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Diversification Patterns in the Growth of Firms: Evidence from Italian Manufacturing

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2003/16 **September 2003**

ISSN (online) 2284-0400

Diversification Patterns in the Growth of Firms: Evidence from Italian Manufacturing*

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Abstract

We present empirical evidence on diversification patterns in Italian manufacturing firms and detect a robust relationship between firm size and diversification levels, with an elasticity of diversification that does not depend on firm size and is well below unity. Diversification does not lead to decreased corporate risk when measured in terms of the growth performance of Italian manufacturing firms. The findings support the Penrosian theory of diversification in the process of firm growth. In addition, we also speculate about the role of technology in the size-diversification nexus.

1 Introduction

Why do firms diversify? According to the survey of corporate diversification theories by Montgomery (1994), we can distinguish three broad perspectives in approaching the question. The first, judged to lack empirical credibility, is the market power view by which large firms thrive at the expense of smaller ones through their exercise of conglomerate power. The second perspective synthesizes insights from agency theory and is primarily dealing with diversification through merger and acquisition activity, where agents (managers) have incentives to act against the interest of principals (shareholders) by pursuing inefficient diversification strategies, either to directly enrich themselves at the principals' expense or to decrease the risk associated with managerial human capital, i.e. to decrease the agent's risk of being sacked. The third perspective, the resource view, develops around the work of Penrose (1959) and argues that firms diversify in response to excess capacity in productive factors, the rationale being that diversification is a way to profitably employ underutilized resources.

In contrast to the agency view—a theory of diversification through external expansion—the resource view emphasizes the process of a company's internal growth, also leading to questions about the boundaries of the firm.

A more recent set of contributions (see a survey in Dosi et al. (2000)) has been shaping a 'capability-based' theory of the firm. In this view firms are characterized by specific organizational capabilities i.e. by specific ways of 'doing things'. Thus corporate organizations

*We would like to thank Giulio Bottazzi, Elena Cefis and Giovanni Dosi for their comments, and Roberto Monducci from the Italian Statistical Office (ISTAT) for providing access to the relevant data.

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approach every new event or any decision process in terms of what they already know internally. While capabilities represent the very essence of firms, their relative stickiness constrains the way firms make decisions and adapt to the competitive environment. In this view, the scope of diversification is better understood by taking into account the way firms generate, organize and reconfigure their capabilities (Teece et al. (1994)).

Montgomery (1994) cites ample evidence in favor of both the resource as well as the agency view, which do not seem incompatible on *a priori* grounds. It is not our ambition to discriminate between the two views here, but to simply investigate the size-diversification nexus with the data at hand, which tell us more about the internal productive structure of firms rather than about external growth and profitability. We should mention that the subject matter of our study is mainly empirical and concerns the statistical properties of diversification and its relation to size in a large sample of Italian manufacturing firms; we do not aim for a specific formal model that would account for the observed regularities at this stage.

After arguing why our new data regarding the Italian manufacturing industry can be considered as a diversification proxy, we observe a very robust relationship between diversification and firm size, in line with a previous finding of Bottazzi (2001). The relationship supports the Penrosian competence-based view of the firm and is reinforced by a variant of the 'Italian puzzle,' referring to the absence of a negative relationship between firm size and growth rate variance[1]—also absent in the case of diversification. In other words, more diversified firms do not have a lower variance in their growth rates than less diversified ones. This is what we expect if diversification develops along the lines of the resource-based view, whereby internally driven diversification follows already existing corporate competences and would lead to correlated activities. Hence, corporate diversification would have little effect on reducing corporate exposure to 'risk.' We conclude by investigating whether the technological characteristics of firms shed more light on the diversification-size nexus, essentially by disaggregating the statistical analysis according to the Pavitt (1984) taxonomy of sectoral patterns in technical change.

2 Descriptive Statistics of the Diversification Proxy

The Italian Statistical Office (ISTAT) has organized the database MICRO.1 that covers several thousand Italian firms with 20 or more employees over roughly a decade.[2] Our investigation concerns a previously unexplored foreign trade survey that is linked to this database and contains the number of sectors $N_i(t)$ that firm i exported to between 1993 and 1997. $N_i(t)$ measures export sector activity on a four-digit level disaggregation of the industrial classification system NACE, which is very similar to ISIC codes and structure. When ISTAT compiled the database, it chose to classify firms according to their three-digit 'primary code' of activity. Unfortunately, such a procedure does not allow us to directly observe a firm's diversification in production, and the linked foreign trade survey provided us with a welcome opportunity around this dilemma.

The high level of disaggregation suggests that the number of export sectors will be directly proportional to the number of product markets a firm is engaging in. At the same time, however, several reasons prevent a meaningful analysis of the dynamic properties of $N_i(t)$.

[1] Cf. Bottazzi et al. (2002).

[2] For more details about MICRO.1 the interested reader should turn to Bottazzi et al. (2002). The database has been made available to our team under strict censorship of any information that would allow the identification of individual companies.

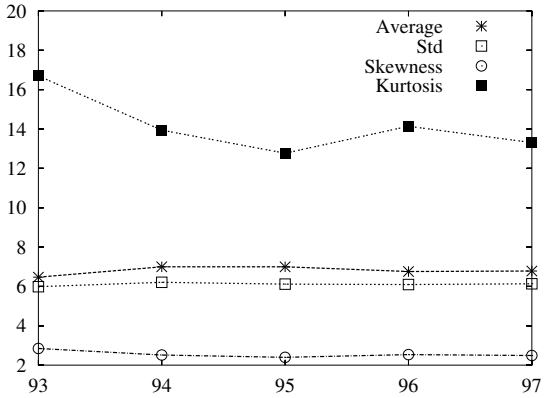

Figure 1: First four moments of the number of sectors $N_i(t)$ a firm exports to during the observational period.

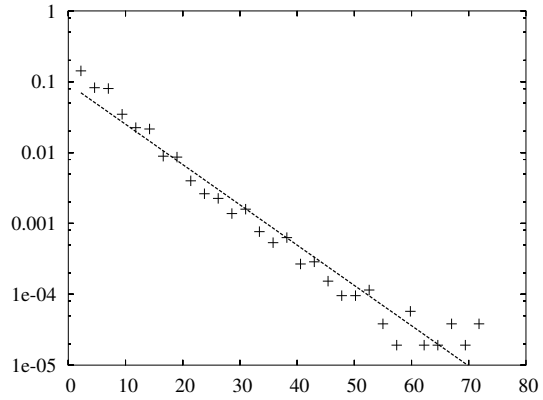

Figure 2: Binned empirical density of the number of sectors N_j a firm is exporting to for the pooled data.

First, the time series is extremely short, covering only five periods. Second, accounting issues prevent us from reliably interpreting the series as reflecting the dynamics of corporate diversification—think, for example, of a pharmaceutical company selling an used company car to a foreign country. The sale will increase $N_i(t)$ but certainly has no bearing on the productive activities of the firm. Consequently we focus on a 'static' analysis of corporate diversification. Unfortunately, data on the value of exports by sector are not available, so that we are not able to calculate concentration indices (like Herfindahl's, for example).

Among the 8,728 firms that are exporting in all five years, we restrict our attention to firms with an export-to-total sales ratio of at least 5%, which should ensure a meaningful operation from the viewpoint of their production processes.[3] At the 5% threshold, we still have well over 4,000 observations for $N_i(t)$ in each of the years.

Figure 1 plots the first four moments of $N_i(t)$ and should persuade us that its distribution is stationary. Therefore—and to facilitate the presentation of results—we pool all data together for a total of 21,763 observations, denoting the new variable by N_j henceforth.[4] Figure 2 shows the empirical density of N_j on semi-log scale constructed by grouping data in bins of equal width. The plot is well fitted by a line, whose slope is $b = -0.13 \pm 0.00$. A straight line in the semi-log scale indicates that the number of sectors firms are exporting to is exponentially distributed.

3 How Much More Diversified Are Large Firms?

We are interested in the relationship between corporate size and diversification. In a study of the world's 150 largest pharmaceutical companies, Bottazzi (2001) detects the non-linear relationship $N = \alpha s^{\beta}$ between a firm's size s and the number of sub-markets N it is active in.

We will call the coefficient β the *elasticity of diversification*. As Bottazzi (2001), we measure

[3]We have performed our subsequent analysis at different threshold levels, ranging from 5% to 50%, and are happy to report that the results are very robust with respect to the threshold specification, as Table 4 illustrates.

[4]The apparent variation in kurtosis stems from noise in very few observations at the high end of the distribution. The concerned reader may rest assured that we have also validated our analysis on an annual basis, as reported in Table 5.

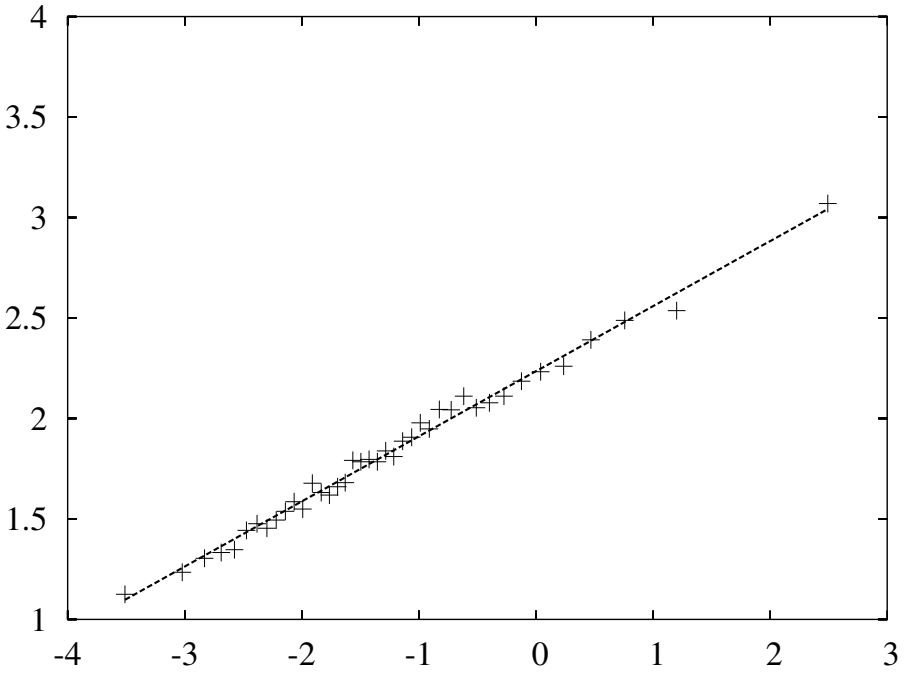

Figure 3: The relationship between size and corporate diversification on double-logarithmic scale. The horizontal axis shows the normalized mean size in 40 equally populated bins (quantiles), while the vertical axis shows the mean number of export sectors associated with the corresponding bin.

firm size $S_i(t)$ as total sales of company i at time t, and we also proceed to consider normalized size $s_i^t = S_i(t)/ < S_i(t) >$ to eliminate any trends that might apply on macroscopic scale.[5] For the pooled data, we adopt the notation $s_j = S_j/ < S_j >$ and fit the relationship

$$\log N_j = \log \alpha + \beta \log s_j, \tag{1}$$

plotted in Figure 3 with an intercept $\log \alpha = 2.23 \pm .009$ and an elasticity of diversification $\beta = .32 \pm .005$. Interestingly, Bottazzi et al. (2001) observe a diversification elasticity of $.39 \pm .02$ for the world's largest pharmaceutical companies. Given that the diversification proxy in Bottazzi (2001) is of high quality, the case being made by Bottazzi et al. (2001), the similarity of results yields an *ex post* justification for our interpretation of N_j as a diversification proxy. The results should, however, not be compared in strict quantitative terms because of the different measures of diversification.

None the less, in both cases the elasticity of diversification is markedly below unity. Large firms are more diversified than smaller ones but less than proportionally so. In a dynamic interpretation of our result, firms diversify in the process of growth but their diversification cannot proceed at the same rate as their growth in overall size. Such an interpretation supports a Penrosian view of the firm in which competences are not acquired with the same ease as activities are extended or, to use the original terminology of Penrose (1959), productive services do not expand on the same scale as resources do.

Bottazzi (2001) shows how such an empirical relationship between diversification and size is predicted by a branching process for diversification. Under this hypothesis new activities

[5]The notation $< . >$ stands for the sample mean, in this case of course the mean over i in year t.

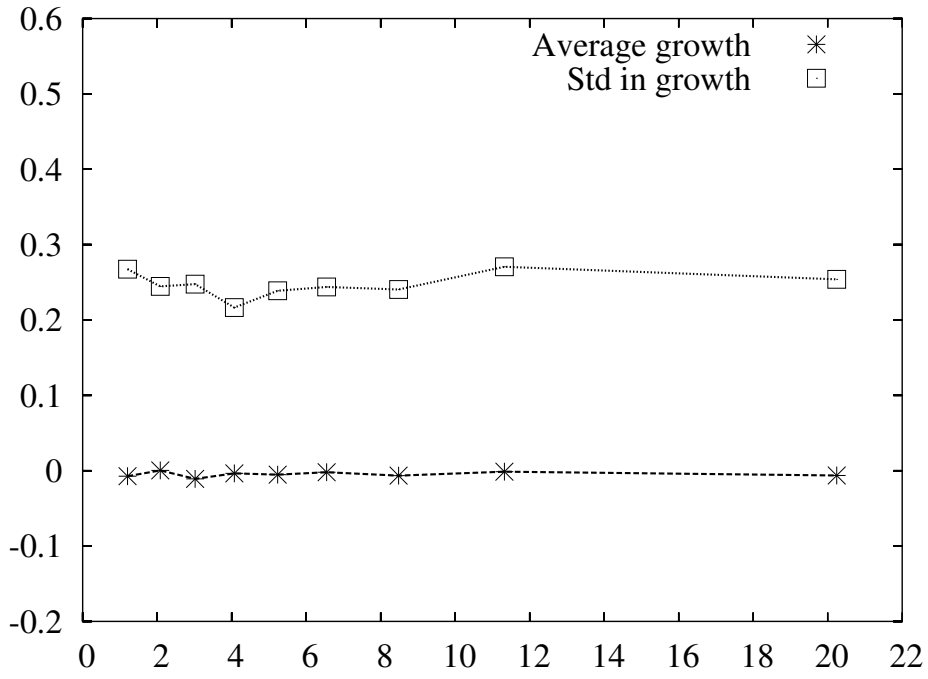

Figure 4: The horizontal axis shows the average number of export sectors in 9 equally populated bins (quantiles), while the vertical axis shows the mean and standard deviation in the growth of firm size in the corresponding bin. Notice the lack of any relationship between growth rate variance and diversification.

would be undertaken with a probability that depends on the current degree of diversification of firms, as opposed to a standard Poisson process with independent arrivals that has no memory of previous started activities.

Similarly, Teece et al. (1994) argue that as firms grow more diverse their overall coherence— i.e. the degree to which a firm's constituent businesses are related— does not change much, though the degree of coherence shows considerable variation across firms depending on the degree of corporate learning, its historic paths to already acquired competences, and the competitive environment the firm faces in product and capital markets.

The basic argument behind all resource-based interpretations boils down to the assertion that a firm's diversification will take place in related processes or, put differently, that history matters for the process of diversification in the sense that newly developed competences depend on previously acquired ones. If this was the case we would expect a lower degree of risk reduction in the operation of firms than if diversification proceeded along completely uncorrelated activities. Under the assumption that large firms are simply an agglomeration of small firms of equiproportional size with uncorrelated activities, Hymer and Pashigian (1962) demonstrate that the relationship between growth rate variance and size should have a slope of $-.5$ on double-logarithmic scale.

Bottazzi et al. (2002) already point out that a negative relationship is completely absent in our Italian manufacturing data. To judge the riskiness of a firm's operation explicitly with respect to its diversification level, we first calculate period-by-period growth rates in normalized size and pool the data. Then we construct equally populated bins according to firms' diversification levels N_j, calculating the variance in growth rates for the different bins,

which we plot in Figure 4. The mean does not differ among the different diversification levels but neither does the standard deviation. Since we know that there is no negative relationship between size and growth rate variance, and because we have discovered a constant elasticity of diversification with respect to size, it is not really surprising that we observe another variant of the 'Italian puzzle' in which diversification does not lead to any decrease in risk.[6] Our empirical evidence on the size-diversification nexus strongly supports the resource-based view and makes randomly driven diversification or diversification through expansion in unrelated activities extremely unlikely.

4 Technological Factors in Diversification

Pavitt (1984) proposed a taxonomy for sectoral patterns of technical change that has become standard fare in the Schumpeterian tradition of innovation and market structure theories,[7] as well as in evolutionary theories of industrial dynamics.[8] The taxonomy distinguishes four groups that we order and denote in the following way—$Pavitt(1)$: supplier dominated; $Pavitt(2)$: scale intensive; $Pavitt(3)$: specialized suppliers; $Pavitt(4)$: science based.

First we would like to ensure that the number of export sectors N_j is not biased because of the sectoral classification system, which is quite possible because different Pavitt groups have a different level of four-digit level coarseness relative to the three-digit level classification. Firms in $Pavitt(4)$, for example, would be particularly prone to such a bias because their three and four-digit level classification is mostly identical, i.e. the three-digit classification contains only a single four-digit category. To check for such a potential bias, we calculate the ratio of the number of four-digit classifications to the number of three-digit classifications in each of the four Pavitt groups and compare it to the actually observed number of four-digit sectors a firm is exporting to. A low ratio indicates a coarser classification structure compared to a higher ratio. The results, together with higher order moments of N_j, are reported in Table 1 and should alleviate any concerns regarding the potential bias. It certainly appears that the coarseness of the classification system does not bias the actually observed diversification level—unless one can come up with an explanation why the two Pavitt groups with the coarsest four-digit classification would have a markedly higher average number of four-digit export sectors than the other two Pavitt groups?

We chose not to plot the distribution of N_j by Pavitt group as they look very similar, keeping the exponential shape that we observed in Figure 2 for the pooled data. For each of the four Pavitt groups we then estimate the elasticity of diversification from Equation 1 and report it in Table 3. The exponential of the intercept equals the average diversification level of the average-sized company in each of the groups, and we can observe an interesting pattern between the Pavitt groups. Science based and scale intensive firms have a relatively low elasticity of diversification compared to specialized suppliers and traditional supplier dominated firms. At the same time, the average-sized science based company or specialized supplier have a higher average level of diversification than scale intensive operations or supplier dominated firms, who show the lowest average level of diversification.

[6] We term the absence of a negative relationship between growth rate variance and size a 'puzzle' because Amaral et al. (1998) and Stanley et al. (1996) detect the negative relationship in US firm data, while Bottazzi (2001) finds it as well among the world's largest pharmaceutical companies. Notice that in all three cases the slope is markedly shallower than the slope of .5 that would apply in the case of entirely unrelated activities.

[7] Cf. Cohen and Levin (1989) for a survey.

[8] Cf. Dosi (1988) for an overview.

	Mean	Standard deviation	Skewness	Kurtosis	4-digit/3-digit ratio in NACE
Supplier dominated	5.69	5.18	2.45	9.10	102/40
					(2.55)
Scale intensive	6.56	6.04	3.01	15.11	91/33
					(2.93)
Specialized supplier	8.82	7.09	2.30	9.60	27/13
					(2.08)
Science based	8.77	6.87	1.69	4.19	13/11
					(1.18)

Table 1: Descriptive statistics of the number of export sectors N_j by Pavitt group. The last column is a measure of the classification coarseness in the respective groups, a lower ratio representing a coarser structure relative to a higher ratio.

	Mean	Standard deviation
Supplier dominated	9.60	1.15
Scale intensive	9.95	1.30
Specialized supplier	9.74	1.11
Science based	10.17	1.55

Table 2: First moments of the (log) size distribution by Pavitt group.

	Diversification elasticity	Intercept	No. observations in pooled data
Supplier dominated	.3400	1.9511	9,520
	(.0085)	(.0122)	
Scale intensive	.2970	2.2510	6,102
	(.0113)	(.0225)	
Specialized supplier	.3441	2.4043	4,753
	(.0103)	(.0145)	
Science based	.2613	2.530	1,101
	(.0159)	(.0365)	

Table 3: Elasticity of diversification by Pavitt group. Estimated standard errors reported in parentheses.

Employing the Pavitt (1984) taxonomy, we know that supplier dominated and scale intensive companies both share cost-cutting technological trajectories, cater to price sensitive clients, and are characterized by process innovation. Science based firms and specialized suppliers, in contrast, both have performance sensitive customers in common, their technological trajectories are generally driven by product design, and their innovation is often product oriented. Conversely, the source of technology in science based and scale intensive companies is mostly research and development, which is generally not true for specialized suppliers and supplier dominated firms. Therefore we speculate that the intrinsically high level of generality in research and development activities will be responsible for the low elasticity of diversification that we observe.

5 Conclusion

Larger firms are more diversified than smaller ones but less than proportionally so and with an elasticity of diversification that is independent of size. A dynamic interpretation of the diversification elasticity in our sample suggests that Italian manufacturing firms are able to 'pass on' a third of their growth into diversification of their activities.

Moreover, more diversified Italian manufacturing firms appear to be as risky as less diversified ones. If firms were expanding their range of activities (in this case their range of export sectors) by simply adding independent new activities, one would predict more diversified firms to be less volatile in their growth performance. The lack of such a relationship can be taken as evidence against a view of corporate diversification that depicts the outcome of the diversification process as the result of the cumulation of uncorrelated new activities. Conversely, the data strongly support a view of diversification whereby diversification proceeds in line with previously acquired competences and is not independent of them. This view is supported both by a resource-based theory of diversification, and by a capability-based theory, which in different but complementary ways claim the importance of firm-specific internal knowledge in explaining the dynamic process of corporate diversification.

Finally, we speculate about the influence of technological factors in the patterns of diversification and propose possible sources for the observed differences in levels as well as elasticities of diversification across Pavitt groups.

References

Amaral, L. A. N., S. V. Buldyrev, S. Havlin, M. A. Salinger, and H. E. Stanley (1998): "Power Law Scaling for a System of Interacting Units with Complex Internal Structure," *Physical Review Letters*, 80, 1385–1388.

Bottazzi, G. (2001): Firm Diversification and the Law of Proportionate Effect , LEM working paper 2001-1.

Bottazzi, G., E. Cefis, and G. Dosi (2002): "Corporate Growth and Industrial Structure. Some Evidence from the Italian Manufacturing Industry," *Industrial and Corporate Change*, 11, 705–723.

Bottazzi, G., G. Dosi, M. Lippi, F. Pammolli, and M. Riccaboni (2001): "Innovation and Corporate Growth in the Evolution of the Drug Industry," *International Journal of Industrial Organization*, 19, 1161–1187.

Cohen, W. M., and R. C. Levin (1989): "Empirical Studies of Innovation and Market Structure," in *Handbook of Industrial Organization, Vol. II*, ed. by R. Schmalensee and R. D. Willig. New York: North Holland.

Dosi, G. (1988): "Sources, Procedures, and Microeconomic Effects of Innovation," *Journal of Economic Literature*, 26, 1120–1171.

Dosi, G., R. Nelson and S. Winter (2000) eds.: *The Nature and Dynamics of Organizational Capabilities*, Oxford/New York: Oxford University Press.

Hymer, S., and P. Pashigian (1962): "Firm Size and Rate of Growth," *Journal of Political Economy*, 70, 556–569.

Montgomery, C. A. (1994): "Corporate Diversification," *Journal of Economic Perspectives*, 8, 163–178.

Pavitt, K. (1984): "Sectoral patterns of technological change: Towards a taxonomy and a theory," *Research Policy*, 13, 343–373.

Penrose, E. (1959): *The Theory of the Growth of the Firm*. Oxford: Basil Blackwell.

Silverman, B. S. (1999): "Technological resources and the direction of corporate diversification: Toward an integration of the resource-based view and transaction cost economics," *Managment Science*, 45, 1109–1124.

Stanley M. H. R., L. A. N. Amaral, S. V. Buldyrev, S. Havlin, H. Leschhorn, P. Maass, M. A. Salinger, and H. E. Stanley (1996): "Scaling Behaviour in the Growth of Companies," *Nature*, 379, 804–806.

Teece, D. J., R. Rumelt, G. Dosi, and S. Winter (1994): "Understanding corporate coherence: Theory and evidence," *Journal of Economic Behavior and Organization*, 23, 1–30.

Table 4: Elasticity of diversification at different thresholds for the pooled data. Estimated standard errors reported in parentheses.

Export-to-total sales threshold	Diversification elasticity	Intercept	No. observations in pooled data
10%	.3146	2.2819	18,857
	(.0053)	(.0092)	
15%	.3103	2.3131	16,695
	(.0055)	(.0095)	
20%	.3104	2.3389	14,869
	(.0055)	(.0096)	
25%	.3124	2.3641	13,339
	(.0063)	(.0111)	
30%	.3135	2.3803	11,957
	(.0068)	(.0118)	

Table 5: Elasticity of diversification when estimated year-by-year at the 5% threshold. Estimated standard errors reported in parentheses.

Year	Diversification elasticity	Intercept	No. firms
1993	.3354	2.1854	4,132
	(.0100)	(.0169)	
1994	.3257	2.2550	4,508
	(.0108)	(.0183)	
1995	.3086	2.2414	4,216
	(.0091)	(.0154)	
1996	.3364	2.2298	4,639
	(.0088)	(.0150)	
1997	.3240	2.2472	4,268
	(.01003)	(.0180)	