Identifying an Instrument for Endogenous Entry

Aghion *et al.* (2008) describe the incentive of incumbent firms to innovate as an escape entry strategy, that is, in order to escape leading-edge entry, incumbents located at the technology frontier innovate and, by so doing, maintain their market position. In their analysis, these authors assume that leading-edge entry is foreign entry, which is then instrumented by changes in entry regulation. Based on a sample of U.K. firms, Aghion *et al.* (2008) find a positive escape-entry effect from foreign entry on domestic incumbents if those incumbents are at the technology frontier. When taking domestic entry into consideration in their robustness checks, they find no significant effect of domestic entry on incumbent innovation. However, the authors mention that this finding could result from their aggregated domestic entry data, which do not allow distinguishing between types of domestic entrants.

Against this background, our contribution takes a closer look at domestic entry and, following Klepper (2002), distinguishes experienced from inexperienced entry. Experienced entrants obtain their know-how from prior employment in an incumbent firm, their parent. Accordingly, they initially possess the leading-edge technological knowledge from their

former employment in the parent firms and thus share the characteristics of the foreign entrants in Aghion *et al.* (2008). These new entrants—the experienced spinoffs—contribute to industry innovation as they attempt to exploit R&D that their parent firms cannot (or will not). This activity probably does not directly interfere with their parent's core business but, from an industry perspective, their exploration of riskier projects has the potential to result in pioneering developments. If successful, these spinoffs can either open up new opportunities for incumbents, in the case of a complementary innovation, or replace the incumbent with their better substitute product or process.

The knowledge externalities that can provide a foundation for spinoffs result from several barriers hindering incumbents from innovating, thereby creating a mechanism where entrepreneurial opportunities are endogenous and depend on incumbent innovation (Acs *et al.* 2006). For example, Cassiman and Ueda (2006) present a model where incumbents simply lack the capacity to commercialize all the ideas resulting from their R&D; moreover, the incumbent might decide that the gains from commercializing the new knowledge are too uncertain (cf. Knight 1921) and will thus prefer to exploit rents from existing, standardized products. Alternatively, there might be an incentive problem in commercializing new knowledge, especially in large incumbent firms with performance-oriented remuneration systems: employees might be more interested in protecting the cash flow generated by their old innovations (cf. Acs *et al.* 1999) than they are in putting a new (possibly competing) product on the market.

At bottom, of course, all barriers to innovation rest on the incumbent's strategic decisions—management decides to abandon some ideas in favor of pursuing others. According to Klepper and Thompson (2006), these decisions can lead to disagreements within the firm that drive some employees to resign and found a new venture. The authors illustrate their theory that disagreement can lead to spinoff with a variety of examples from different industries,

resulting in a detailed spinoff analysis in which Klepper (2007) finds similar patterns again and again: (i) better-performing firms have a higher spinoff rate, (ii) better-performing firms spawn better-performing spinoffs, (iii) spinoffs perform better than the average firm, and (iv) spinoffs locate in proximity to their parents.

These detailed industry observations allow for conclusions in two dimensions—space and time. In space, Klepper (2009) argues that a successful incumbent is likely to spawn a number of successful spinoffs, which, in turn, give birth to new firms, and so on. This process is a good description of how local industry agglomerations evolve, as observed in the automobile industry around Detroit or the high-tech industry in Silicon Valley. As such, agglomerations of successful firms can be regarded as drivers of regional economic growth. However, an exploration of the time dimension reveals that an agglomeration's potential to spawn spinoffs is not unlimited and, moreover, only a fraction of those spinoffs survive. In the evolution and development of an industry, one would expect that more spinoffs will occur during more mature phases of the lifecycle because in these more mature phases, much of a firm's knowledge is based in learning-by-doing and many firms are mostly engaged in the production of standardized products, with little space left for exploring new ideas. Accordingly, within-firm disagreement leading to spinoff activity is likely to occur and thus the number of firms in the industry increases. Considering that spinoffs are likely to locate in proximity to their parent firm, this process is also a factor in industry agglomeration. However, past a certain point, increasing age of the industry decreases the number of spinoffs as knowledge becomes more embodied in the physical capital of mass-producing firms than in employee human capital. In this phase, declining price-cost margins inhibit new entry and a large incumbent's higher productivity from scale-economies can drive competitors out of the market, resulting in an oligopoly with high spatial concentration (Klepper 1996, 2002).

In summary, combining the findings on how spinoffs occur and evolve over *space* and *time*, we arrive at an inverse u-shaped relationship between entry by spinoffs and geographic concentration along the industry evolution. Initially, when there is no industry concentration, entry is low. Once incumbents have developed a dominant product standard, they start spawning new ventures, thereby increasing industry concentration. This situation is followed by the shakeout phase, where entry and the overall number of firms decrease sharply and the industry evolves into a geographically concentrated oligopoly.[1] Reducing this relationship to space by analyzing a given point in time will now help us overcome the problem of endogenous entry in the following empirical analysis.

Concentrating on space means that we are not interested in spinoffs as drivers of agglomeration over time but, instead, in the impact of agglomeration on spinoff activity at a given point of time. This leads to an analysis across industries at different stages of their evolution. As a result, industry geographic concentration becomes an instrument for entry by spinoff where the number of spinoffs evolves in an inverse u-shape with increasing concentration across industries. However, instrumenting entry by industry geographic concentration only works if there is no direct effect of concentration on incumbent innovation, which will be the case if industry geographic concentration is more driven by natural advantages than by agglomerative spillovers, i.e., innovation-enhancing regional knowledge flows (cf. Ellison and Glaeser 1997). In this regard, Ellison and Glaeser (1999) find that at least half the geographic concentration in U.S. manufacturing industries is driven by natural advantages. This finding is a first indication for the validity of the identification strategy we apply in the following empirical section of the paper.

[1] See, especially, Klepper (2002, Figure 2) for some descriptive graphs on the number of producers, entry, and exit in the automobile, tires, television, and penicillin industries.

3. Data on Incumbent Innovation and Entrepreneurship for West German Manufacturing Industries

To investigate the effect of endogenous entry by spinoffs on incumbent incentive to innovate, we combine West German incumbent innovation data with data on firm entry. The data are on the industry level for 11 broadly defined manufacturing industries for the period 1987 to 2000. Concentrating on a single country is advantageous in that basic institutions, e.g., regulation or administrative barriers, and also mentalities, i.e., an entrepreneurial spirit, will be the same throughout the country. Therefore, the analysis should not be hampered by unobserved country-specific characteristics as might be the case in a cross-country analysis. Nevertheless, there is still enough variation between industries within a single country to make it possible to identify the impact of entry on incumbent incentive to innovate.

Industry-specific innovation activities of incumbent firms are derived from the Ifo Innovation Survey (see Lachenmaier 2007, for a description of the dataset). More than 1,000 surveyed firms report yearly on whether or not they have introduced an innovation, i.e., a product or process innovation. The surveyed firms are a subsample of firms that are surveyed monthly for business cycle research. Therefore, there is no special focus on young firms or startups in the subsample. Furthermore, all surveyed firms have at least 20 employees. These specifics make it possible to derive information on incumbent innovation behavior from the Ifo Innovation Survey (cf. Falck 2008). From the Ifo Innovation survey, the industry-specific number of firms that have introduced an innovation in general or a product innovation in the year preceding the survey can be projected to the population of firms.[2]

Information on firm entry in an industry is derived from the German Social Insurance Statistics (see Brixy and Fritsch 2004, for a description of the dataset). The German Social Insurance Statistics requires every employer to report certain information, e.g., qualifications,

about every employee subject to obligatory social insurance. The information collected can be transformed into an establishment file that provides longitudinal information about the establishments and their employees. As each establishment with at least one employee subject to social security has a permanent individual code number, entry and exit can be identified: the appearance of a new code number can be interpreted as an entry, the disappearance of a code number can be interpreted as an exit. The unit of measurement is the establishment, not the firm. The empirical data thus derived include two categories of entities: firm headquarters and subsidiaries. Because several studies have documented that "real" entries tend to be small, new establishments with more than 20 employees in the first year of their existence are excluded from our sample, resulting in a considerable number of new subsidiaries of large firms contained in the database not being counted as real entries. However, it is not possible to distinguish between entry in general and entry by spinoff.

From the establishment file, one can derive not only the industry-specific number of entries, but also the number of employees having a degree in engineering or the natural sciences. Engineers and natural scientists are most likely to occupy R&D positions in incumbent firms and are therefore regarded as a control for firm internal knowledge.

Industry geographic concentration is measured by an index proposed by Ellison and Glaeser (1997):

$$\nu = \frac{G - (1 - \sum_{r=1}^{M} x_r^2)H}{(1 - \sum_{r=1}^{M} x_r^2)(1 - H)} \qquad (1)$$

Employment data from the establishment file of the German Social Insurance Statistics are used to calculate the Ellison-Glaeser index, where G is the Gini coefficient of concentration

[2] The size distribution of the surveyed firms is not identical to the size distribution in the population of firms. Therefore, observations in the Ifo Innovation Survey are weighted by the relative size of six size classes in the

and x_r is the industry's share of overall manufacturing employment in region r. Regions are comprised of 75 West German planning regions. The $(1-\sum_{r=1}^{M} x_r^2)$ term is included so that the index has the property $E(\nu)=0$ when neither agglomerative spillovers nor natural advantage are present. H is the Herfindahl index of the industry's establishment size distribution. The method proposed by Schmalensee (1977) is employed to calculate the Herfindahl index. As industries are defined very broadly, it is not surprising that the Ellison-Glaeser index is relatively small for each of the 11 industries. Nevertheless, for all industries, the Ellison-Glaeser index is larger than zero, which implies excess concentration (see Table 1 for descriptive statistics).

Table 1: Descriptive statistics (means over the period 1987–2000)

Industry	Incumbent innovations		Entry	R&D employment: Engineers and natural scientists	Ellison-Glaeser index
	Overall innovations	Product innovation			
Food and Tobacco	1,758	1,507	1,536	2,649	0.002
Textiles, Apparel, and Leather	1,262	1,076	939	1,843	0.012
Wood Products, Furniture, Paper, and Pulp	1,486	1,151	2,572	3,636	0.006
Publishing and Printing	556	226	758	653	0.002
Chemicals	790	714	178	32,580	0.018
Rubber and Plastics	1,097	880	462	7,473	0.002
Non-Metallic Mineral Products	978	683	516	5,733	0.009
Metals and Fabricated Metal Products	2,242	1,545	2,584	22,445	0.009
Machinery	2,883	2,453	954	53,464	0.001
Electrical Apparatus, Radio, TV, Communication, Office Machinery, and Computers	2,843	2,561	2,121	98,347	0.004
Motor Vehicles and Other Transport Equipment	1,077	939	1,888	46,378	0.007

All industry-level variables used in this analysis prove to be very persistent over the period 1987 to 2000. Thus, regressing an arbitrary variable y_{it} in industry i at time t on its lagged value y_{it-1} excluding a constant results in a very precisely estimated coefficient near one for all variables, confirming the persistence of the variables in use (cf. Table 2).

Table 2: Persistence of variables

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population.

	Incumbent innovations (log)		Entry (log)	R&D employment: Engineers and natural scientists (log)	Ellison-Glaeser index
	Overall innovations	Product innovations			
Lagged dependent variable	0.995*** (0.001)	0.995*** (0.002)	1.00*** (0.001)	1.00*** (0.001)	0.983*** (0.004)
Number of observations	143	143	143	143	143
R^2	0.99	0.99	0.99	0.99	0.99

*** statistically significant at the 1% level.
** statistically significant at the 5% level.
* statistically significant at the 10% level.
Cluster (industry-level) robust standard errors in parentheses. No constant.

The persistence of the industry-level variables basically signifies that the period from 1987 to 2000 can be viewed as a mere snapshot taken at one point in time of the long-run industry evolution. This is accords with our identification strategy where we consider industry geographic concentration at a given point of time and then apply industry geographic concentration as instrument for entry by spinoff. As persistency means that there is very little within-industry variation that can be exploited for our empirical analysis, we rely on the variation between the 11 industries in order to identify the effect of entry by spinoff on incumbent incentive to innovate. Accordingly, we run a cross-section analysis over 11 industries.

4. Estimation and Results

4.1 The Strategy

To assess the effect of entry on incumbent incentive to innovate, we are interested in estimating the following equation:

$$\log(Inno_i) = \alpha + \beta_1 \log(Entry_i) + \beta_2 \log(R\,\&\,D\,Empl_i) + \beta_3 EG_i + \varepsilon_i \qquad (2)$$

All variables are industry means over the timespan 1987 to 2000. $Inno_i$ is the number of firms in industry i ($i=1,\ldots,11$) that have introduced an innovation in general or a product innovation. $Entry_i$ is the number of entries in industry i. $R\&D\ Empl_i$ is how many of the incumbents' employees have a degree in engineering or natural science and functions as a

control for the internal knowledge of incumbent firms. EG_i is the Ellison-Glaeser index for industry *i*'s geographic concentration.

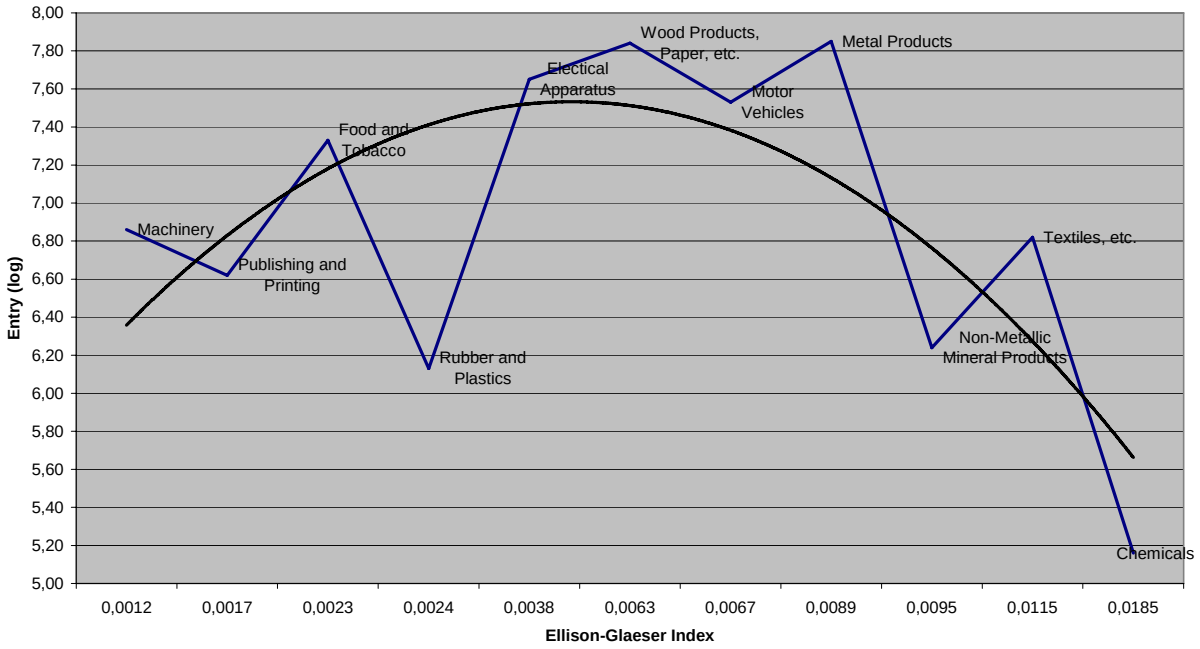
β_1 is the coefficient we are interested in and is thus a measure of the impact of entry on incumbent incentive to innovate. β_2 measures the incumbents' efficiency in turning the knowledge embodied in R&D employees into innovation. β_2 is expected to be positive. β_3 is not different from zero when it is only natural advantages that drive industry geographic agglomeration and there are no agglomerative spillovers, i.e., innovation-enhancing regional knowledge flows. However, industry geographic concentration has a positive impact on innovation if industry geographic concentration is driven by agglomerative spillovers.

Entry is expected to be endogenous itself and depends on incumbent innovation. The entry equation has the following form:

$$\log(Entry_i) = \alpha + \beta_1 \log(Inno_i) + \beta_2 EG_{it} + \beta_3 EG^2{}_{it} + \varepsilon_{it} \qquad (3)$$

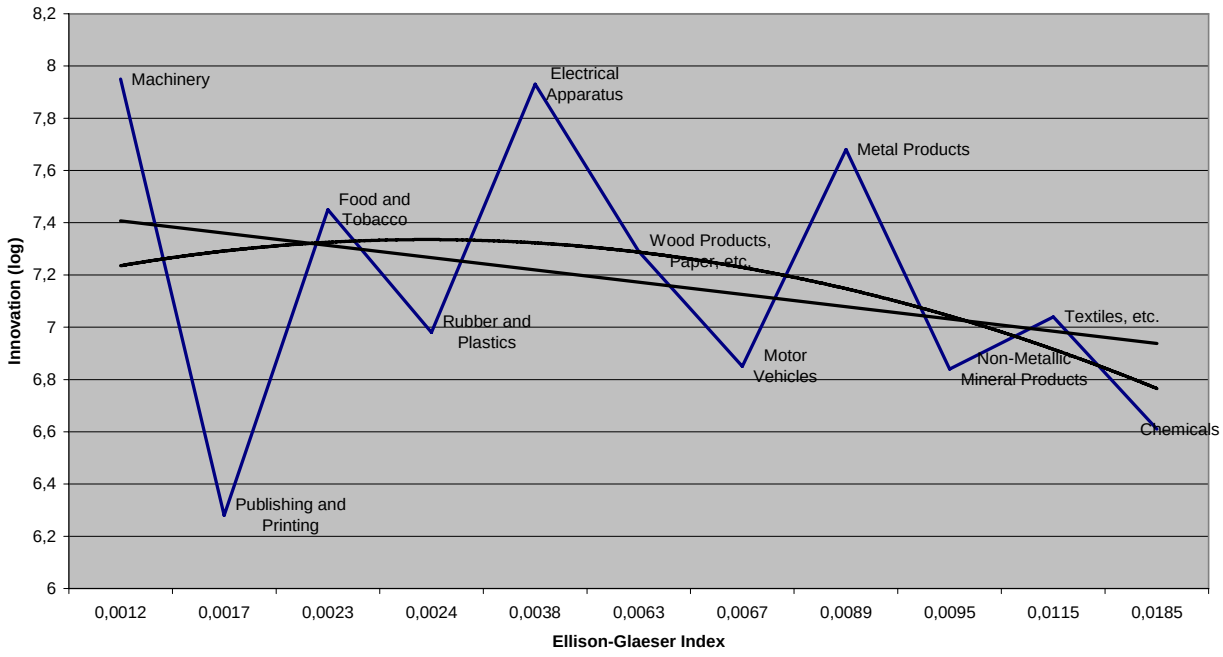
β_1 should have an arbitrary effect. On the one hand, better-performing incumbents are expected to spawn new entrants and thus should have a positive effect. On the other hand, declining price-cost margins from productivity increasing innovations can block off new entry. For those entries that are by spinoff, we expect an inverted u-shaped relationship between entry and geographic concentration across industries. Therefore, if the share of entries by spinoff in *Entry* is fairly high, β_2 should be positive and β_3 should be negative.

Figure 1: Entry and Industry Geographic Concentration


8,00
7,80
7,60
7,40
7,20
7,00
6,80
6,60
6,40
6,20
6,00
5,80
5,60
5,40
5,20
5,00
Entry (log)
Machinery
Publishing and Printing
Food and Tobacco
Rubber and Plastics
Electical Apparatus
Wood Products, Paper, etc.
Motor Vehicles
Metal Products
Non-Metallic Mineral Products
Textiles, etc.
Chemicals
0,0012
0,0017
0,0023
0,0024
0,0038
0,0063
0,0067
0,0089
0,0095
0,0115
0,0185
Ellison-Glaeser Index

If industry geographic concentration is more driven by natural advantages than by agglomerative spillovers, we can overcome the problem of endogeneity in this system of two equations by instrumenting *Entry* in a first stage with a nonlinear function of the Ellison-Glaeser index. Figure 1 shows the relationship between geographic concentration and entry across industries. Different industries at different levels of agglomeration exhibit entry numbers that are in line with our theoretical considerations: the number of entries tends to take an inverse u-shape with increasing concentration of the respective industry. In the second stage, only that part of the variation in the *Entry* variable that can be explained by *EG* and EG^2 enters the innovation equation. The part of variation in the *Entry* variable that can be explained by *EG* and EG^2 is in accord with our theoretical considerations assuming it to be entry by spinoff. Figure 2 displays incumbent innovation by geographic concentration across the same sample of industries. Apparently, there is almost no correlation between the two variables, which is the case if industry geographic concentration is rather driven by natural advantages than agglomerative spillovers. Accordingly, these two figures provide first descriptive evidence for the validity of our instrumental variable approach.

Figure 2: Innovation and Industry Geographic Concentration



4.2 Results

Table 3 sets out the results of the OLS regressions of Equation (2). The dependent variable is either the logarithm of the number of incumbent firms that have introduced an innovation in general or those that have introduced a product innovation. However, results for the different types of innovation—general or product—are not significantly different.

Table 3: Results—OLS regressions

Variable	Overall innovations (log)	Overall innovations (log)	Overall innovations (log)	Product innovations (log)	Product innovations (log)	Product innovations (log)
Entry (log)	0.278	0.341**	0.352	0.305	0.341*	0.378
	(0.172)	(0.147)	(0.273)	(0.239)	(0.178)	(0.380)
R&D employment (log)	0.176*	0.164*	0.165*	0.254*	0.247**	0.244*
	(0.081)	(0.077)	(0.088)	(0.112)	(0.103)	(0.125)
Ellison-Glaeser index	-21.152		-60.867	-12.095		-51.547
	(27.775)		(112.041)	(38.529)		(156.269)
Squared Ellison-Glaeser index			2,475.78			2,459.415
			(6,735.24)			(9,393.96)
Constant	3.773**	3.317**	3.447*	2.531	2.271	2.208
	(1.362)	(1.191)	(1.704)	(1.890)	(1.599)	(2.376)
Number of observations	11	11	11	11	11	11
Adj. R^2	0.44	0.47	0.36	0.36	0.43	0.26
F statistics	3.63*	6.94***	2.42	2.85	4.77**	1.87

*** statistically significant at the 1% level.
** statistically significant at the 5% level.
* statistically significant at the 10% level.

R&D employment has a significantly positive impact on innovation in all specifications, and this result does not change when using only natural scientists instead of the sum of engineers and natural scientists. Therefore, only results derived from using the sum of engineers and natural scientist as a proxy for R&D employment are presented.

When both *Entry* and *EG* are included in the regressions, neither of the two corresponding coefficients is significantly different from zero. This result also holds when accounting for nonlinearities in the relationship between *EG* and *Inno*, suggesting that natural advantage is a stronger driver of industry geographic concentration than agglomerative spillover. When *EG* is dropped from the equation, the *Entry* coefficient becomes significantly positive. These results point toward severe problems of multicollinearity between *Entry* and *EG* and, in fact,

the partial correlation between *Entry* and *EG* is 0.59, and the partial correlation between *Entry* and EG^2 is –0.71.

So far, these findings support our instrumental variable approach, in which we instrument *Entry* by *EG* and EG^2. The results of the instrumental variable approach are summarized in Table 4. In the first stage, an inverted u-shaped relationship between *Entry* and *EG* is found across industries. We would expect this inverted u-shaped relationship if a substantial percentage of total entry is due to entry by spinoff. In the second stage, only that part of the variation in the *Entry* variable that can be explained by *EG* and EG^2 and that is assumed to be entry by spinoff enters the innovation equation. The results of this second stage reveal that instrumented entry has a significantly positive impact on innovation. Therefore, the null hypothesis that the instruments are valid cannot be rejected by means of a Sargan test – always being aware of the limitations of such tests in a small sample.

Table 4: Results—IV regressions

Variable	First stage	Second stage	
	Entry (log)	Overall innovations (log)	Product innovations (log)
Entry (log)		0.334**	0.320*
		(0.156)	(0.193)
R&D employment (log)	0.115	0.164**	0.247***
	(0.117)	(0.066)	(0.088)
Ellison-Glaeser index	257.155*		
	(120.819)		
Squared Ellison-Glaeser index	-18,201.94**		
	(6,289.51)		
Constant	5.421***	3.358***	2.404
	(1.168)	(1.180)	(1.585)
Number of observations	11	11	11
Partial R^2 of excluded instruments	0.65		
F test of excluded instruments	6.43**		
Instrumented		Entry (log)	Entry (log)
Instruments		EG, EG^2	EG, EG^2
Sargan statistic		1.060	0.248

*** statistically significant at the 1% level.
** statistically significant at the 5% level.
* statistically significant at the 10% level.

In summary, our instrumental variable approach confirms Aghion *et al.*'s (2008) theory that entry has an impact on incumbent incentive to innovate. However, the choice of the instruments is based on the assumption that entry is not foreign entry but domestic entry by

spinoff in an environment of industry agglomeration as discussed by Klepper and Thompson (2006). As *Entry* and *Inno* enter the regression as logs, one can interpret the coefficients as elasticities, i.e., a 1% increase in the number of entries results in a 0.334% increase in the number of incumbent firms introducing an innovation in general and a 0.320% increase in the number of incumbent firms introducing a product innovation. These results are also robust to outlier industries. When chemicals, which is an outlier in terms of incumbent innovation, entry, and industry geographic concentration (cf. Table 1), is dropped from the analysis, the results do not change significantly.

5. Conclusions

Starting from a recent contribution by Aghion *et al.* (2008), this paper argues that new entrants do not only impose a threat to incumbents but may, in fact, complement their production. In accordance with this argument, we apply Klepper and Thompson's (2006) explanation for the spinoff process where employees of incumbents choose to start their own venture, a spinoff, when they disagree with management decisions on which projects to pursue. Depending on the spinoff's success, this mechanism can replace incumbents that backed the wrong horse, *but* it can also open up new opportunities for incumbents in case of a complementary innovation. As spinoffs are likely to locate in proximity to their parents, industry geographic concentration is a factor in this process. To identify the impact of endogenous entry on incumbent innovation, we then concentrate on the impact of an industry's geographic concentration on spinoff activity at a given point of time. Thus, industry geographic concentration, as measured by the Ellison-Glaeser index, becomes an instrument for entry by spinoff, where the number of spinoffs evolves in an inverse u-shape with increasing concentration across industries. The corresponding IV regressions show that entry by spinoff has a positive impact on incumbent innovation.

These results have important policy implications not only in view of the fact that entries, and spinoffs in particular, are generally regarded as socially beneficial but also because we have shown that entries and spinoffs have a positive impact on incumbent innovation. Policies that promote new firm formation are en vogue across the globe. Audretsch (2007) speaks about the age of *the entrepreneurial society* and there is no doubt that reducing barriers to entrepreneurial activity is a welcome development. With regard to the emergence of spinoffs, examples of barriers to the spinoff process are trade secret laws (Jackson 1998) or post-employment covenants not to compete (Stuart and Sorensen 2003).

The preliminary results provided in this paper at the level of 11 broadly defined industries suggest the value of further study into the relationship between incumbent innovation and entrepreneurship. The availability of more disaggregated data would make it possible to more fully explore this complex relationship.

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