Small Firm Entry in Manufacturing Industries: Lower Saxony, 1979—1989*

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ABSTRACT. This paper is an empirical study of inter-industry and inter-temporal variations in entry of new firms using longitudinal data covering all manufacturing establishments in Lower Saxony between 1979 and 1989. Patterns of entry are reported for 29 industries based on numbers of new firms, gross rates of entry, and entry intensities (shares of employees) in different types and size classes of new firms. Entry varies considerably between firm types, industries, and over time. Focussing on entry by small single firms an empirical model is applied to search for industry characteristics that are highly correlated with entry. Pooling of cross-section and time-series data allows to control for influences of varying macroeconomic conditions and unobserved industry characteristics. A highly robust estimation method is applied for the first time in a study of entry rates, and it turns out that extreme observations often have large effect on the results. Entry intensity tends to be positively related to industry growth, concentration, and high unemployment, but negatively to high interest rates, profits, and (insignificantly) to intensive use of capital and R&D. I plead for further research via *learning by asking those who are doing.*

1. Introduction

Some 30 years ago Edwin Mansfield (1962, p. 1023) complained: "Because there have been so few econometric studies of the birth, growth and death of firms, we lack even crude answers to the following basic questions regarding the dynamic processes governing an industry's structure. What are the quantitative effects of various factors on the rates of entry and exit? . . ." According to Mueller (1991, p. 11), despite their theoretical importance in market dynamics, entry and exit have been the subject of empirical research in only the last 15 years, and although the tempo of this area of research has quickened in recent years, many questions about the nature and effects of this processes remain unanswered.

This lack of comprehensive empirical evidence on the extent of entry, its causes, and its consequences is especially evident in the case of the Federal Republic of Germany. While there are numerous econometric investigations for other countries (in particular, Canada, the U.S., and the U.K.),[1] to the best of my knowledge only four empirical studies on inter-industry differences in entry have been published hitherto using German data.[2] Without giving details of the models and summaries of the findings, the approaches applied by the authors can be outlined as follows:

Otremba (1980, 1982) takes net changes of the number of firms in industries, and he computes simple linear regressions to explain these changes, using various variables one at a time. The period covered and the number of industries included varies because of data availability. The application of simple (instead of multiple) regression models and the use of net (instead of gross) entry measures are to be criticized.

Schwalbach (1987) measures entry by the share of production in 1982 by firms which have their base industry in another industry. He, therefore, considers the cumulative diversifying entry by established firms only, and not the extent of entry by de novo firms and its determinants.

Boeri (1990) considers gross entry rates, i.e., the number of new plants over the total number of plants in the base year. His entry data are based on information from the employment records of individual establishments, computed from official statistics of employees with social insurance. The period covered is 1977 to 1988, and data are pooled over ten years and nine sectors. The nine sectors used in Boeri's study, however, are rather

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broad, covering, e.g., all industries that manufacture investment goods in one sector.

Schwalbach (1991) gives information on the importance of entry of firms in selected 183 four-digit manufacturing industries for the period 1983—85, using data on the cumulative number and size of entrants published by the German Monopoly Commission. For a sample of 79 four-digit industries he estimates a model of the now "standard type" often used in the international literature to explain the gross entry rates.

It follows from this rather cursory look at the German literature that the recently published paper by Schwalbach (1991) contains the only econometric study on the determinants of inter-industry differences in entry intensities based on detailed data for manufacturing industries. However, this model is estimated for a cross section only, and data cover only a selected part of the manufacturing sector (details as regards the selection are not reported).

Further research on entry in German industries, therefore, is needed, at least for three reasons:

First, recent analyses based on longitudinal data of entries show that in Germany the medium-term impact of a cohort of entries (a group made of all firms founded in year t) on employment roughly equals the impact in year t (cf. Boeri, 1990; Boeri and Cramer, 1991; Gerlach and Wagner, 1992; and Schasse, 1992). Therefore, "any theory which is capable of identifying the determinants of entry is also a theory of employment growth in the long run" (Boeri, 1990, p. 9). Evidently, in periods of high unemployment this is an important topic.

Second, studies on the determinants of entry are closely related to investigations of the consequences of entry, and of market dynamics in general (see Geroski, 1991).

Third, to learn more about the role of different institutional settings (e.g., competition policy, or industrial relations) in the process of market dynamics, cross-country comparisons are an important tool, and studies using German data to replicate analyses done for other countries can provide important information here, too.

This motivates the present study, the rest of which is organized as follows: Section 2 discusses data issues related to the identification of entries, section 3 gives descriptive information on entry in manufacturing industries in Lower Saxony between 1979 and 1989, section 4 discusses the specification of the empirical model, section 5 reports the results of the econometric investigation, and section 6 gives a summary and conclusions with some considerations about future research.

2. Data issues: identification of entries

The empirical analysis is based on data at the establishment level collected by the Statistical Office in all firms belonging to the manufacturing sector in Lower Saxony, one of the "old" Federal States of Germany. Data from two sources were matched, i.e. from the monthly report of all establishments that have a minimum of twenty employees itself or that are part of an enterprise with twenty or more persons employed, and from the annual report of small manufacturing establishments covering the rest of the manufacturing sector (for details and the questionnaires, see Methner, 1992). A longitudinal data base covering 10743 firms with information on the average number of persons employed in each establishment in the years between 1978 and 1990 was built.

If an establishment reports some employees in the year t but no employees in $t-1$, this can mean that the firm was newly founded in t, or that it existed before but interrupted production in $t-1$, or that it switched (temporarily or permanently) into the manufacturing sector (out of, e.g., services) in t, or relocated into Lower Saxony in t from a different Federal State (or a foreign country).

Without checking the files kept in the Statistical Office for each single establishment identification of 'true' entries is impossible. Checking these files, however, was prohibited by strong data protection laws (and budget constraints).

To reduce the 'fuzzyness' caused by different possibilities for firms to enter the longitudinal data base described above, we proceeded as follows: Each establishment has an unchangeable identification number used in the official surveys, and it is known which numbers are assigned to establishments entering the survey population during a given year. A firm is considered as an entry in t only if its identification number has been assigned during the year t. This information makes it possible to identify firms that interrupted produc-

tion in manufacturing for one or more years before t and to exclude them from the further analysis.

Although the ambiguity as regards the identification of entries is reduced by the procedure described above, it is not removed completely, because permanent relocations from either other sectors or other Federal States (or foreign countries) cannot be distinguished from 'true' entries.

3. Patterns of entry in manufacturing industries: Lower Saxony, 1979–1989

By applying the procedure outlined in the last section all entries in manufacturing industries in Lower Saxony were identified for the period between 1979 and 1989. The period of investigation starts in 1979, because the official statistics that form the base of our panel data set was initiated in 1977, and until 1978 existing old and newly founded firms were given identification numbers, so we can use these numbers for our purposes from 1979 on only. We will look at entries until 1989 only for reasons of data availability; furthermore, in 1990 the Federal States of the former German Democratic Republic joined the Federal Republic of Germany, and this process of (re)unification surely constitutes a structural break, the consequences of which on the activities in the manufacturing sector of Lower Saxony — a state with large (former) border regions — will be analyzed separately.

In the literature, various concepts are used to measure entry in an industry (cf. Geroski, 1991b, p. 287ff.). One can simply count the number of new firms entering during a period (gross entry), or can compute the change in the number of firms from the beginning to the end of the period (net change), one can express gross entry or net entry as a percentage of the number of incumbents (gross entry rate and net entry rate, respectively), and one can weight the entries, which usually are small compared to incumbents, by, say, volume of sales or number of employees, and compute the share of new firm sales or employment in an industry.

As always, the right choice of measure depends on the purpose of the exercise (and, often, is restricted by the data at hand). Our focus is on entry, not on exit and its relation to entry; therefore, we consider gross entry. Below, we present information on the number of firms that entered manufacturing industries during the period covered, and on the gross entry rate. However, entries usually are not all of the same size,and they differ in size from incumbent firms. One large entrant with, say, 500 employees, is not the same as another new firm with only 10 employees, and 10 small entrants with 20 employees each are not one percent of an industry with 1000 firms having on average 500 employees. Thus, inter-industry comparisons of entry should not be based on numbers of new firms (cf. Acs and Audretsch, 1989, p. 467). Therefore, employment shares of entrants are computed, too, to give a measure of entry intensity weighted by the relative importance of new firms (cf., e.g., Hause and Du Rietz, 1984, and Acs and Audretsch, 1989). Furthermore, as stated in the introduction above, recent analyses based on longitudinal data of entries show that in Germany the medium-term impact of a cohort of entries on employment roughly equals the impact in the year of entry. Evidently, in periods of high unemployment a study of entries should focus on employment shares of new firms.

New firms can be distinguished by size (small versus large entries), relationship to other firms (part of a multi-establishment enterprise or not), and origin (domestic versus foreign-based). There is evidence in the literature that determinants of inter-industry and inter-temporal variation of entry may differ in sign and size for various kinds of new firms (cf., e.g., for small versus large entries Acs and Audretsch, 1989; for new versus diversifying entries Gorecki, 1975; and Khemani and Shapiro, 1988; for domestic versus foreign entrants Gorecki, 1976, and Shapiro, 1983). Therefore, we will consider employment shares of various groups of new firms: all entries, small entries (with up to 49 persons employed), large entries (with 50 or more persons employed), entries by single firms (that are not part of a multi-establishment enterprise) and non-single firms, and by single and non-single firms of the two size classes. Three comments on this classification of entries are in order: First, casual and anecdotal evidence shows that many (but not all) firms with 50 or more employees in their first year classified as entries according to the method used here are not newly founded firms but movers of some kind (see discussion of data issues in section 2). Second,

from the data at hand we are able to identify new establishments that are part of a multi-establishment enterprise (because in this case the identification number of the new local production unit in the official survey differs from the identifier of the enterprise used in there; for details, see Methner, 1992), but we are unable to check whether other establishments of the same enterprise are active in the same industry as the entrant or not. Third, we cannot distinguish between domestic and foreign-based entries; moreover, all entries that are founded by a multinational enterprise that had no production unit either in Lower Saxony or in another German federal state before are considered single firm entries (because there is no enterprise identifier that differs from the identifier of the new local production unit).

Average values for the number of new firms, for the gross entry rate, and for employment shares of various types of new firms during 1979—1989 for 29 manufacturing industries in Lower Saxony are given in Table I.

TABLE I
Entry in manufacturing industries: Lower Saxony, 1979—1989

Industry	New Firms		Employment Share of New Firms (percentage)								
	Number	Gross Entry Rate (%)	All	Small	Large	Single	Small Single	Large Single	Non-Single	Small Non-Single	Large Non-Single
01 Oil refineries	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
02 Stone, sand, clay industry	14.09	1.80	0.84	0.58	0.26	0.57	0.37	0.20	0.27	0.21	0.06
03 Iron and steel industry	0.27	3.16	0.98	0.02	0.96	0.02	0.02	0.00	0.96	0.00	0.96
04 Non-ferrous metal industries	0.91	2.47	1.09	0.09	1.00	1.09	0.09	1.00	0.00	0.00	0.00
05 Iron and steel foundries	0.27	1.06	0.47	0.12	0.35	0.47	0.12	0.35	0.00	0.00	0.00
06 Steel drawing, cold rolling mills	9.91	6.07	2.04	1.00	1.01	1.68	0.95	0.70	0.36	0.05	0.31
07 Constructional steel	10.27	5.32	1.60	0.87	0.72	1.31	0.79	0.50	0.29	0.07	0.21
08 Engineering	25.82	4.43	1.07	0.49	0.58	0.89	0.41	0.48	0.18	0.08	0.10
09 Vehicle building industries	8.00	1.95	0.14	0.09	0.05	0.10	0.06	0.03	0.05	0.03	0.02
10 Shipbuilding	1.64	4.45	0.67	0.11	0.56	0.55	0.09	0.45	0.12	0.01	0.11
11 Aircraft and aerospace industry	0.45	5.48	0.58	0.02	0.56	0.25	0.02	0.23	0.32	0.00	0.32
12 Electrical equipment	23.36	6.56	1.18	0.35	0.83	0.73	0.31	0.42	0.44	0.04	0.40
13 Precision eng., optics, etc.	5.36	3.23	0.92	0.44	0.47	0.67	0.36	0.31	0.24	0.08	0.16
14 Metal products	11.00	4.68	0.77	0.62	0.14	0.74	0.60	0.14	0.02	0.02	0.00
15 Musical instruments, etc.	2.27	4.67	0.87	0.60	0.27	0.56	0.56	0.00	0.31	0.04	0.27
16 Chemical industry	8.18	2.58	0.61	0.27	0.35	0.40	0.23	0.17	0.21	0.04	0.17
17 Office and data-processing mach.	1.55	11.23	0.62	0.27	0.35	0.26	0.26	0.00	0.36	0.01	0.35
18 Fine ceramics	0.36	5.93	2.24	0.43	1.81	2.24	0.43	1.81	0.00	0.00	0.00
19 Glass industry	2.00	3.90	0.59	0.46	0.13	0.59	0.46	0.13	0.003	0.003	0.00
20 Sawmills, timber processing	3.45	1.54	0.98	0.57	0.40	0.88	0.48	0.40	0.09	0.09	0.00
21 Wood processing	11.27	3.06	0.96	0.76	0.19	0.94	0.75	0.19	0.02	0.02	0.00
22 Cellulose, paper and board ind.	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
23 Paper and board	3.73	2.81	0.65	0.51	0.14	0.61	0.47	0.14	0.04	0.04	0.00
24 Printing	13.27	2.86	0.99	0.67	0.32	0.99	0.66	0.32	0.01	0.01	0.00
25 Plastics manufacturing	18.09	5.85	1.19	0.73	0.45	1.00	0.68	0.31	0.19	0.05	0.14
26 Rubber industry	1.73	3.30	0.17	0.13	0.04	0.15	0.11	0.04	0.02	0.02	0.00
27 Leather and leather products	0.91	1.89	0.23	0.23	0.00	0.23	0.23	0.00	0.00	0.00	0.00
28 Textiles	3.36	2.03	0.42	0.17	0.24	0.40	0.15	0.24	0.02	0.02	0.00
29 Clothing industry	12.64	3.60	1.95	1.02	0.89	1.60	0.99	0.58	0.33	0.03	0.30
Mean	6.70	3.65	0.86	0.40	0.45	0.69	0.38	0.32	0.16	0.03	0.13
Standard deviation	7.18	2.28	0.57	0.31	0.41	0.53	0.29	0.37	0.21	0.04	0.21

Note: Average of annual values, 1979—1989; small firms have less than 50 persons, large 50 and more; single firms are not part of a multi-firm enterprise, non-single firms are. Denominator is the number of employees in the industry minus the number of employees in the group of entries considered (see text).
Source: own calculation

Entry varied considerably between industries. Industries 01 (Oil refineries) and 22 (Cellulose, paper, and board) are the only industries without any new firm entry in the period covered. Industries 08 (Engineering) and 12 (Electrical equipment) had the highest average value of new firms, while the highest gross rate of entry is recorded for industries 17 (Office and data processing equipment) and 12 (Electrical equipment). The mean of the employment share of all new firms was 0.86%; about half of this was due to small firms, and about 80% due to single establishment firms. On average, entries by firms belonging to existing multi-establishment enterprises play a minor role only. However, large non-single entries added nearly all employees in newly founded firms in industry 03 (Iron and steel industry), and more than half of it in industry 17 (Office and data processing equipment).

Table II gives the correlation matrix for measures of entry in manufacturing industries. Evidently, the various entry measures differ; some of them are even negatively correlated, and non-single and single firm entry rates vary extensively.

When looking at these entry rates it should be kept in mind, however, that measurement errors are expected to increase with start-up size (see above). On the other hand, most of the new firms are small, and most of the small entries are single firms: From the 2339 firms that entered manufacturing industries in Lower Saxony between 1979 and 1989, about 90 percent (2109 firms) were small (i.e., they had less than 50 employees at start-up time), and about 88 percent (1853 firms) of the new small firms were single firms (i.e., they were not part of a multi-establishment enterprise). Therefore, our investigation will focus on small firm entry, and total entry will be analyzed for purpose of comparison only (ignoring the potentially important errors in variables problem as regards the identification of "true" entries among new larger firms in the longitudinal data set used).

As can be seen from Table III the inter-industry structure of total entry, small firm entry, and entry by small single firms is not constant over time. Often, the coefficient of correlation between the same entry intensity measure for two years is either about zero or even negative.

A high amount of year by year variation in the entry data that appears to be fairly unsystematic over time is reported for the UK, too: Geroski (1991a, p. 18) looks at the correlation of entry penetration (defined as the sales of entrants divided by total industry production plus imports less exports) across industries over time between 1974 and 1979, and he finds that industries do not show persistently high or low rates of entry. He concludes that cross-section differences in entry rates are large, but, large as they are, they are dominated by variations over time within industries (cf. Geroski, 1991a, p. 48). The lowest correlation coefficient over time he reports is, however, +0.2377, and is much higher than many of the coefficients we found in our data for Lower

TABLE II

Correlation matrix for measures of entry in manufacturing industries: Lower Saxony, 1979—1989

	Number of New Firms	Gross Entry Rate	All	Small	Large	Single	Small Single	Large Single	Non-Single	Small Non-single
Gross Entry Rate	+0.24									
All	+0.37	+0.46								
Small	+0.55	+0.30	+0.71							
Large	+0.10	+0.41	+0.84	+0.23						
Single	+0.33	+0.33	+0.93	+0.72	+0.74					
Small Single	+0.51	+0.32	+0.72	+0.99	+0.24	+0.74				
Large Single	+0.08	+0.22	+0.76	+0.25	+0.86	+0.85	+0.27			
Non-single	+0.16	+0.39	+0.32	+0.08	+0.39	−0.05	+0.05	−0.12		
Small Non-single	+0.48	−0.05	+0.20	+0.42	−0.04	+0.14	+0.28	−0.02	+0.16	
Large Non-single	+0.06	+0.41	+0.28	−0.01	+0.40	−0.08	−0.01	−0.12	+0.98	−0.05

Source: Own calculation based on data reported in Table 1

TABLE III
Inter-temporal correlation of measures of entry-intensity: all, small, small single

		1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
	All	−0.13									
1980	Small	+0.81									
	Small Single	+0.78									
	All	−0.07	+0.69								
1981	Small	+0.09	+0.19								
	Small Single	+0.09	+0.16								
	All	+0.33	+0.01	+0.16							
1982	Small	+0.48	+0.51	+0.01							
	Small Single	+0.48	+0.53	−0.03							
	All	−0.05	+0.04	+0.06	+0.20						
1983	Small	+0.38	+0.51	+0.58	+0.38						
	Small Single	+0.39	+0.52	+0.57	+0.41						
	All	+0.02	−0.10	−0.04	+0.11	−0.12					
1984	Small	+0.52	+0.49	+0.02	+0.48	+0.35					
	Small Single	+0.51	+0.43	+0.00	+0.52	+0.37					
	All	−0.02	+0.72	+0.41	+0.02	+0.05	−0.11				
1985	Small	+0.49	+0.51	−0.01	+0.49	+0.14	+0.63				
	Small Single	+0.55	+0.53	−0.04	+0.58	+0.21	+0.70				
	All	−0.06	−0.05	−0.004	+0.39	+0.01	−0.02	−0.07			
1986	Small	+0.49	+0.55	+0.05	+0.86	+0.37	+0.58	+0.53			
	Small Single	+0.50	+0.59	+0.02	+0.85	+0.38	+0.63	+0.70			
	All	+0.18	+0.20	−0.002	+0.37	−0.06	−0.02	+0.13	+0.20		
1987	Small	+0.34	+0.43	+0.001	+0.63	+0.14	+0.62	+0.65	+0.77		
	Small Single	+0.35	+0.47	−0.004	+0.65	+0.16	+0.65	+0.72	+0.77		
	All	+0.32	−0.14	+0.10	+0.60	+0.17	−0.02	−0.02	+0.09	+0.11	
1988	Small	+0.72	+0.69	+0.10	+0.62	+0.47	+0.68	+0.62	+0.58	+0.49	
	Small Single	+0.62	+0.65	+0.08	+0.57	+0.46	+0.67	+0.62	+0.52	+0.47	
	All	+0.15	−0.10	+0.34	+0.12	+0.13	−0.02	+0.04	−0.03	+0.09	+0.42
1989	Small	+0.49	+0.67	+0.12	+0.31	+0.31	+0.60	+0.73	+0.38	+0.43	+0.60
	Small Single	+0.49	+0.60	+0.11	+0.29	+0.34	+0.54	+0.67	+0.35	+0.43	+0.59

Source: Own calculations; for a definition of variables, see text

Saxony. For the U.S., however, Dunne and Roberts (1991, p. 189) report a degree of entry for each industry that is fairly stable over time. This stability might be caused by the way these authors measured entry, because they used census data and, therefore, entry rates are averages over the years between two censuses (e.g., 1963—7).

Evidently, therefore, entry rates differ for the various groups of firms, and they vary between industries in a year and to a fairly high degree within industries over time. Why?

4. Model specification

As Acs and Audretsch (1989, p. 470) recently put it, "the empirical model used to estimate entry has by now become quite standard with only minor variations ... In general, explanatory variables representing three different factors are included — market structure characteristics inhibiting entry or so-called barriers to entry, factors inducing entry, principally growth and profitability, and measures of the technological environment."

In a nutshell, this standard approach is based on the simplest model of entry penetration that

attempts to explain penetration E_t at time t in terms of the difference between expected post-entry profits $PEXP_t$ and entry costs F (cf., e.g., Geroski, 1991a, p. 71). F is usually proxied by a linear combination of factors such as capital intensity and seller concentration. $PEXP_t$ is unobservable, and a path most often followed in the literature is to assume that potential entrants base their expectations on the level of past profit rates. According to Geroski (1991, p. 71), the virtue of using lagged profits to proxy expected post-entry profitability is that it is an easy solution to a rather complex latent variables problem and, for small-scale entry, it may not even be a bad one, because small entrants will only add a negligible amount to existing industry output and are unlikely to have considerable impact upon prices. Evidently, more complicated indicators based on extrapolative or rational expectations predictors have been used, too (e.g., Geroski, 1991, p. 72ff.).

In this paper, the view of Schmalensee (1989, p. 1000) is adopted that "inter-industry research in industrial organization should generally be viewed as a search for empirical regularities, not as a set of exercises in structural estimation." The goal is to identify industry characteristics that are highly correlated with entry, and to assess their relative importance. The orientation is exploratory and descriptive, rather than a stringent test of structural relationships, an orientation identical to that explicitly chosen in, e.g., the studies by von der Fehr (1991) using Norwegian and by Dunne and Roberts (1991) using U.S. data.

Following the tradition established in the literature, the following explanatory variables are included (further details are given in the appendix):

Profit rate (measured as profits over value of gross production) and *growth rate* (of sales) are expected to be factors inducing entry, *concentration* (Herfindahl index) and *capital intensity* (fixed capital per employee) are expected to act as barriers to entry, and *R&D intensity* (percentage of employees working in R&D) measures the technological environment. All these variables are lagged by one year.

Models with one of the entry penetration variables discussed in section 3 as endogenous variable and the explanatory variables just mentioned are estimated using pooled cross-section time-series data for 29 manufacturing industries and entry variables from 1979 to 1988 (excluding 1989 because the profits data are available until 1987 only). Furthermore, adding fixed time effects allows to control for macroeconomic influences that are invariant over the industries.[3] More precisely, and following Audretsch and Acs (forthcoming) and Yamawaki (1991), including lagged values of the *rate of unemployment* and the *rate of interest* (i.e., the rate of discount fixed by the Deutsche Bundesbank) enables us to identify the extent to which startup activity responds to conditions in the labor market and the credit market.[4] High rates of unemployment are expected to be positively related to entry activity because, on the one hand, labor tends to be cheaper and more easy to hire in periods of high unemployment, and, on the other hand, more unemployed persons may decide to start their own business. High rates of interest are expected to hinder startups due to higher costs of credit.

To control for unobservable and non-included industry characteristics that are invariant over time, models augmented by a set of fixed industry effects are considered, too. As is argued by Dunne and Roberts (1991, p. 192), the interesting questions which this raises are, first, how important these omitted factors (which could include variables like the level of entry costs or degree of entry costs which are sunk) are relative to the more easily quantifiable factors, and second, whether controlling for these unobservables alters size, sign, and significance of the estimated relationship between entry intensity and industry characteristics included.

5. Regression results

Based on pooled cross-section time-series data from 29 industries and the period 1979 to 1988 models for the employment share of all, small, and small single new firms were estimated including lagged industry variables (profits, growth, concentration, capital intensity, R&D intensity) and lagged macro variables (unemployment rate and discount rate), and with and without industry dummies.

In a first step, these models were estimated using ordinary least squares (OLS). Because heteroscedasticity of an unknown kind often tends to bias the estimates of the variances of the

estimated coefficients in analyses based on cross-section data White's heteroscedasticity-consistent covariance matrix estimator was used to compute all t-values reported.

Furthermore, it is well-known that the coefficients estimated by OLS may be sensitive to a small number of extreme cases, and therefore the methods of least median of squares (LMS) and reweighed least squares (RLS) are applied to detect outliers and to estimate the equation in a robust way in a second step.[5]

Regression results for models with and without industry dummies estimated by OLS and by LMS/RLS are reported in Table IV.

As stated above, the focus of the econometric study is on entry by small firms, and on the determinants of inter-industry and inter-temporal variations of employment shares of new small firms. Therefore, we will start the evaluation of the regression results by looking at models for *Small Firm Entry* and *Small Single Firm Entry* in columns 5 to 12 of Table IV.

Pairwise comparisons of the results from identically specified models for small firm entry and small single firm entry (i.e., a comparison of columns 5 and 9, 6 and 10, 7 and 11, and 8 and 12) reveal minor differences regarding size and statistical significance of the respective coefficients only, the one exception being a positive but insignificant coefficient of R&D intensity in the small firm entry model with industry dummies estimated by LMS/RLS from column 8 compared to a negative but insignificant coefficient in the same model for small single firm entry (cf. column 12). This high degree of similarity is not surprising, because nearly 90 percent of all new small firms in our sample are single firms. New small single firms come closest to the concept of "true de novo"

TABLE IV
Regression results

Dependent variable		All entry				Small firm entry				Small single firm entry			
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Exogenous variable	Method	OLS	OLS	LMS/RLS	LMS/RLS	OLS	OLS	LMS/RLS	LMS/RLS	OLS	OLS	LMS/RLS	LMS/RLS
Profit Rate (%)	β	−0.039	−0.043	0.036	−0.004	0.026	0.005	0.014	−0.021	0.024	0.008	0.013	−0.019
	t	−0.64	−0.40	4.28**	−0.27	3.23**	0.25	2.71**	−2.52*	3.11**	0.47	2.63**	−2.63**
Growth Rate (%)	β	0.015	0.016	−0.001	0.001	0.003	0.004	0.003	0.005	0.003	0.004	0.002	0.004
	t	1.80	1.90	−0.48	0.59	1.11	2.06*	1.60	3.48**	1.26	2.05*	1.45	3.57**
Concentration (Herfindahl)	β	−0.001	0.002	−0.004	−0.0001	−0.001	−0.0003	−0.002	0.0002	−0.001	−0.003	−0.002	0.001
	t	−0.68	0.46	−6.23**	−0.1	−3.82**	−0.22	−5.56**	0.14	−3.12**	−0.21	−5.70**	3.11**
Capital Intensity	β	−0.002	−0.006	−0.0006	−0.0009	−0.0006	−0.0006	−0.0004	−0.0005	−0.0006	−0.0005	−0.0004	−0.0003
	t	−5.39**	−1.58	−5.98**	−1.41	−5.75**	−0.97	−6.63**	−1.22	−5.52**	−0.91	−6.63**	−0.96
R&D Intensity	β	−0.011	−0.336	0.064	0.013	−0.005	−0.018	0.018	0.002	−0.011	−0.012	0.016	−0.022
	t	−0.21	−1.43	4.02**	0.32	−0.42	0.40	2.27*	0.06	−1.08	−0.27	2.30*	−0.91
Unemployment Rate (%)	β	0.035	0.079	0.008	0.005	0.021	0.019	0.010	0.006	0.021	0.019	0.010	0.009
	t	0.76	1.44	0.65	0.50	1.80	1.62	1.17	1.00	1.92	1.66	1.31	1.60
Discount Rate (%)	β	−0.066	−0.075	0.001	−0.019	0.012	0.004	−0.005	−0.024	0.014	0.009	−0.004	−0.020
	t	−1.44	−1.37	0.08	−1.41	0.80	0.29	−0.53	−3.27**	0.98	0.58	−0.41	−2.96**
Constant	β	1.326	5.998	0.479	0.695	0.317	0.401	0.334	0.394	0.267	0.317	0.292	0.259
	t	2.38*	2.03*	3.26**	1.38	2.92**	0.74	3.93**	1.23	2.57**	0.59	3.76**	0.89
Industry Dummies		no	yes	no	yes	no	yes	no	yes	no	yes	no	yes
R^2		0.039	0.166	0.303	0.602	0.183	0.442	0.259	0.658	0.177	0.441	0.265	0.663
$\bar{R}^2$		0.015	0.051	0.283	0.538	0.163	0.365	0.238	0.605	0.156	0.364	0.245	0.610
N of Cases		290	290	254	254	290	290	259	259	290	290	257	257

Note: t-values are computed using White's heteroscedasticity-consistent covariance matrix estimator
* (**) = significant for $\alpha = 0.05$ (0.01)

firms, and, therefore, further discussion will focus on results reported in columns 9 to 12 of Table IV.

Results from OLS estimation of the model not including industry dummies are reported in column 9. These results are mostly in accordance with theoretical expectations: higher rates of expected profits (proxied by the lagged profit rate) and industry growth induce higher entry rates, while higher degrees of concentration, capital intensity, and R&D intensity act as barriers to entry. The coefficients of the growth rate and of R&D, however, are not statistically significant at a conventional level. Furthermore, small single firm entry is (as expected) positively related to higher rates of unemployment in the economy as a whole, and (contrary to expectations) to a higher rate of discount, too. The coefficient of the unemployment variable, however, is statistically significant at a level of slightly less than 5 percent only, and the coefficient of the discount rate is not significant at any conventional level.

Estimating this model augmented by a complete set of industry dummies (using industry number 1, i.e. oil refineries, as the reference group) to control for unobservable and left-out industry characteristics that are invariant over time leads to results computed by OLS reported in column 10. An *F*-test of the nullhypothesis that the coefficients of all fixed effects are zero clearly rejects the null at an error level of one percent: the value of the test statistic is 4.3 with a critical value of about 2.13 at the one percent level of significance. Compared to results from the model without industry fixed-effects (given in column 9) all signs are the same, but most of the coefficients differ in size and statistical significance: while the profit rate, concentration, and capital intensity are not significant in the model with fixed effects, industry growth is. Results for the macroeconomic variables do not change drastically, although both the coefficient of the discount rate and its *t*-value decline by order of magnitude.

It should be noted that from the six econometric studies of entry based on pooled cross-section time-series data I am aware of three (Audretsch and Acs (forthcoming), von der Fehr (1991), and Sleuwaegen and Dehandschutter (1991)) did *not* include industry fixed effects. While Geroski (1991a, p. 73) reports results from models with fixed effects included only, Dunne and Roberts (1991) and Yamawaki (1991) present results for both models with and without industry dummies. While signs, size and significance of coefficients of the macro variables included in the models of Yamawaki did not change dramatically when industry effects are controlled for, the same is not true for the coefficients of some of the industry specific variables (see Yamawaki, 1991, p. 179, and Dunne and Roberts, 1991, p. 191ff.). This illustrates that it is important to estimate entry models based on panel data with industry fixed effects included!

Results reported in columns 11 and 12 show that a small number of extreme cases (outliers) influence some of the estimations heavily:

When the model without industry fixed effects is estimated by LMS, 33 cases (i.e., about 11 percent of all observations) are identified to be outliers. If the model is estimated excluding these 33 observations (i.e., by RLS), results — reported in column 11 — differ markedly from those based on the full sample given in column 9 in two respects: R&D intensity now has a positive and statistically significant effect on the small single firm entry rate, and a higher discount rate deters entry as expected (although the coefficient is not statistically significant at a conventional level).

A closer look at the 33 cases labeled as outliers by LMS reveals that more than half of them come from five industries in different years: six from industry 29 (clothing), four from industry 6 (steel drawing, cold rolling mills), and three from industry 15 (musicial instruments, etc.), industry 17 (office and data processing equipment), and industry 21 (wood processing). The rest are one or two observations from nine different industries and various years. In no case, therefore, all observations from either an industry or a year are labeled as outliers.

From Table I it can be seen that industries 29 and 6 have the highest average values of small single entry rates, and extreme values of the endogenous variable in one or some of the years covered by the period under investigation seem to explain most (if not all) of the "stigmatization" done by LMS. To illustrate this point, consider the following three examples: Industry 5 (iron and steel foundries) had no small single firm entry in eight years between 1979 and 1988, but for 1983 the employment share of new small single firms is

1.08 percent — this is an outlier. Industry 14 (metal products) had some entry in every year covered, the employment share of new small single firms in the years except 1985 was on average 0.53 percent — in 1985 it was 1.13 percent. For industry 18 (fine ceramics) no entry of small single firms is reported but in 1981 and 1983 — employment shares were 3.54 percent and 1.23 percent, respectively!

These large inter-temporal intra-industry variations of entry rates (that cause the often low and sometimes negative inter-temporal correlation of entry-intensities reported in Table III) cannot be modeled satisfactorily by using industry variables that tend to change only very slowly over time (like concentration, capital intensity, and R&D intensity), or that do fluctuate but not that erratic (like profits, or growth of sales).

If, on the other hand, extreme cases like those mentioned above are included in the sample they *can* heavily influence the outcome of an OLS estimation of the model, as is illustrated by the different coefficient estimates for R&D intensity reported in columns 9 and 11. If one is interested in the identification of industry characteristics that are highly correlated with entry, and in an assessment of their relative importance, such an exploratory and descriptive orientation should focus on the pattern revealed by the bulk of the data, leaving a discussion of "special cases" or idiosyncratic events like an extremely high rate of entry in a single year to industry or case studies. Therefore, in my view an application of LMS/RLS is more appropriate than the (sole) use of OLS.

It seems to be inappropriate, however, to base conclusions on results reported in column 11, because an *F*-test of the nullhypothesis that the coefficients of all fixed effects are zero clearly rejects the null at an error level of one percent: the value of the test statistic is 10.76 with a critical value of about 2.13 at the one percent level of significance. Although all signs there are as expected theoretically (and four of them are statistically significant), and the positive coefficient of R&D intensity shows that small single firms are entering high-tech industries more intensively than low-tech industries, with a higher technology intensity, therefore, not acting as an entry barrier (which is good news from the point of view of many economists and politicians), estimation of an augmented model that includes industry dummies turns some of the results upside down (cf. column 12).

From the robust regression of the model with industry fixed effects it follows that macroeconomic conditions matter in a way that is in accordance with expectations, i.e. a higher rate of interest discourages entry, while a higher rate of unemployment has a positive impact (although this coefficient is not statistically significant at a level of 5 percent). Furthermore, entry by small single firms is more intensive when the growth rate of sales of the industries is higher. Both a higher capital intensity and a higher R&D intensity act as barriers to entry, the negative coefficients, however, are not statistically significant at any conventional level. It comes as a surprise that higher rates of concentration are positively related to entry intensity, while higher rates of profit have a negative impact (and both coefficients are statistically significant at a level of 1 percent). However, a high degree of concentration may leave plenty of room for new small firms in certain local market niches, and a negative nexus between profits and entries may simply be the result of successful strategic entry-prevention behavior of incumbents when profits are high.

Before the results reported in column 12 can form a solid basis for the identification of stylized facts related to determinants of inter-industry and inter-temporal variation of small firm entry intensity, however, the (unobserved) time-invariant factors represented by fixed industry effects and their interaction with observed industry characteristics must be unraveled.

In passing, some comments on the regression results for total entry are in order. Without going into details here, a glance at the results reported for all entering firms reveals that OLS and LMS/RLS differ (compare columns 1 and 3), and that including industry dummies changes results markedly in several cases (see columns 2 and 4 compared to columns 1 and 3). Furthermore, results for small firm entries and all firm entries differ by sign, size, and statistical significance of various coefficients (compare columns 3 and 11, and columns 4 and 12). Because of the measurement problems regarding non-small firm entry, however, we will not elaborate on the results for all firms entries.

All of this said, it must be concluded that the econometric investigation performed here cannot contribute much to an answer for the question asked at the end of section 3. According to Geroski (1991a, p. 100f.) this holds for entry models in general, and the most important reason for this seems to be that the time series variation in the data is both substantial and poorly understood.

6. Concluding remarks

At the end of the day, an important conclusion from this study of new firm entry in Lower Saxony emerges that is quite similar to Geroski's (1991a, p. 103) from his investigation using U.K. data: entry is both rather noisy and idiosyncratic. This points to the need to apply both panel data and robust methods of estimation to detect and take care of the effects that "strange" entry rates in some industries and periods may have on the regression results, because we are interested in the identification of industry and market characteristics that are highly correlated with entry *in general*, and in an assessment of their relative importance.

However, using more sophisticated proxies (e.g., rational expectations predictors for expected rates of profits) and more elaborate techniques for dynamic panel data models might not take us thus far. As Geroski (1991a, p. 260) puts it, "the very small size of most entrants suggests that local market conditions in particular market niches are bound to matter a lot to individual entrants, and these are the kinds of factors that researchers using broad cross-sections composed of . . . industries in national markets are likely to find all but impossible to proxy." A promising alternative way to learn more about entry, its determinants and consequences, is to remember that economists are better off than researchers in many other sciences in one important respect: "Getting the opinions of the subjects of our research is also the only advantage we have over physicists. Quarks and gluons do not talk about what they do or why . . ." (Freeman, 1989, p. xi) — but the subjects that populate the economies we study do. An interesting topic in the context of entry is, e.g., to explore the determinants of expected profits as seen through the eyes of (potential) entrants (cf. Geroski, 1991a, p. 56).

Notes

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[1] A comprehensive study discussing the literature and presenting evidence for the U.K. is Geroski (1991a), short surveys are given by Schmalensee (1989, p. 996ff.) and by Scherer and Ross (1990, p. 391ff.); for collections of studies for various countries, see the papers in Geroski and Masson (1987), and in Geroski and Schwalbach (1991), summarized in Cable and Schwalbach (1991).

[2] Empirical studies of new firm formation in Germany are surveyed in ISW (1992). On inter-regional differences in entry, see Fritsch (1992), and Audretsch and Fritsch (1992); Müller (1987) and Schasse (1992) give some descriptive information on entry in various sectors and regions of Lower Saxony. Based on interviews conducted in 1990 with some 1800 German business founders from Bavaria, growth and survival of new firms is investigated in several papers by members of the "Munich Founder Study" research group (e.g., Brüderl and Schüssler, 1990; Brüderl, Preisendörfer and Ziegler, 1992).

[3] For a discussion of methods for the econometric analysis of panel data, see Hsiao (1986); these methods have been used to study entry only recently by Audretsch and Acs (forthcoming), Dunne and Roberts (1991), Geroski (1991), Sleuwaegen and Dehandschutter (1991), and Yamawaki (1991).

[4] Audretsch and Acs (forthcoming) and Yamawaki (1991) include the rate of growth of real gross national product (GNP), too. We did not follow this suggestion, because the coefficient of correlation between the rate of discount and the GNP growth rate is −0.75 for the period considered, and multicollinearity makes it impossible to identify the role of both the rate of discount and the rate of GNP growth. A negative coefficient of the rate of discount, therefore, points to a positive influence of overall growth, and vice versa.

[5] See Rousseeuw and Leroy (1987). To sketch the idea of LMS, consider a simple regression with an intercept. Geometrically, minimizing the median of the squared residuals corresponds to finding the narrowest strip covering half of the observations, and the LMS regression line lies exactly at the middle of this band. A disadvantage of the LMS method, however, is its lack of efficiency. Therefore, it is only used as a data analytic tool to discover outliers, considering all cases to be outliers which have large (appropriately standardized)

LMS-residuals. Cases identified as outliers are then given a weight zero while all "good" cases keep their weight one, and a regression named RLS in performed on their weighted data. The computations were done using PROGRESS written by Peter J. Rousseeuw. I thank Professor Rousseeuw for the permission to use the program.

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Appendix

Data sources

The various *entry rates* are computed from the longitudinal establishment level data base for all manufacturing firms in Lower Saxony. These confidential data are kept in the Statistical Office of Lower Saxony.

Industry variables

General remark: All industry data are for West Germany as a whole, because comparable data are neither published nor available for Lower Saxony due to data protection legislation.

Profit rate is defined as profits over value of gross production (without value added tax) and is measured in percentage terms. Data are taken from: Luitpold Uhlmann, Die Gewinne der Industrieunternehmen, München: Ifo 1989, Tabelle 4. For six industries in one or two years no profit rates are reported in this source, and these missing values were replaced by the average values reported for the industry groups in these years (e.g., for fine ceramics in 1985 the average value for all consumer goods industries was imputed). No profits are reported for two-digit industry 6 (steel drawing, cold rolling mills; SYPRO 30), and the average of the values reported for two 4-digit industries (SYPRO 3011, 3015) in table A—1 are used.

Growth rate is defined as the percentage rate of growth of sales. Data are taken from: Bernd Görzig, Joachim Schintke und Manfred Schmidt, Produktionsvolumen und -potential, Produktionsfaktoren des Bergbaus und des Verarbeitenden Gewerbes in der Bundesrepublik Deutschland, Statistische Kennziffern, 32. Folge 1970—1989, Berlin: DIW 1990.

Concentration is the value of the Herfindahl-index for sales. Data are taken from Statistisches Bundesamt, Fachserie 4, Reihe S.9, Konzentrationsstatistische Daten für den Bergbau und das Verarbeitende Gewerbe 1954 bis 1982 (for 1978 to 1982), and from various current issues of Statistisches Bundesamt, Fachserie 4, Reihe 4.2.3, Konzentrationsstatistische Daten für den Bergbau und das Verarbeitende Gewerbe sowie das Baugewerbe (for 1983 ff.) Missing values for some industries in some years were replaced by the average values reported for the years before and after the respective year.

Capital intensity is defined as gross fixed capital per employee in constant 1980 prices. Data were taken from the same source as the growth rates.

R&D intensity is measured as the percentage of all employees in an industry made of engineers, chemists, and natural scientists. These are unpublished data based on the so-called Beschäftigtenstatistik (statistic of employees), covering all employees with social insurance. Data used here are based on printouts with a breakdown of employees by industries and various groups of professions that were computed and kindly supplied by Professor Franz-Josef Bade from the University of Dortmund.

Macro variables

Unemployment rate is defined as the number of unemployed persons over the sum of employed plus unemployed persons (in percentage terms). Data are taken from: Jahresgutachten 1991/92 des Sachverständigenrates zur Begutachtung der gesamtwirtschaftlichen Entwicklung, Deutscher Bundestag, Drucksache 12/1618, Bonn: Heger 1991, Tabelle 20*.

Discount rate is the official rate fixed by the Deutsche Bundesbank. Data were taken from: Monatsberichte der Deutschen Bundesbank 44 (1992), No. 8, Tabelle V.1. If the rate was changed during a year, the value valid at July 1 was used.