Small Business in German Manufacturing*

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ABSTRACT. The study provides empirical evidence about the determinants of the size distribution and the importance of small business in German manufacturing industries. The adopted empirical model distinguishes short-run from long-run effects and estimates the rate of adjustment when a departure from long-run equilibrium occurs. The results show a significant impact of industry-specific factors on the presence of small plants and the size distribution of plants. Foremost, technological factors, like scale economies, limit the prosperity of small business. In addition, industries with a high intensity of investments in advertising and R&D, and large domestic and foreign output volumes are dominated by large business. The dynamic analysis revealed that departures from long-run equilibrium are only of a very short duration.

I. Introduction

In recent years, one observes a renaissance of small business research efforts. The stimuli came from different directions. One strand of more policy oriented research concentrated on the impact of small businesses on the creation of new employment opportunities.[1] Another host of studies paid attention to the relationship of innovation productivity of small versus large business.[2] And industrial economics research examined the role of small businesses as actual and potential challengers of larger competitors in a given market.[3] Whatever motive guided this research, it was emphasized that the cumulated knowledge about large business behavior is by far greater than about their small business counterparts.

Among the existing studies on the economics of small business, there is a considerable variance of research efforts across countries. In the Federal Republic of Germany (FRG), there exists a long tradition of public policies which are directed toward support of small and medium-sized business. Part of this tradition is the production of policy oriented research which is mainly performed by the government supported Institute for Small and Medium-Sized Business Research (Institut für Mittelstandsforschung) in Bonn. Like in other countries, in recent years, a lot of attention has been paid to employment effects and to start-up problems by small business. Controversial results can be found to the role of small business in the creation of new job opportunities.[4] And start-ups mainly face, according to a study by Albach (1984), problems like high taxes, high labor cost, and high competitive pressure.[5]

This paper departs from the just mentioned German studies in the sense that it provides some fundamental empirical evidence about the determinants of the size distribution and the importance of small business in the FRG. The adopted explanatory model distinguishes short-run from long-run effects and estimates the rate of adjustment when deviations from the long-run equilibrium level are observed. The paper is organized as follows: Section II provides some insights into the size distribution of businesses in the manufacturing sector and shows the importance of small businesses over time. Section III presents the empirical model and Section IV reports the empirical results. A summary and conclusions are found in the final section.

II. Size distribution and the importance of small business

The general impression about the development of the number of businesses and its distribution across industry groups is exhibited in Figure 1.

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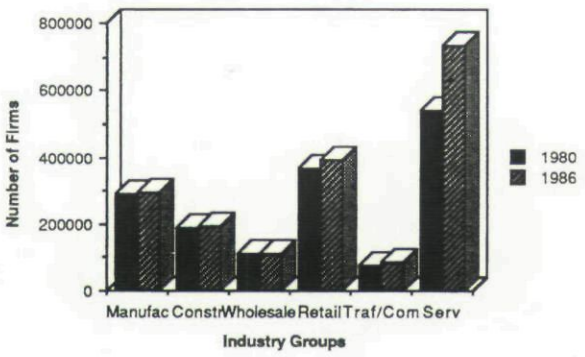

Fig. 1. Firms in industry groups.

In 1980, among the 1 688 690 firms paying value added taxes, 17.2 percent were present in manufacturing, 11.1 percent in construction, 6.6 percent in wholesaling, 21.7 percent in retailing, 4.7 percent in traffic/communication, 32.1 in services, and the remaining firms are in other sectors. Figure 1 shows that within the time period 1980—86 the number of firms increased slightly in all sectors, with the exception of services where a significant increase can be observed which corresponds to a share increase to a level of 38.0 percent. A more detailed analysis of the size distribution and the importance of small businesses in each sector can only be performed for manufacturing for which relatively rich census data sets are available. Therefore, the following analysis concentrates on the manufacturing sector only.

Tables I and II summarize the extent of the size distribution and the importance of small businesses (firms and plants) in German manufacturing industries in 1986. The tables reveal that the size distributions are highly skewed. For example, 75.7 percent of all plants have less than 50 employees and can be considered small, but only 2.6 percent are large plants with at least 500 employees. The same applies to firms, where 45.7 percent are small (20—49 employees) and only 5.7 percent are large firms (over 499 employees). While the distribution of the share of total number of businesses are skewed to the right, the opposite is observed if the shares of sales and employment are taken into consideration. Large businesses accounted for more than 50 percent of all sales and employment.

Table II, in addition, also shows that within the small size group all plants contributed significantly to the high share of the total number, although plants with either one employee or between 5 to 19 employees had a slightly lower share. If the shares of employment and sales are considered,

TABLE I
Firm size distribution in German manufacturing industries, 1986

	Employment size classes						
	Small firms	Medium-sized firms			Large firms		
	20—49	50—99	100—199	200—499	500—999	1000 and more	Total
Number of firms	15 312	8120	4888	3287	1051	860	33 499
Share of total number of firms (in %)	45.7	24.2	14.6	9.8	3.1	2.6	100.0
(cumulative share)	(45.7)	(69.9)	(84.5)	(94.3)	(97.4)	(100.0)	
Share of total employment (in %)	7.2	8.2	9.8	14.5	10.4	49.9	100.0
(cumulative share)	(7.2)	(15.4)	(25.2)	(39.7)	(50.1)	(100.0)	
Share of total sales (in %)	5.3	6.4	8.6	13.6	10.0	56.1	100.0
(cumulative share)	(5.3)	(11.7)	(20.3)	(33.9)	(43.9)	(100.0)	

Source: Statistisches Bundesamt, Fachserie 4, Reihe 4.2.1 and own calculation.

Table II indicates, that beside large plants, medium-sized plants with 100 to 199 employees accounted for the third highest share. At the firm level, the relative importance of a size class diminishes with increasing firm size as far as the share of total number of firms is concerned but increases when the shares of employment and sales are considered. Table II, however, shows one exception. In the size class of 500—999 employees the share is lower relative to neighbouring size classes. Tables I and II, therefore, show that the observed plant size distribution does not completely reflect a well behaving function of size distribution.

Table III reveals the importance of small, medium-sized, and large businesses over the period 1977 to 1986. Considering first the share of total number of plants, it is apparent that the share of small plants increased slightly over time, while the shares of medium-sized and large plants both decreased. Interestingly, the increasing

TABLE II
Plant size distribution in German manufacturing industries, 1986

	Employment size classes												
	Small plants			Medium-sized plants							Large plants		
	1	2—4	5—9	10—19	20—49	50—99	100—199	200—299	300—399	400—499	500—999	1000 and more	Total
Number of plants	8961	15645	12698	13361	16634	9358	5825	2259	1185	701	1326	965	88918
Share of total number of plants (in %)	10.1	17.6	14.3	15.0	18.7	10.5	6.6	2.5	1.3	0.8	1.5	1.1	100.0
(cumulative share)	(10.1)	(27.7)	(42.0)	(57.0)	(75.7)	(86.2)	(92.8)	(95.3)	(96.6)	(97.4)	(98.9)	(100.0)	
Share of total employment (in %)	0.1	0.6	1.2	2.6	7.6	9.1	11.3	7.6	5.6	4.3	12.8	37.2	100.0
(cumulative share)	(0.1)	(0.7)	(1.9)	(4.5)	(12.1)	(21.2)	(32.5)	(40.1)	(45.7)	(50.0)	(62.8)	(100.0)	
Share of total sales (in %)	0.06	0.5	1.0	2.2	6.0	7.7	10.2	7.4	5.4	4.7	14.2	40.6	100.0
(cumulative share)	(0.06)	(0.6)	(1.6)	(3.8)	(9.8)	(17.5)	(27.7)	(35.1)	(40.5)	(45.2)	(59.4)	(100.0)	

Source: Statistisches Bundesamt, Fachserie 4, Reihe 4.1.2, and own calculation.

TABLE III
Importance of small, medium-sized and large businesses in German manufacturing industries, 1977—1986[a]

Year		Small		Medium-sized		Large	
		Firms (20—49)	Plants (1—49)	Firms (50—499)	Plants	Firms (more than 499)	Plants
1977	Number	n.a.	74.4	n.a.	22.9	n.a.	2.7
	Employment	n.a.	12.4	n.a.	38.3	n.a.	49.3
	Sales	n.a.	10.6	n.a.	35.7	n.a.	53.7
1981	Number	47.1	75.2	47.3	22.2	5.6	2.6
	Employment	7.5	12.4	32.5	38.1	60.0	49.5
	Sales	5.7	10.0	27.4	34.0	66.9	56.0
1986	Number	45.7	75.7	48.6	21.7	5.7	2.6
	Employment	7.2	12.1	32.5	37.9	60.3	50.0
	Sales	5.3	9.8	28.6	35.4	66.1	54.8

[a] All figures represent the percentage of the total numbers of employees accounted for by that particular size class.

number of small plants did not contribute to a growth of employment and sales shares. Instead, large plants increased their share of employment although fewer large plants were in operation. In addition, Table III indicates that the sales shares of large plants show a positive trend over time. Medium-sized plants, on the other hand, lost shares not only in total number but also in employment and sales.

Only a shorter time period is available for the size distribution of firms. Between 1981 and 1986, the shares of small firms decreased in contrast to medium-sized and large firms. Medium-sized firms increased their sales share as well as their share of the total number, but the employment share stagnated. Large firms, on the other hand, improved their employment share and share in total number, but lost shares of sales. In sum, Table III reveals that the relative importance of small business diminished over time in the German manufacturing sector, but the overall importance with respect to the total number of businesses is still significant.

III. The empirical model

Stochastic growth models and simulation experiments reveal that in the long-run businesses are unequal in size even though they began with the same size.[6] It was argued that stochastic processes generate a size distribution which ". . . have at their core something like Gibrat's law of proportionate effect — the postulate that expected rate of growth is independent of present size." (Ijiri and Simon, 1977, p. 154). What has been observed, therefore, was a frequency distribution which is highly skewed and often represented by log normal, Pareto, or Yule distribution. Although entry by new business and exit of existing ones may affect the size distribution in the short-run, it should not, according to the stochastic process theory, vary the adjustment process toward the long-run equilibrium level.

There is support that the observed size distribution of an industry is not purely a result of mere chance or luck. Market structure and business behavior have been seen as additional important determinants of the size distribution.[7] The existing size distribution of business can therefore be explained by the following model:

$$S_{it} = \alpha_{0t} + \alpha_{jt} X_{jit} + \mu_{it} \qquad (1)$$

where S_{it} represents a measure of size distribution or a section of the distribution in industry i at period t, X_{jit} is a vector of k ($j = 1, \ldots, k$) observable industry-specific variables, and μ_{it} reflects all stochastic variables. In addition, α_0 and α_j are regression coefficients.

If industries i are in long-run equilibrium, we would expect constant and stable regression coefficients, i.e. $\alpha_{jt} = \alpha_{jt+1}$. But if the α_j's deviate over time, we would expect an adjustment process toward the long-run equilibrium level of size distribution in the following way:

$$S_{it} - S_{it-1} = \lambda(S_i^* - S_{it-1}) \qquad (2)$$

where S_i^* is the long-run level of size distribution expected by established and new businesses in industry i. The coefficient, λ, represents the rate of adjustment to deviations of the initial, short-run level of size distribution from its long-run equilibrium level. We expect that λ must be greater than zero and less than one. The smaller λ is, the higher will be the speed of adjustment toward the long-run level. The industry is in long-run equilibrium if λ takes on values of zero or one.

S_i^* cannot be observed, but it can be replaced by a proxy which represents industry-specific determinants of long-run size distribution. Substituting these determinants into our dynamic model, we derive the following empirically testable model:

$$\Delta S_{i,\,t,\,t-1} = \gamma_0 - \gamma_1 S_{it-1} + \gamma_j X_{ji}^* + \varepsilon_{it} \qquad (3)$$

where the change in the size distribution is determined by the previous size distribution level and a vector of various industry-specific variables. The intercept γ_0 is equal to α_0 times λ. The estimates of γ_1 reflect the speed of adjustment ($\gamma_1 = \lambda$), and all γ_j's represent values which are equal to λ times α_j, which are the long-run effects of the selected variables. If industry i is in long-run equilibrium, S_{it} is equal to S_{it-1} and, consequently, all γ's are equal to zero. In the case that short-run equilibrium deviates only slightly from long-run equilibrium, we expect values for all γ's to be close to zero.

IV. Empirical results

The coefficients of the empirical models (1) and (3) have been estimated for up to 106 four-digit manufacturing industries for the years 1979 and 1985. As dependent variables we alternatively use the entropy measure of size distribution and the share of total employment accounted for by small plants with less than 50 employees. The entropy measure of the size distribution is defined as the sum of the weighted share of each business or group of businesses in industry i, where the weights are the logarithm of the inverse of the share. The entropy of the distribution has the useful properties that it is sensitive to very small businesses and, most important, it can be decomposed into within-group and between-group entropies.[8] The decomposition property is relevant for this study, since the available data on the size distribution are presented only for size groups but not for individual businesses. As a consequence, the calculated entropy represents the between-group measure of size distribution. In general, the value of entropy varies between zero and the logarithm of the number of equally sized business. The more unequal the business sizes are, the lower will be the entropy value and, in the one extreme, it takes on a value of zero if one business has a share of one.

The explanatory industry-specific variables used for X_{ji} for models (1) and (3) were selected based on theoretical and empirical grounds. Included are measures of economies of scale, product differentiation intensity, R&D intensity, investment intensity, extent of multi-plant operation, degree of specialization, demand growth, exports, and market size. Observations for these variables were available for the years 1979 and 1985 at the four-digit industry level. Detailed information on the measurement of these variables can be found in the appendix.

The estimates of the static and dynamic model are summarized in Table IV. Columns (1), (2), (4), and (5) show the results of the static model for each measure of S_{it} for the years 1979 and 1985. Columns (3) and (6) report the results of the dynamic model. By concentrating first on the static model, the results suggest that economies of scale are a very powerful determinant of the presence of small plants and the plant size distribution, independent of time. Thus, the larger the extent of scale economies, the stronger is the incentive to operate plants which are close to the cost efficient size. If that size is large relative to the size of the market, it will be difficult for small plants to survive in the long-run. The result in Table IV, however, is biased upwards since scale economies are proxied by the average size of the plant located at the 50 percent point of the cumulative size distribution.

Table IV, furthermore, shows that advertising and R&D intensive industries account for a lower share of small business but do not favour only large business. The positive, although statistically not significant, coefficients in columns (4) and (5) suggest that medium-sized business enjoy a relatively high and increasing share in those industries. By contrast, Table IV reveals that a high intensity in investments in the production process of goods does not deter small business from entry and survival in that industry. Investment intensive industries, instead, reduce the chance for medium-sized business to remain viable and, thus, exhibit a higher share of small and large businesses.

Industries with a high extent of multi-plant operation seem to be, according to the results in Table IV, highly concentrated. Firms in those industries, therefore, operate mainly with large plants but, as the results suggest, also with some small plants. It is worth mentioning that multi-plant operation strategies greatly depend on other industry-specific phenomena. One expects that the extent of multi-plant operation might be influenced by the extent of scale economies in relation to the size of the market and by the segmentation of the market. We tested the expected simultaneity bias but could not find any statistical support.

Table IV, furthermore, shows the impact of demand growth on the presence of small business and the size distribution. The coefficients are not statistically significant, but nonetheless indicate that demand growth affects small plants' presence positively and contributes to a deconcentration of the plant size structure of the industry. Larger markets, on the other hand, favour large plants and seem to provide less room for small plants. The results in Table IV are somewhat surprising, since the conventional belief suggests that larger

TABLE IV
Regression results: Determinants of the size distribution and presence of small plants

Determinants	Presence of small plants			Size distribution		
	S_i 1979 (1)	S_i 1985 (2)	ΔS_i 1985–79 (3)	S_i 1979 (4)	S_i 1985 (5)	ΔS_i 1985–79 (6)
Economies of scale	−3.753**	−2.616**	−0.043	−2.126*	−2.201**	−0.827*
	(−5.10)	(−4.99)	(−0.81)	(−1.75)	(−2.47)	(−1.77)
Product differentiation	−0.050*	−0.060*	−0.006	0.045	0.074	0.007
	(1.79)	(−2.20)	(−1.14)	(0.99)	(1.62)	(0.28)
R&D intensity	−0.058*	−0.072*	−0.001	0.008	0.004	−0.050*
	(−1.77)	(2.06)	(−0.015)	(0.15)	(0.05)	(−2.15)
Investment intensity	0.009**	0.004**	−0.001	−0.017**	−0.014**	−0.006*
	(3.10)	(2.35)	(−1.30)	(−3.49)	(−3.73)	(−2.03)
Multi-plant operation	0.003	0.003	0.002	−0.093**	−0.093**	−0.004
	(0.24)	(0.20)	(0.56)	(−2.65)	(−2.62)	(−0.32)
Demand growth	0.003	0.009	0.008*	0.050	0.014	0.004
	(0.17)	(0.49)	(1.75)	(1.02)	(0.42)	(0.30)
Exports	−0.478**	−0.572**	0.005	−0.060**	−0.299	0.055
	(−3.83)	(−5.13)	(0.13)	(−3.57)	(−1.56)	(0.62)
Market size	−0.083**	−0.082**	−0.004	−0.028	−0.077**	0.021*
	(−6.23)	(−6.16)	(−1.20)	(−0.86)	(−3.42)	(1.96)
Specialisation	0.034	0.050	−0.014**	−0.083**	−0.006	0.034*
	(0.92)	(0.64)	(−2.87)	(−2.59)	(−1.04)	(1.78)
Previous level of S_i	—	—	−0.047	—	—	−0.049
			(−1.59)			(−1.65)
Constant	1.502	1.536	0.127	0.948	0.741	−0.166
	(6.79)	(6.69)	(1.64)	(2.60)	(1.90)	(−0.77)
R^2	0.553	0.545	0.316	0.416	0.363	0.364
F	16.661	18.179	13.731	15.464	16.602	10.912
N	104	106	104	98	106	104

Note: t-values are given in parentheses, * significant at the 0.05 level, ** significant at the 0.01 level.

markets attract new businesses which are predominantly small in relation to the size of incumbents. However, if scale economies are a significant industry-specific factor, one would expect fewer small businesses. This result suggests that large markets are conducive to substantial scale economies and, therefore, provide no profitable market share for small plants.

According to Table IV, small business viability is negatively affected by international trade flows. Industries with a high export intensity are dominated by larger plants, which might be due to the fact that a minimum size is required to exhaust scale economies, and seems to preclude the viability of small businesses in the presence of international competition. Small businesses, instead, are highly specialized in the production and distribution of goods. The results in Table IV show that small plants are predominantly present in those industries in which specialized skills can be developed to exploit cost savings from specialization.

By comparing the coefficients for each explanatory variable for 1979 and 1985, the results in Table IV reveal that the coefficients deviate only slightly for most determinants. For those variables we expect a coefficient close to zero in the dynamic model since the short-run effect deviates only slightly from the long-run effects. The results in columns (3) and (6) indicate that, indeed, most of these coefficients are close to zero, although not all of them are statistically significant. If the short-run and the long-run deviate by a small margin, we expect a rather rapid adjustment process toward the long-run. Table IV shows that the adjustment parameter exhibits a very small value, which indicates that the short-run effects are quite short lived.

V. Conclusions

The study has provided empirical evidence identifying the determinants of the plant size distribution and the importance of small plants in German manufacturing industries. The adopted empirical model distinguishes short-run from long-run effects and estimates the rate of adjustment when a departure from long-run equilibrium occurs. The results show a significant impact of industry-specific factors on the presence of small plants and the size distribution of plants. Foremost, technological factors, like scale economies, limit the prosperity of small business. In addition, industries with a high intensity of investments in advertising and R&D, and large domestic and foreign output volumes are dominated by large business. The dynamic analysis revealed that departures from long-run equilibrium are only of a very short duration. The last observation is interesting since it shows that any stochastic shocks due to entry, exit, or other events will be absorbed instantaneously.

Appendix

Definition and measurement of variables

Economies of Scale:	Proxied by the average size of the plant located at the 50 percent point of the cumulative size distribution. For details about alternative measures of scale economies, see Scherer (1980).
Product Differentiation:	(0, 1)-dummy variable for the extent of advertising intensity. The value of 1 is assigned to industries with above average advertising expenditures.
R&D Intensity:	(0, 1)-dummy variable for the extent of R&D expenditures. The value of 1 is assigned to industries with above average R&D expenditures.
Investment Intensity:	Ratio of outlays for investments in machinery and other equipments to number of employees.
Multi-Plant Operation:	Average number of plants operated by multi-plant firms.
Demand Growth:	Ratio of domestic sales in 1977/1979 and 1979/1985, respectively.
Exports:	Ratio of foreign sales to total sales.
Market Size:	Logarithm of domestic sales.
Specialisation:	Ratio of sales in the base four-digit industry to total sales.

Data sources

Most data are publicly available from the German Census Bureau (Statistisches Bundesamt) in Wiesbaden and are gathered from the publications of Fachserie 4 for the years 1977 to 1985. R&D data were provided by the Stifterverband für die deutsche Wissenschaft. Advertising data were gathered from various published sources.

Notes

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[1] See Storey and Johnson (1987).

[2] See Acs and Audretsch (1988).

[3] See Baumol, Panzar, and Willig (1982) and Geroski and Schwalbach (1985).

[4] For a survey see Fritsch and Hull (1987).

[5] See also Albach and Hunsdiek (1985).

[6] See Ijiri and Simon (1977) and Scherer (1980).

[7] See Jovanovic (1982) and Evans (1987).

[8] See Theil (1967).

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