

The Life History of Cohorts of Exits from German Manufacturing

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ABSTRACT. An investigation of the life history of three cohorts of exits based on longitudinal data covering the population of all manufacturing firms in a German federal state reveals three empirical regularities: (1) Although the probability of exit tends to decline with age *ceteris paribus*, only about a quarter of all exits is from the group of young firms aged five years or less. (2) Only a minor fraction of exits lived through a period of continuous decline of employment for five years or more before closing down. (3) The “impact effect” of job loss due to exits can differ sharply from the “long run effect”.

1. Introduction

Starting at least with the publication of a series of seminal papers by Tim Dunne, Mark Roberts and Larry Samuelson (1988, 1989a, 1989b) a new literature emerged in empirical industrial organization looking at various aspects of what has been labeled *industrial ecology*. Themes in this literature are the birth and death, growth and shrinkage of firms, and its relationship to and consequences for the structural characteristics of industries, and the evolution of economies over time. These empirical studies are usually based on comprehensive sets of longitudinal data at the level of the firm.¹

At the center of an important part of this literature is the question of the employment impact of firm births and deaths in various periods, regions, and industries – a highly relevant topic in times of persistently high rates of unemployment. Job turnover studies give information on the share of jobs created by entries or lost due to exits in a year, and investigations on the post-entry

performance of newly founded firms show the employment impact of entries in the longer run.² One area, however, is still *terra incognita*: To the best of my knowledge, no empirical study looked at the pre-exit performance of closedowns. To put it differently, many studies looked at the number of jobs lost due to exits in the year the firms disappeared, and some looked at the determinants of exit rates at the industry or regional level, or at the determinants of exit vs. survival at the level of individual firms,³ but none followed the life history of closedowns backwards through their last years.

This paper contributes to the literature on industrial ecology by reporting findings of an empirical investigation of three cohorts of exits from German manufacturing, covering all firms that closed down in one year between 1990 and 1992 in Lower Saxony (one of the “old” German federal states), and their fate in the years before since 1978 (or the year of entry for firms born later). We will document a set of empirical regularities emerging from this investigation, and we will have a closer look at two questions: First, is it true that “The likelihood of a firm exiting apparently declines with both age and size”? David Audretsch (1995, p. 149) considers this a stylized fact regarding the type of firm exiting. Second, is there a *shadow of death* sneaking round the corner of the building of a firm bound to die, and if so, how long is it?

The paper is organized as follows: Section 2 gives a short description of the data used in this study, section 3 describes the cohorts of exits and their evolution over time, section 4 reports results from estimation of an empirical model linking the probability of exit to firm size, firm age, and productivity, and section 5 concludes with summarizing stylized facts on exits emerging from this investigation.

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2. Data and measurement issues

This study uses a unique set of longitudinal micro data for German manufacturing establishments. It is based on data collected regularly in official surveys by the Statistical Office. All local production units are covered that are located in Lower Saxony, one of the “old” Federal States of Germany. The reason for this limited regional coverage is that in Germany due to strict data protection legislation it is in general impossible for researchers from outside the Statistical Office to have access to micro data from official statistics, and it is only due to a joint project with the Lower Saxonian Statistical Office that calculations like the ones discussed below are possible.

Data from two sources were matched, i.e. from the monthly report of all establishments that have a minimum of twenty employees 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. All data are for local production units, and the expression *establishment* and *firm* is used here for these units. A longitudinal data set was built covering all firms that existed in at least one year between 1978 (the year the surveys mentioned started for the population described above, using the SYPRO classification of industries) and 1994 (the last year before a new NACE based industry classification was introduced, and the population surveyed was changed for some parts of manufacturing). For each year the data base includes information about the industry (at the 4-digit-level), the location (the *Kreis*, or county), the number of employees (either at the end of September, or an average from all monthly reports), and the amount of total sales (in 1000 DM at current prices). Note that even micro manufacturing firms with only the owner working in it are covered.

The data set is an unbalanced panel, because some firms did not report a number of employees (or an amount of total sales) in some years. If an establishment reports some employees in the year $t - 1$ but no employees in the year t , this can mean various things: either the firm closed down, or it interrupted production, or it switched (temporarily or permanently) out of manufacturing (into, e.g., services), or it relocated to another federal state

(or a foreign country). This makes it difficult to identify exits (and, for similar reasons, entries), because it is impossible to differentiate between the various possibilities mentioned based on the information contained in the data set alone, and checking the written files in the Statistical Office is not possible due to data protection legislation and budget constraints. A look at the complete life histories of all 11,272 firms that reported a positive number of employees in at least one year between 1978 and 1992 reveals that interruptions (due to temporary stops of production, or switches to another sector, or location outside Lower Saxony) lasting a maximum of one or two years are found in 218 or 1.93 percent of these firms, while interruptions of three or more years are more rare events found in only 85 or 0.75 percent of all establishments. To reduce the ambiguity as regards the identification of exits we therefore decided to consider all firms that existed in 1989, but not in one year between 1990 and 1994, as a member of the 1990 cohort of exits, and to use the same procedure for the identification of the 1991 cohort of exits (no employees in 1991 to 1994), and the 1992 cohort (no employees in 1992 to 1994). Furthermore, due to the presence of “perforated” life histories the age of a firm was computed based on the year the establishment reported a positive number of employees for the first time.

3. A look at three cohorts of exits (1990, 1991, 1992)

Manufacturing in Lower Saxony (and in Germany as a whole) declined in the period covered by the panel data set under consideration. As can be seen from Table I, both the number of firms and the number of employees diminished between 1978 and 1994, while the average number of employees per establishment remained more or less constant. From empirical studies decomposing the net change in the number of employees between two years into gross flows (according to changes in the number of employees in entries, exits, growing and declining firms) we know that between 0.90 percent and 1.90 percent of all jobs were lost due to exits in the manufacturing sector of Lower Saxony in a year between 1978 and 1992 (Gerlach and Wagner 1995, p. 272).⁴

TABLE I
The population of manufacturing establishments in Lower Saxony, 1978–1984

Year	Number of establishment	Number of employees	Average number of employees
1978	7584	733206	96.7
1979	7408	735126	99.2
1980	7415	740391	99.9
1981	7416	727751	98.1
1982	7250	700141	96.6
1983	7068	669503	94.7
1984	6947	655988	94.4
1985	6883	658681	95.7
1986	6773	674584	99.6
1987	6688	669713	100.1
1988	6630	662924	100.0
1989	6722	676584	100.6
1990	6694	697929	104.3
1991	6640	710208	107.0
1992	6643	696971	104.9
1993	6720	654135	97.3
1994	6620	615769	93.0

Tables 2A, 2B, and 2C report details of the cohorts of exits for 1990, 1991, and 1992, respectively. A look at the left-most panel of these tables (covering all exits of the cohort) reveals the striking fact that the bulk of these exits are of the oldest vintage, i.e. between 53 percent and 61 percent of them were founded in or before 1978 (the year in which the official surveys the panel is based upon started, see above). For each cohort the average firm size declined over the years from 1978 until the year of exit by some 50 percent, while the number of employees in the cohort diminished much less dramatically. This result is a consequence of the higher proportion of smaller firms from the most recent vintages among the exits that are in a cohort.

Figure 1 shows the share of employees in an exits cohort, measured as a percentage of all manufacturing employees. While this share remained more or less constant over time in the firms from the 1990 cohort, it did exhibit a sharp slowdown in the five to six years before exit in

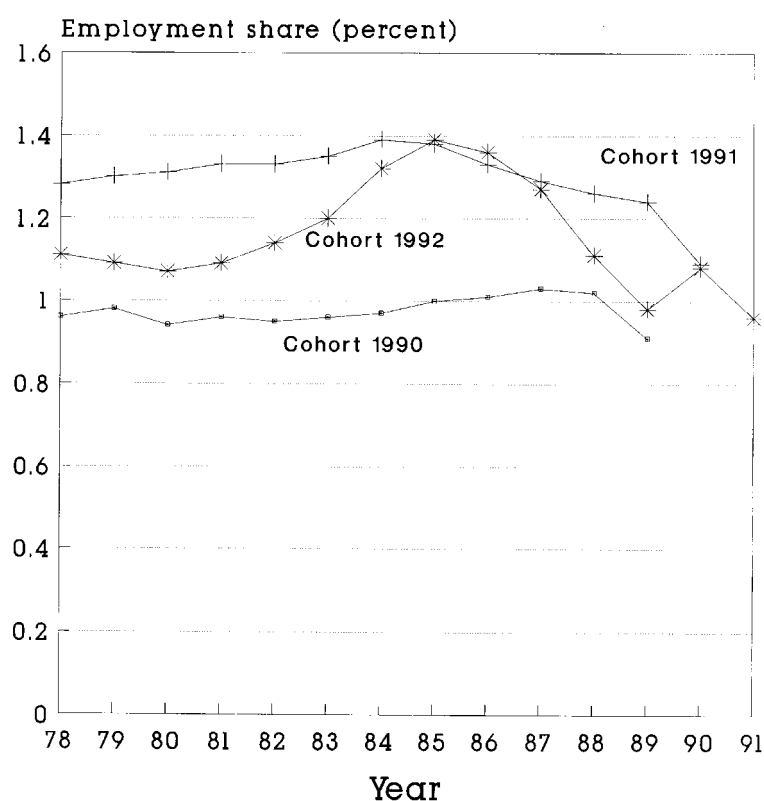


Figure 1. Employment share of exit cohorts.

TABLE IIA
Cohort of exits, 1990

Year	All exits (<i>N</i> = 257)			Exits aged maximum 5 years (<i>N</i> = 73)			Exits with declining employment for at least 5 years (<i>N</i> = 13)			Other exits (<i>N</i> = 171)		
	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.
1978	157*	7036	44.8	—	—	—	12	1208	100.7	145	5828	40.2
1979	3	7232	45.8	—	—	—	12	1286	107.2	146	5946	40.7
1980	2	6990	43.4	—	—	—	12	1295	107.9	149	5695	38.2
1981	10	6986	41.6	—	—	—	12	1298	108.2	156	5688	36.5
1982	2	6683	38.9	—	—	—	13	1281	98.5	159	5402	34.0
1983	7	6456	36.5	—	—	—	13	1231	94.7	164	5225	31.9
1984	3	6341	35.4	—	—	—	13	1136	87.4	166	5205	31.4
1985	8	6616	35.4	8	201	25.1	13	1158	89.1	166	5257	31.7
1986	5	6332	35.4	13	293	22.5	13	1025	78.8	167	5514	33.0
1987	10	6912	33.7	23	452	19.7	13	940	72.3	169	5520	32.7
1988	22	6747	29.9	45	752	16.7	13	728	56.0	168	5267	31.4
1989	28	6188	24.1	73	1018	13.9	13	546	42.0	171	4624	27.0
1990	—	—	—	—	—	—	—	—	—	—	—	—
1991	—	—	—	—	—	—	—	—	—	—	—	—
1992	—	—	—	—	—	—	—	—	—	—	—	—
1993	—	—	—	—	—	—	—	—	—	—	—	—
1994	—	—	—	—	—	—	—	—	—	—	—	—

* Born in or before 1978 (see text).

TABLE IIB
Cohort of exits, 1991

Year	All exits (N = 274)			Exits aged maximum 5 years (N = 67)			Exits with declining employment for at least 5 years (N = 18)			Other exits (N = 189)		
	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.
1978	162*	9389	58.0	—	—	—	15	3099	266.6	147	5390	36.7
1979	5	9557	57.2	—	—	—	16	4082	255.1	151	5475	36.3
1980	5	9721	57.2	—	—	—	15	4079	271.9	155	5642	36.4
1981	7	9661	54.6	—	—	—	17	4103	241.4	160	5558	34.7
1982	2	9330	52.4	—	—	—	17	4021	236.5	161	5309	33.0
1983	4	9047	49.4	—	—	—	18	3937	218.7	165	5110	31.0
1984	11	9088	47.3	—	—	—	18	3824	212.4	174	5264	30.3
1985	11	9104	44.8	—	—	—	18	3871	215.1	185	5233	28.3
1986	17	9001	41.3	17	212	12.5	18	3592	199.6	183	5197	28.4
1987	9	8635	38.0	26	450	17.3	18	2745	152.5	183	5440	29.7
1988	11	8334	34.9	37	586	15.8	18	2210	122.8	184	5538	30.1
1989	16	8390	32.9	53	870	16.4	18	1956	108.7	184	5564	30.2
1990	14	7620	27.8	67	888	13.3	18	1405	78.1	189	5327	28.2
1991	—	—	—	—	—	—	—	—	—	—	—	—
1992	—	—	—	—	—	—	—	—	—	—	—	—
1993	—	—	—	—	—	—	—	—	—	—	—	—
1994	—	—	—	—	—	—	—	—	—	—	—	—

* Born in or before 1978 (see text).

TABLE IIC
Cohort of exits, 1992

Year	All exits (<i>N</i> = 304)			Exits aged maximum 5 years (<i>N</i> = 88)			Exits with declining employment for at least 5 years (<i>N</i> = 0)			Other exits (<i>N</i> = 216)		
	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.	Vintage	Number of employ.	Average number of employ.
1978	162*	8161	50.4	—	—	—	—	—	—	162	8161	50.4
1979	7	7988	47.5	—	—	—	—	—	—	168	7988	47.5
1980	4	7897	45.9	—	—	—	—	—	—	172	7897	45.9
1981	4	7910	45.2	—	—	—	—	—	—	175	7910	45.2
1982	4	7975	44.6	—	—	—	—	—	—	179	7975	44.6
1983	4	8046	44.2	—	—	—	—	—	—	182	8046	44.2
1984	6	8666	46.1	—	—	—	—	—	—	188	8666	46.1
1985	11	9186	46.2	—	—	—	—	—	—	199	9186	46.2
1986	14	9199	43.0	—	—	—	—	—	—	214	9199	43.0
1987	9	8472	38.0	9	82	9.1	—	—	—	214	8390	39.2
1988	16	7361	31.3	25	287	11.5	—	—	—	210	7074	33.7
1989	27	6650	25.3	51	786	15.4	—	—	—	212	5864	27.7
1990	22	7511	26.5	71	1347	19.0	—	—	—	212	6164	29.1
1991	14	6836	22.5	88	1335	15.2	—	—	—	216	5501	25.5
1992	—	—	—	—	—	—	—	—	—	—	—	—
1993	—	—	—	—	—	—	—	—	—	—	—	—
1994	—	—	—	—	—	—	—	—	—	—	—	—

* Born in or before 1978 (see text).

both the 1991 and the 1992 cohort. This points to the fact that judging the employment effect of exits based on the impact effect revealed in decomposition analyses of the now common type, i.e. using data on employees in the year before exit only, can be highly misleading.

For a closer look at these cohorts, exits were divided into three groups: firms that were five years old or younger (*Group 1*), firms with a decline in the number of employees over (at least) the last five years before exit (*Group 2*), and other exits (*Group 3*). While young firms from *Group 1* account for about a quarter of all exits, nearly three quarters are made of firms that were neither young (using the definition applied here) nor suffered a continuous decline in the number of employees over a period of five years or more before exit. Note that the young firms that exited tend to be small on average compared to the other exits, and that the number of jobs lost in these young firms is, therefore, small in absolute and relative terms. Furthermore, note that firms with a decline in employment over five years before exit are a rare species (only 13 firms in the cohort of 1990, and 18 in the cohort of 1991, are in *Group 2*, while none of the exits of 1992 falls into this category); therefore, we have no evidence that there is something like a ‘long shadow of death’ prevalent.

4. On the role of firm age, firm size, and productivity

Evidently, the descriptive evidence presented in section 3 is interesting per se; the numbers in Tables IIA–IIC, however, can not tell us anything about the ceteris paribus effect of firm size, or firm age, on the probability of exit or survival: Exits tend to be small compared to all firms, but what about the role of the industry composition of both groups? The average firm size differs between industries, and if exits tend to be concentrated in industries with on average small firms, what can we learn from the tables about the firm size – propensity to exit nexus? Similarly, only about a quarter of exits is five years old or younger, but what about the share of firms exiting in the various vintages of the population of firms?

To answer these questions, and to test whether the “stylized fact” that the likelihood of a firm

exiting apparently declines with both age and size (Audretsch 1995, p. 149) can also be found for firms from manufacturing industries in Lower Saxony, we look at an empirical model that links the probability of exit of a firm to its age and size, controlling for industry. Furthermore, the model includes the turnover per employee as a proxy for labor productivity to see whether firms with a lower volume of sales per head (given size, age, and industry) have a higher likelihood to exit.⁵ Regression results are reported in Table III.⁶

For all three cohorts we find that after controlling for industry affiliation at the most detailed level available the probability of exit declines with firm age and (at a decreasing rate) with firm size. This is in accordance with what we know from the literature. Note that a higher labor productivity (proxied by turnover per employee) has a statistically significant negative impact on exit in the model estimated for the 1990 cohort only, the coefficients of turnover per employee in both models for 1991 and 1992 exits being insignificant at any conventional level. This again illustrates that conclusions should not be drawn from estimates based on one cohort only (cf. Wagner 1994). Given that a low level of turnover per employee (controlling for size, age, and industry affiliation) does not tend to increase the probability to exit we again have no evidence for such thing as a “shadow of death” to exist.

5. Concluding remarks

Following the life history of closedowns from three cohorts revealed three empirical regularities that shed some light on a hitherto neglected part of industrial ecology:

- (1) Although the probability of exit tends to decline with age ceteris paribus, only about a quarter of all exits is from the group of young firms aged five years or less, and the number of jobs lost in these young firms exiting is relatively small because these establishments tend to be small firms on average.
- (2) We have no evidence for the existence of a “shadow of death” – only a minor fraction of exits lived through a period of continuous decline of employment for five years or more before closing down.

TABLE III
Regression results for exits vs. survivors^a [Dependent variable: Exit (Dummy; 1 = yes)]

Variable (measured in year before exit)	Cohort of exits	1990	1992	1993
Age of establishment (years)	β	-0.36e-2	-0.23e-2	-0.31e-2
	t	-4.21**	-3.26**	-4.13**
Number of employees	β	-0.23e-4	-0.18e-4	-0.22e-4
	t	-2.81**	-3.78**	-4.05**
Number of employee (squared)	β	3.23e-10	2.81e-10	3.46e-10
	t	3.15**	3.86**	4.07**
Turnover per employee (1000 DM)	β	-8.88e-6	-8.30e-8	0.14e-4
	t	-2.56**	-0.01	0.87
Constant	β	0.076	0.065	0.073
	t	7.79**	7.38**	6.95**
190 industry controls		Included	Included	Included
Number of observations		6429	6429	6355
F -test statistic		10.50	9.98	13.64
(Prob > F)		(0.000)	(0.000)	(0.000)
R^2		0.042	0.049	0.053

^a Linear probability model; t -values are robust for heteroscedasticity, * (**) indicate statistical significance at 0.5 (0.1) level).

- (3) The number of jobs in a cohort of exits taken as a fraction of all jobs in manufacturing industries is not necessarily constant over time, and, therefore, the “impact effect” of job loss due to exits can differ sharply from the “long run effect”.

Further research is needed to validate these empirical regularities with longitudinal micro data sets from other countries, and to model the exit decision based on much richer data.

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Notes

¹ For a summary of many of the findings in this literature relating to the U.S. and Canada, see the books by Kirchoff (1994), Baldwin (1995), Audretsch (1995), and Davis, Haltiwanger and Schuh (1996); for the U.K., see Geroski (1991), and for Germany, see Gerlach and Wagner (1995).

² For job turnover studies, see the literature mentioned in

footnote 1. Recent studies on the post-entry performance of firms from various countries include the papers in Audretsch and Mata (eds.) (1995), and Wagner (1994) for Germany.

³ Recent studies on the determinants of exit rates include papers in Geroski and Schwalbach (eds.) (1991); for a study of exit vs. survival using firm level data, see Wagner (1999).

⁴ Note that in these decomposition exercises exits cover all firms with employees in $t - 1$ and no employees in t , i.e. the possibility of “returns” in perforated life histories is not controlled for. Therefore, gross flows due to exiting firms reported therein are slightly higher than in this study using the methodology described in section 2 above to identify exits.

⁵ Note that the volume of sales is the only other information available for the firm in the data set used in this inquiry. For a study of exits using a much richer but both much smaller and shorter set of establishment level data from German manufacturing industries see Wagner (1999).

⁶ Given that the dependent variable is dichotomous (to exit or not to exit, that is the question), PROBIT or LOGIT should be applied to estimate the empirical model. However, controlling for industry affiliation of the firms is important here, and estimation of a model with 190 industry controls using PROBIT or LOGIT was not computationally feasible inside the Statistical Office. Therefore, a linear probability model is used in which the large number of industry controls can be simply absorbed. We know from introductory econometrics textbooks that the linear probability model is flawed, having a heteroskedastic error term, and predicted values can be less than zero or greater than one. To deal with the first problem the White estimator is used to compute t -values that are robust for heteroskedasticity. Given that results for models *without* industry controls estimated by PROBIT and OLS did not differ as regards the signs and significance levels of the estimated

coefficients it seems reasonable to assume that we can draw valid conclusions about the ceteris paribus influence of firm size, age, and productivity on the likelihood of exit from the model estimated by OLS (for a discussion, see Greene, 1997, p. 874).

References

- Audretsch, David B., 1995, *Innovation and Industry Evolution*, Cambridge, MA and London, England: MIT Press.
- Audretsch, David B. and José Mata (eds.), 1995, *The Post-Entry Performance of Firms*, Special issue of the *International Journal of Industrial Organization* **13**, 413–614.
- Baldwin, John R., 1995, *The Dynamics of Industrial Competition*, Cambridge: Cambridge University Press.
- Davis, Steven J., John C. Haltiwanger and Scott Schuh, 1996, *Job Creation and Destruction*, Cambridge, MA and London, England: MIT Press.
- Dunne, Timothy, Mark J. Roberts and Larry Samuelson, 1988, 'Patterns of Firm Entry and Exit in U.S. Manufacturing Industries', *RAND Journal of Economics* **19**, 495–515.
- Dunne, Timothy, Mark J. Roberts and Larry Samuelson, 1989a, 'Plant Turnover and Gross Employment Flows in the U.S. Manufacturing Sector', *Journal of Labor Economics* **7**, 48–71.
- Dunne, Timothy, Mark J. Roberts and Larry Samuelson, 1989b, 'The Growth and Failure of U.S. Manufacturing Plants', *Quarterly Journal of Economics* **104**, 671–698.
- Gerlach, Knut and Joachim Wagner, 1995, 'Employment Dynamics, Firm Growth, and New Firm Formation', in Friedrich Buttlar et al. (eds.), *Institutional Frameworks and Labor Market Performance*, pp. 270–284, London and New York: Routledge.
- Geroski, Paul A., 1991, *Market Dynamics and Entry*, Oxford, U.K. and Cambridge, USA: Blackwell.
- Geroski, Paul A. and Joachim Schwalbach (eds.), 1991, *Entry and Market Contestability*, Oxford, U.K. and Cambridge, U.S.A.: Blackwell.
- Greene, William H., 1997, *Econometric Analysis*, Third Edition, Upper Saddle River: Prentice-Hall.
- Kirchhoff, Bruce A., 1994, *Entrepreneurship and Dynamic Capitalism*, Westport, Conn. and London: Praeger.
- Wagner, Joachim, 1994, 'The Post-Entry Performance of New Small Firms in German Manufacturing Industries', *Journal of Industrial Economics* **XLII**, 141–154.
- Wagner, Joachim, 1999, 'Who Exits from German Manufacturing and Why?', in David B. Audretsch and Roy A. Thurik (eds.), *Innovation, Industry Evolution and Employment*, pp. 253–264, Cambridge: Cambridge University Press.

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