Relatedness, Coherence, and Coherence Dynamics Empirical Evidence from Italian Manufacturing

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Abstract

This paper investigates the determinants of coherence and coherence change using a sample of Italian leading firms in the period 1993-1996. Following a methodology developed by Teece et al (1994), the observed diversification patterns of our sample firms provide the information required to construct an index of relatedness between pair of sectors, which is in turn used to obtain a measure of firm's coherence. The econometric analysis highlights that relatedness is higher when sectors share similar technological and marketing characteristics, and when they are positioned at different stages of the productive chain. Analogously, coherence is higher for firms active in industries characterised by similar R&D intensities and exploiting vertical integration links. Firms which enter the group of top 5 leaders are more coherent than the average. From a dynamic perspective, we find that coherence increases for firms with main activities in sectors which are expected to be more affected from EU integration. Finally, the results show that a deepening of vertical integration strategies is good for coherence change, while an increase of diversification brings a reduction in coherence.

Keywords: relatedness, coherence, diversification
JEL codes: L2, L21

*The contents of this work are the result of our own analyses and evaluations, and they are independent of the views of Accenture.

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1. Introduction

Notwithstanding in the popular press diversification strategies have become less fashionable, while words such as refocusing or return to the core have entered the common language, firms continue to manufacture different products and are still simultaneously acting in many markets. Among the different views on the birth, growth and decline of multiproduct firms, the resource theory (Penrose, 1959) sees diversification as driven by the accumulation of firm specific tangible and intangible assets, that, being sharable between uses, can be fruitfully employed to enter new related industries. According to Teece (1980 and 1982), there must be significant transaction costs of using the market in order for diversification to be the preferred governance mechanism to co-ordinate such interrelated assets. Wernerfelt (1984) extends the discussion by highlighting that the relationship between firms' accumulated resources and product diversification may be better represented as a two-way link: on the one hand the availability of resources pushes firms to enter new industries, on the other hand firms which manufacture different goods develop new resources. The latter can stimulate diversification waves towards industries where the link with the original set of firms' assets may gradually disappear[1].

Thus, according to the resource theory, firms should pursue related diversification strategies, by exploiting the complementarities and synergies due to the sharing of common technology or market characteristics. However, the choice between highly related and relatively unrelated diversification is linked to the specificity or generality of firms' resources. For instance, an accumulated technological knowledge may be more or less suitable to be used for producing new goods. A localised knowledge limits the scope for diversification, while a more general technical competence may be consistent with broader diversification strategies.

Different approaches have been introduced in order to operationalize the concept of relatedness:

– the first approach exploits the different levels of aggregation of sectors in standard industry classifications[2]. A well known criticism is that, since industry classifications are based on technological and market similarities between

[1] Grandstrand (1998) examines the complex relationship between *resource diversification* (the firm's expansion of its asset base) and *business diversification* (the firm's expansion of its product base) with the aim of developing a theory of the technology based firm.

[2] For example, industries classified in the same 3 digit category may be considered as related. Pavitt (1984) and Rumelt (1974) introduced two widely used taxonomies.

products, they may consider as dissimilar two industries characterised by vertical integration links, or as related two sectors which do not share a common resource. Another drawback is that relatedness is considered as a one-or-zero phenomenon, and it is not possible to measure the relative distance between two activities.

- the second approach looks at similarities in R&D and advertising intensities, or in human resources profiles (percentages of engineers, managers, sales persons, and R&D personnel in total industry employment). A criticism which can be moved against this method is that an industry is equally distant (in terms of relatedness) from all the other industries which are endowed with a similar R&D or ADV intensity[3].
- the third approach matches patent data with standard industry classifications (Silverman, 1998). The equidistance problem is overcome by linking industry and industry j on the basis of the applicability of industry i's registered patents to sector j. However, relatedness based on marketing or human capital skills cannot be captured using this method[4].

While the first approach classifies *a priori* two sectors as related, and the second and third approaches try (albeit at different degrees) to find some common characteristics between a set of industries, a fourth method which addresses relatedness by directly looking at how firms behave in the real world has been devised. The link between two activities is not assumed by exploiting the different levels of disaggregation of standard industry classifications, or by looking at similarities between firms' resources, but it depends on the frequency with which firms operate jointly in those activities. A particular link is purposive (Scott, 1993) or coherent (Teece et al., 1994) if it appears frequently in the population of firms under investigation. Using such an innovative methodology, Teece et al (1994) developed a measure of relatedness between pair of industries, which is the basis for constructing an index of coherence of firms' diversification patterns.

In this paper we calculate industry relatedness and firm coherence on a sample of firms operating in Italian manufacturing in 1993 and 1996. The aim is to test, according to the resource view of diversification, if firms are coherent diversifiers that exploit interrelated assets and if coherence is increasing as a result of the greater competitiveness that the completion of the Single European Market is expected to bring. Section 2 briefly reviews the paper by Teece et al (1994) and critically discusses the few

[3] This would imply that aerospace and pharmaceuticals, to cite some examples of high R&D sectors, are considered as related. The disaggregation of workers in homogenous categories according to the different working positions covered in the firm, however, makes this drawback less stringent, since it creates more variance in the data (Farjoun, 1994; Chang, 1996).

[4] For a discussion on the use of patent data, see Pavitt (1988).

empirical works that have made use of relatedness and coherence measures. Section 3 presents first descriptives for our sample of firms, while section 4 proposes an econometric investigation of the determinants of coherence and of coherence dynamics between 1993 and 1996. Section 5 concludes.

2. Literature review

Teece et al (1994) observe that there is some coherence in the ways firms diversify, and that the activities of diversified firms are related to one another. By applying the survivor principle, following which the destiny of inefficient firms (i.e. non coherent diversifiers) is to gradually disappear, industry i and industry j are seen as related if firms in the real world are frequently combining those activities. It is assumed then that the more a particular combination is observed, the higher the probability that firms are exploiting in a synergistic way accumulated assets or vertical integration links. Coherent firms are in turn those who operate in a set of related sectors. The main advantage of this method, as we have already seen, is that it *lets the firm speak*, without necessarily assuming, irrespective of the frequency with which firms are combining them, that activities i and j are related.

Let us consider a population of K diversified fims and define the following variables:

C_{ik}=1 if firm *k* is active in industry *i* and 0 otherwise;
$m_k=\Sigma_i C_{ik}$ is the number of industries *i* in which firm *k* is active;
$n_i=\Sigma_k C_{ik}$ is the number of firms *k* active in industry *i*;
$n_j=\Sigma_k C_{jk}$ is the number of firms *k* active in sector *j*;
$J_{ij}=\Sigma_k C_{ik}C_{jk}$ is the number of firms simultaneously active in *i* e *j* with $0<J_{ij}\leq\min(n_i,n_j)$.

J_{ij} offers a first indication of the degree of *relatedness* between the two activities. However, it is a rough measure in that the probability to have high values of J_{ij} increases with n_i and n_j. In order to obtain a more reliable measure of inter-business relatedness, one can compare the observed J_{ij} with the number of links that would emerge from random diversification. The latter can be calculated trough the hypergeometric random variable X_{ij}. After having extracted without replacement from a population of K firms two samples n_i and n_j, the probability to find x firms operating simultaneously in i and in j is the following:

$$\Pr(X_{ij} = x) = \frac{\binom{n_i}{x}\binom{K - n_i}{n_j - x}}{\binom{K}{n_j}}$$

The mean and variance of X_{ij} are respectively:

$$\mu_{ij} = E(X_{ij}) = \frac{n_i n_j}{K}$$

$$\sigma_{ij}^2 = \mu_{ij}\left(1 - \frac{n_i}{K}\right)\left(\frac{K - n_j}{K - 1}\right)$$

The index of relatedness can be constructed by comparing the observed value of J_{ij} with μ_{ij}, and scaling the difference with the standard deviation of X_{ij}:

$$t_{ij} = \frac{J_{ij} - \mu_{ij}}{\sigma_{ij}}$$

High values of t_{ij} are evidence of a strong link between i and j, while low values reflect the fact that only a few number of firms has combined the two activities, not so differently from the frequency that one would observe if firms diversified randomly.

The measure of firm coherence is simply based on the weighted average of the degrees of relatedness between the firm's primary industry i and all the other industries j in which it is diversified:

$$WAR_k = \frac{\sum_{j \neq i} t_{ij} v_j}{\sum_{j \neq i} v_j}$$

with v_j indicating firm k's sales in industry j.

Teece et al (1994) calculated t_{ij} and WAR_k on a sample of 18620 diversified firms (extracted from the Trinet Large Establishment Tape) operating in 958 different 4 digit industries. Coherence was found to decrease with the number of activities, but the relationship was not linear, since firms with 18-19 activities were exhibiting the same coherence than firms active in 12-13 sectors. Moreover, a second measure of firm coherence based on the m-1 most related pairs of activities was not found to decrease

with diversification, suggesting that "as US manufacturing firms grow more diverse, they maintain a certain level of (local) coherence between neighbouring activities"(p. 9). In the second part of the paper the authors develop a theory of corporate coherence based on an evolutionary economics framework, that includes ingredients such as learning, path dependency, technological opportunities, firms' complementary assets and the selection environment. Foss and Christensen (1996, p. 10) have nicely summarised the following predictions coming from such a theory:

" - *In the long run, more coherent corporations tend to outperform less coherent corporations.*
- *The degree of corporate coherence is a function of the interaction between: (a) learning dynamics in the firm; (b) path dependencies (as shaped by existing competences and complementary assets and technological opportunities), and (c) the selection environment.*
- *The tighter the selection environment, the more likely it is that the boundaries of the corporation is drawn 'close in' to the core capabilities and that less coherent corporations will be outperformed."*

To the best of our knowledge, only three studies which make use of the measures proposed by Teece et al (1994) have appeared in the literature.

Orecchia (1998) measured relatedness and coherence on a sample representative of the top 5 leaders in each of the 100 three digit (classification NACE 1981) European manufacturing industries in 1987. By observing the diversification patterns followed by the 224 diversified firms in the sample (out of 313 leaders) the author calculated a measure of relatedness between a sector and all the other 99 sectors (*wide* relatedness) together with a measure of relatedness between a sector and all the other sectors classified in the same 2 digit industry (*close* relatedness). The second figures are much higher than the former, suggesting that EU leaders were not diversifying uniformly in all industries but they were concentrating activities in a set of close industries (within the same 2 digit cluster). The results for coherence, based on relatedness between each firm's primary activity and all the other secondary activities, confirm that the relationship between coherence and diversification is not linear[5]. Orecchia (1998) conducts two econometric exercises. The first equation is aimed to test if, according to the expectations, relatedness depends positively on common technological and market characteristics between lines of business. The results confirm the hypothesis, since sectors i and j exhibit high levels of relatedness if they share similar R&D and

[5] Firms active in 3 industries had and average value of 4.31, while firms operating in 8-9 industries had a value of 4.8. The average coherence for firms with more than 15 sectors was 3.09.

advertising intensities, if they require similar labour skills, or if they are positioned backward of forward in the vertical chain. In the second econometric model coherence is the dependent variable, whereas country dummies and firm level proxies for size, diversification, average advertising and R&D intensities and average labour skills are among the explanatory variables. The results are quite weak, but it seems that big Italian firms are less coherent than the average (while small Italian firms are more coherent than the average) and that broad spectrum diversification (across two digit industries) has a negative impact on coherence while narrow spectrum diversification has a positive impact on coherence.

The second empirical work we refer to is Piscitello (2000), who obtained relatedness measures from the 1985 Trinet Large Establishment Data set, and used them to calculate the coherence of a sample of firms extracted from the 248 US, European and Japanese world's largest industrial companies for the years 1977, 1986 and 1995. Sales activities and patenting activities of the above firms have been allocated to 26 manufacturing sectors. The novelty here is that product diversification and technological diversification have been jointly considered. In particular, the regression of relatedness between industry i and j includes among the independent variables a proxy for relatedness of technological activities, built on the basis of firms' patenting activities[6]. The results obtained by Orecchia (1998) for relatedness are basically confirmed as far as the positive role of vertical integration links and of common marketing characteristics between lines of business. Moreover, the index of technological relatedness was found to have a positive impact on product relatedness. Finally, a measure of coherence based on relatedness between a firm's principal technological activity and the other technological fields in which it had patented has been constructed together with an index of coherence of product diversification for the years 1977, 1986 and 1995. The results show a decreasing pattern for coherence of product diversification, especially in the second period, while coherence of technological diversification was remaining quite constant across periods. The author interprets these findings as evidence that firms are becoming less coherent in product portfolios and more coherent in choosing the technological fields where to patent[7].

[6] Analogously to the relatedness index constructed on product diversification data, industry i exhibits technological links with industry j if firms are frequently patenting simultaneously in i and j. The data on patenting activities of firms for the year 1985 refer to a big data set built at the University of Reading.

[7] However, the two relatedness measures are calculated for 1985 and are used to obtain estimates of coherence for 1977, 1986 and 1995. Thus, the diversification strategy chosen by a firm in 1995 is judged more or less coherent on the basis of what was considered as related in 1985. In our view such a method, other than not allowing changes in what is seen as related during a time span of 20 years, may bias the results in favour of a higher level of coherence for the 1986 sample and lower levels for the 1995 sample.

Unfortunately, no econometric exercise on the determinants of coherence has been undertaken.

The third contribution is Vonortas (1999). Using a sample of US firms diversified into 4-digit industries, he constructs four relatedness measures, based on different sub-samples: a) the whole sample consisting of 18945 firms; b) the sample of 17992 firms not participating to a research joint venture; c) the sample of 953 firms participating to a research joint venture; d) the reduced sample of 466 research joint ventures (RJVs). Since he observes different (and lower) values of relatedness for research joint ventures, and, to a lesser extent, for firms participating to RJVs, he argues that RJVs are exploring new, more dispersed and innovative diversification avenues, particularly in the presence of technological and market uncertainties, while firms which are not members of a RJV follow more traditional (and more coherent, according to the dominant behaviour in the whole population of firms) diversification strategies. The insights that may come from such an analysis are that, by observing low values of coherence for a sub-sample of firms, one cannot jump directly to the conclusion that they are following strategies which are doomed to fail. In fact it may well be the case that such firms are exploring new (and potentially successful) ways of combining activities. Unfortunately the author, other than not conducting econometric analysis on relatedness, does not even use the relatedness index to obtain a measure of coherence.

Summarising, the results reached so far point to a good response of the relatedness measure to its theoretical underpinnings. Both Orecchia (1998) and Piscitello (2000) find that relatedness is positively related to the firm's exploitation of complementary assets and to its presence at different stages of the vertical chain. Much more scant is the evidence available for coherence. The static picture offered by Orecchia (1999) for EU leaders in 1987 suggests at best only the presence of different behaviours according to firm size and country of origin, while the dynamic picture presented by Piscitello (2000) for world's largest firms in 1977, 1986 and 1995 is limited to observing the evolution of average levels of coherence of product and technological diversification through time. No evidence is available that more coherent corporations outperform less coherent firms and that coherence is expected to increase in more competitive environments. In the following sections we obtain measures of relatedness and coherence using a sample of Italian firms for 1993 and 1996. Both measures are then used as dependent variables in econometric investigations aimed at discovering the determinants of relatedness between pairs of industries as well as the determinants of firm's coherence and coherence dynamics.

3. The sample and first descriptive statistics

The dataset used in this work has been built at CERIS-CNR. We have collected data on the largest 5 firms (top 5 leaders) in each manufacturing sector for the years 1993 and 1996[8]. Since the three digit NACE 91 classification comprehends (after some corrections) 95 industries, it is in principle possible to have 475 leading companies (95*5). Due to the presence of firms which are amongst the top five leaders in more than one manufacturing sector, our sample includes a smaller number of firms (337 in 1993 and 355 in 1996)[9]. The latter are responsible for some 37% of total Italian manufacturing sales. For each firm sales have been disaggregated in the different industries in which it has been detected to operate. On aggregate the data-set for one year can be represented by a matrix with 337 (355 in 1996) rows and 95 columns. The matrix for 1993 has 1120 non zero elements (1096 in 1996), highlighting that the average firm was active in 3.32 (3.09) industries. The number of single product firms is 108 in 1993 and 125 in 1996, so that our analysis of firm coherence may be applied only to the 229 (230 in 1996) diversified firms. Suppose that, after having deleted non diversified firms, we construct a square matrix (A) with 95 rows and 95 columns, one for each industry. Each element of the square matrix (a_{ij}) individualises how many firms are active in that particular pair of industries, which is the basic information upon which the measures of industry relatedness and firm coherence are constructed. The matrix for 1993 is characterised with 2718 pairs of industries in which no firm is simultaneously active, while in 978 cases $a_{ij}=1$ (indicating that only one firm is present simultaneously in industry i and industry j). Finally, there are 769 cases of multimarket contact (where 2,3,4, up to 16 firms are combining that particular pair of sectors)[10]. The matrix for 1996 contains 3183 cases in which $a_{ij}=0$, 719 cases in which $a_{ij}=1$, and 563 cases of multimarket contact (with $1<a_{ij}\leq 17$). This first piece of evidence highlights that the probability that a firm is not simultaneously combining industry i with industry j (out of the 4465 possible combinations) increases from 61% to 71%, while the probability of finding only one firm with manufacturing activities in i and j decreases from 22% to 16%. Finally, the probability of having more than one firm decreases from 17% to 13%. Thus, it appears that diversification strategies have become less dispersed. Restructuring activities on the part of State owned firms and big conglomerates are responsible for the remarkable increase in the cases in which $a_{ij}=0$. In particular, IRI and ENI where active

[8] The methodology follows Davies and Lyons (1996).

[9] The increase of the number of firms from 1993 to 1996 is the result of 54 exits from a top 5 position and 72 entries in a top 5 position.

[10] Since the matrix is symmetric, we consider only the triangle above the diagonal. In the diagonal we have information on the number of diversified firms operating in a particular industry.

in 33 and 24 sectors and de-diversified as a consequence of the ongoing privatisation process (in 1996 they were active in 18 and 12 sectors). In a similar vein, both Fiat and Ferruzzi (active in 31 and 16 industries in 1993) abandoned their manufacturing operations in 4 industries. This implies that many examples of unrelated (conglomerate) diversification patterns disappeared in 1996. Finally, since the sum of all a_{ij}'s with multimarket contact gives 2549 (1881 for 1996), the average number of firms diversified in i and j slightly increased from 3.31 to 3.34. Thus, the decrease in the number of cases in which a_{ij} is greater than one has not been accompanied by a decrease of its average value, suggesting that relatedness has remained fairly stable.

3.1. Relatedness

Table 1 reports the observed values of relatedness for 1993 and 1996. Given the reduction of total activities of leading firms and the decrease of observed pairwise contacts, it is not surprising that the average value of the relatedness index dropped from 0.40 to 0.18. The maximum value for 1996 is obtained by the couple of sectors 221 (publishing) and 222 (printing): among the 12 firms operating in publishing and the 13 firms operating in printing, 10 firms are combining the two activities. High values of relatedness are recorded for the couples textile products-textile finishing, cement-concrete, wood sawing-wood boards (and other wood products), iron steel (and steel tubes)-steal forming cold, etc. Table 2 groups the 95 three digit industries in 13 industry aggregates. Together with the average values of relatedness between a particular industry and the other 94 sectors, we show also the average values of relatedness between each industry and the other three digit sectors owning to the same aggregate cluster. Note that while the value of relatedness with respect to all activities decreases sharply, the value of relatedness with respect to neighbouring activities decreases only slightly from 3.29 to 3.17, suggesting that the reduction of contacts between 1993 and 1996 occurred mainly in pair of activities belonging to different industry aggregates. Chemical and pharmaceutical products, electrical and electronic goods, mechanical engineering and motor vehicles and transport are characterised by the highest values of average relatedness, while low values are recorded for mineral products, leather and wood and textiles and clothing. The values of within-cluster relatedness turn out to be much higher, particularly for food and beverages, paper, publishing and printing, and wood products. Interestingly, the figures for mechanical engineering, electric and electronic goods, motor vehicles and other transport fall now below the average. It is not a case that the above cited clusters embrace sectors characterised by an high R&D intensity, since accumulated R&D assets can be used to enter a relative wide range of

activities, not necessarily within the aggregate clusters. On the other side, traditional industries where R&D (and advertising) investments are low are showing less variegated diversification strategies and record much higher levels of within-the-cluster relatedness. Such an interpretation is comforted from the results shown in table 1, in which non differentiated sectors (where R&D and advertising investments are not important and firms mainly compete using the price as a strategic variable) record lower values of average relatedness as compared to differentiated sectors (where firms compete by offering new varieties and different levels of quality)[11]. This has important implications for the interpretation of the results presented in section 4. In fact, it is possible to foresee that firms with related (that is within the cluster) diversification in traditional industries will record higher coherence values with respect to firms with related (that is within or between clusters) diversification in R&D intensive industries[12].

The second classification proposed in table 1 separates industries which have been judged as more sensitive to the deepening of the Single European Market from industries where the abolition of non tariff barriers implied by EU integration was thought to have a smaller impact (see Buiges et al., 1990). Following the hypotheses advanced by Teece et al (1994) one should expect more coherent diversification patterns as the competitive pressure increases. Sensitive sectors show higher relatedness values than non sensitive industries, and the difference is higher in 1996. This suggests that, especially in public procurement industries, diversification strategies are becoming less dispersed.

Summarising the results for relatedness, firms seem to coherently pursue related diversification strategies, by linking activities classified in the same aggregate cluster in the case of traditional (and advertising intensive) sectors, or by diversifying into industries classified in different clusters in the presence of assets such as R&D resources. In order to test if firms are active in industries which share similar resources and/or are exploiting vertical integration links we have run the following simple regression:

$$RELAT_{ij}=\alpha+\beta_1 R\&D_{ij}+\beta_2 ADV_{ij}+\beta_3 SIMADV_{ij}+\beta_4 SIMR\&D_{ij}+\beta_5 SIMADVR\&D_{ij} +\beta_6 FVI_{ij}+\beta_7 BVI_{ij}+\varepsilon_{ij}$$

[11] However, note the low value recorded for advertising intensive industries. It seems that, differently from what observed for research and development, advertising is less apt to represent an accumulated asset to be used to enter new industries. Moreover, table 2 highglights that, similarly to what observed for traditional sectors, food and beverages (where most high advertising industries lie) is characterised with a high value of within-cluster relatedness and a low value of average relatedness.

[12] For such a reason, we will split the sample between firms operating in traditional sectors and firms active in industries where R&D and advertising are important strategic weapons.

where ADV and R&D are the average advertising and research and development intensities which characterise industries i and j, SIMR&D, SIMADV and SIMADVR&D take on the value of one if i and j are both advertising intensive, both R&D intensive, or both advertising and R&D intensive sectors, and BVI and FVI are dummies which take on the value of 1 if input-output tables indicate that i and j are positioned backward or forward in the vertical chain. The results for 1993 and 1996 are shown in table 3. Relatedness is higher in the presence of forward or backward vertical integration links, and when i and j are both exhibiting an high advertising intensity, an high R&D intensity, or an high advertising and an high R&D intensity. Advertising has a positive coefficient, while R&D has a negative coefficient. However, the three coefficients checking for similarity of resource intensities are much higher. It can then be inferred that the less related pairs are those combining an high R&D industry (HR&D) with a traditional one (TRAD= low advertising and R&D intensities), followed by the HR&D-HADV and by the TRAD-TRAD couples. In increasing order of relatedness follow the HADV-TRAD, the HR&DHADV-HR&DHADV and the HR&D-HR&D pairs, to end with the most related HADV-HADV couples.

3.2. Coherence

The data for industry relatedness have been used to calculate the coherence of firms' diversification strategies. Table 4 shows that the average value of coherence is 4.54 in 1993 and 4.53 in 1996. Notwithstanding the dramatic decrease in the index of relatedness and the increase of the number of single product firms from 108 to 125, diversified firms seem to have kept a constant level of coherence. The most coherent firm is De Agostini, which operates in two sectors (printing and publishing). Similarly, among the 15 most coherent firms, only Lucchini combines 5 sectors, while the rest is active in 2, 3, or 4 sectors. Most of them focus on traditional sectors, such as textiles-clothing, food and beverages, cement and concrete, steel. While the index seem to work well for highly coherent firms, it appears to perform less well with respect to lowly coherent firms. Strafor-Facom, the less coherent firm in the sample, produces metal products, glass, and is active in mechanical engineering. It is followed by Marangoni which is active in rubber-pneumatics and in mechanical engineering. In both cases, the presence of vertical integration links might explain the chosen diversification pattern. However, among the 50 firms operating in mechanical engineering, only two firms are active simultaneously in the rubber industry. This means that some peculiar diversification strategies, which are not followed by other firms in the sample, are translated automatically into low values of coherence, even if they may be driven by

synergistic reasons. Table 4 highlights that State owned firms have a low value of coherence, but they are increasing it as a result of the privatisation process and the accompanying restructuring activities. Italian subsidiaries of foreign multinationals are slightly less coherent than the average and, curiously enough, are reducing coherence from 1993 to 1996. This can be partially explained by the fact that they are typically active in R&D intensive industries. The latter, as we have already seen, exhibit relatively high levels of average relatedness but low levels of close relatedness. Private nationally controlled firms, on the other hand, are concentrating their activities in traditional sectors. Finally, the few joint ventures between foreign and Italian firms have remarkably increased the level of coherence.

The above figures are based on coherence of links between a firm's main activity and all the other industries in which it operates (COH_P). However, in many instances firms have 2 or 3 sectors characterised by similar sales shares, each of which can be equally considered as the main activity. Moreover, a firm may, let us say, have 30% of sales in a sector (main activity) and 70% of sales in a group of sectors closely related but with scarce contacts with the main sector. In both cases, measuring coherence starting from the primary industry (as has been done by Orecchia (1998) and Piscitello (2000)) may be misleading. In order to correct for potential distortions, we have calculated two alternative measures of coherence. The first one is COH_A which is simply the average of the m coherence measures obtained by linking each sector i with all the other m-1 sectors ($COH_A = \Sigma_i COH_i/m$). The second one is the maximum value (COH_{MAX}) recorded by the different COH_i's, which may or may not coincide with COH_P. Table 5 shows that COH_{MAX} has increased from 1993 to 1996. Moreover, exiting firms are relatively less coherent and entrants are more coherent than the average firm. This suggests that firms which follow a coherent strategy have more chances to survive (as top 5 leaders) or to become a leading firm, while less coherent firms have an increased probability to exit from a top 5 position, a result which is in perfect accordance with the survivor principle advanced by Teece et al (1994). Finally, in order to compare our results with the ones obtained by Piscitello (2000), we calculated COH_P for the 1996 sample by using the relatedness measure of 1993 ($COH96_{r93}$) and for the 1993 sample by using the relatedness measure of 1996 ($COH93_{r96}$). In the first case we find that coherence decreases from 4.54 to 4.40. In the second case, coherence increases from 4.30 to 4.53. Depending on the evolution of firms' strategies, what is seen as related in 1993 is not necessarily seen as related in 1996, as the results for $COH96_{r93}$ make clear. We believe that building relatedness measures using a base year and applying them to a sample of firms in different periods may bias the results towards higher levels of coherence in the base year and lower levels

in the other periods, so we cast some doubts about the decrease in coherence in Piscitello's sample. In any case, we find quite a constant (or slightly increasing according to COH_{MAX}) level of coherence between 1993 and 1996.

4. Econometric investigation of the determinants of corporate coherence

Following the hypotheses advanced by Teece et al (1994), shortly summarised in section 2, we propose to regress coherence[13] on a vector of firms' characteristics and on a vector of variables checking for the synergistic exploitation of firms' resources. The first set of regressors includes size (the logarithm of total firm sales in manufacturing industries), diversification (the well known Herfindhal-Berry index expressed in its number equivalent form), the form of ownership (two dummies for State owned firms and private domestic firms[14]), and the average R&D and advertising intensities of the industries in which the firm is active. Moreover, in the 1993 (1996) sample a dummy for firms that exited from (entered into) the matrix is included. The second vector includes three variables: VERTIN is the sales shares of secondary activities which are positioned forward or backward with respect to the firm's main activity, while DIFR&D (DIFADV) is the difference in absolute value between the R&D (advertising) intensity of the primary activity and the average R&D (advertising) intensities characterising the secondary activities.

The results shown in tables 6 and 7 are broadly in line with the expectations. Firm size is positively related to coherence in both 1993 and 1996, while diversification has a negative impact in the 1996 sample. The dummy for entrants has a positive and significant coefficient while the dummy for exits has a negative but not statistically significant coefficient. State owned firms appear to be less coherent, especially in 1993, while the coefficient of PRIVATE is not significantly different from zero, suggesting that privately owned domestic firms are not more coherent than foreign firms. Firms active in high R&D sectors are less coherent than the average, while the coefficient for ADV is positive but not statistically significant. The result for R&D, which is apparently counterintuitive, has been already commented in section 3.1[15]. More

[13] As argued in the preceding section, we believe that COH_{MAX} is the more appropriate measure. However, econometric estimates have been obtained also for the other two measures COH_P and COH_A, which gave similar but weaker results.

[14] The behaviour of Italian firms is then compared with the behaviour of foreign firms and with that of joint ventures between a foreign firm and a nationally controlled firm.

[15] We recall that diversification strategies in neighbouring traditional industries are leading to higher coherence values than diversification strategies in neighbouring R&D intensive industries (see table 2).

importantly for our analysis, DIFR&D is negatively related and VERTIN is positively related to coherence, suggesting that firms which exploit vertical linkages and operate in industries requiring similar R&D resources are able to reach higher levels of coherence. The coefficient of DIFADV is however not significantly different from zero. The analysis can be further conducted by splitting the sample into different sub-samples. The second and third columns of tables 6 and 7 show the results for big firms (those with sales higher than the average) and small firms. This partition is motivated by the fact that our sample includes firms which are among the top 5 leaders in at least one of the 95 manufacturing sectors. As a consequence, FIAT, which in 1993 had manufacturing sales amounting at 35128,9 billion lira, was active in 31 industries and was a top 5 leader in 20 sectors, enters as a matrix firm together with CRESSI SUB, which in 1993 had manufacturing sales in two sectors for the total amount of 31 billion lira and was leading in only one sector. The principal differences with respect to the total sample are that the results for entries are much more robust for big firms, while vertical integration strategies are more important for the coherence of small firms. This suggests that large firms (which normally operate in big industries) must be more coherent than the average if they want to become a top 5 leader. For small entrants, on the other hand, coherence is less of a prerequisite. Finally, in the small firms sub-sample, the coefficients of PRIVATE are positive and significant in both years, highlighting that small nationally controlled firms are more coherent than small foreign firms (as far their Italian activities are considered)[16]. The second partition discriminates firms with main activities in differentiated (that is high R&D and/or high advertising) industries from firms operating in traditional sectors. In the first sub-sample EXITS has a negative and statistically significant coefficient while ADV and DIFADV have respectively a positive and negative coefficient (albeit only in 1993 they are statistically significant). In the second sub-sample both PRIVATE and DIFADV have positive and significant coefficients. It can then be inferred that in differentiated sectors (where competition is based on improving the quality and on offering new varieties) coherence is a strategy which enables firms to survive among the top 5 leaders. Firms operating in high advertising industries are more coherent, especially if they diversify in activities which share similar advertising intensities. While the coefficient of PRIVATE is negative but not statistically significant for the sub-sample of firms in differentiated

[16] Note also that DIFADV has a positive and significant coefficient in 1996, highlighting that small firms which combine high advertising with low advertising industries show higher levels of coherence. This result can be explained by considering that most small firms operate in traditional industries. In fact for only 9% of the 115 firms the main activity is HADV (the percentage for the whole population of firms is 20%). Thus, for firms where the principal industry is not HADV the presence in secondary HADV industries has a positive effect on coherence.

industries, private firms appear to be more coherent than foreign firms in the sub-sample of leaders operating in traditional industries. Finally, the positive coefficients for DIFADV in the last columns confirm what observed at the end of section 3.1: firms combining TRAD-TRAD couples are less coherent than firms combining TRAD-HADV couples (see also note 16).

The picture that can be drawn from the above results is both rich and intriguing[17]. Firms which are pursuing vertical integration strategies exhibit higher levels of coherence while firms with combine high R&D sectors with low R&D sectors are less coherent than the average. Advertising intensive firms are more coherent only for the sub-samples including large firms (in 1996) and firms active in differentiated sectors (in 1993), but it is precisely in such circumstances that advertising is expected to produce benefits. National firms are more coherent than foreign firms only for the sub-sample of small firms and for firms operating in traditional industries, while the coefficients of PRIVATE change their sign (without however reaching and acceptable level of confidence) in sub-samples including big firms and firms active in differentiated sectors. Exiting firms which operate in differentiated industries are less coherent than their rivals, as one should expect in environments characterised by a tough competition, while firms entering the matrix are more coherent, especially if they are large players and/or if they operate in differentiated industries. For these latter sub-samples, diversification strategies in 1996 are found to impact negatively on coherence.

The last econometric exercise focuses on the dynamics of coherence for the 190 surviving firms. Table 8 presents the results of a regression in which the change in the level of coherence is the dependent variable ($DCOH_{MAX}=COH_{MAX}96-COH_{MAX}93$). The regressors are coherence as observed in 1993 and a set of variables (DIVER, R&D, ADV and VERTIN) which have been included in their 1993 levels and in first differences. Finally, the dummy SENSITIVE has been added in order to test if firms with principal activities in industries which should be more affected from EU integration are following more coherent diversification patterns. The results show a return to the mean effect for coherence, with highly coherent firms reducing their coherence from 1993 to 1996. Firms operating (and increasing their presence) in high R&D industries record a drop in coherence, while firms increasing their operations in advertising intensive industries benefit from coherence gains. Vertical integration and

[17] We have tried also different specifications of the model, by including a quadratic form for size and diversification, and by including in all equations 12 industry dummies. While the results were basically unchanged, coherence was found to be higher in textiles-clothing, wood and furniture, and lower in rubber-plastics. Finally, we have run regressions for private national firms as opposed to subsidiaries of foreign firms, and for highly coherent firms as opposed to lowly coherent firms, with no remarkable changes.

vertical integration changes have both a positive impact on $DCOH_{MAX}$, while $DIVER_{93}$ and DDIV have a negative effect. Note that the coefficient for DIVER was not different from zero in the 1993 sample, while it was negative and significant in 1996, especially for big firms and form firms operating in differentiated sectors. This further piece of evidence confirms that, differently form vertical integration strategies, diversification has become a less fashionable strategy for coherence. Finally, SENSITIVE has a positive and significant coefficient, suggesting that the tightening of competition in sensitive industries might have pushed firms towards greater coherence in their strategies. The analysis for sub-samples can give a better picture of the relationship between coherence dynamics and firms' characteristics and strategies. For highly coherent firms the coefficients on SENSITIVE and DADV are not significant anymore, while for lowly coherent firms both the levels and the changes of diversification and vertical integration lose their explanatory power. This means that lowly coherent firms active in sensitive industries find it difficult to survive while keeping low levels of coherence, and are pushed to increase their coherence level. This stimulus is not present in the sub-sample of highly coherent firms. For lowly coherent firms, moreover, high initial levels of diversification (vertical integration) or an increase in diversification (vertical integration) are not bad (good) news for coherence change. Finally, the distinction between firms operating in differentiated industries and firms operating in traditional sectors offers some interesting insights. The positive coefficient of SENSITIVE is statistically significant only for the first group of firms, while in the second group the deepening of the single European Market does not seem to have favoured an increase in coherence in sensitive industries. High initial diversification degrees and low initial vertical integration degrees are associated with a decrease of coherence for the sub-sample of firms producing differentiated goods, while de-diversification patterns and the deepening of vertical integration links are leading to an increase in coherence for firms operating in traditional industries[18].

5. Conclusions

In this paper we investigate relatedness between pairs of activities and firm coherence by applying some measures recently introduced by Teece et al (1994) to a sample of leading firms in Italian manufacturing in the period 1993-1996. Our results

[18] Finally, note the negative and significant coefficient for DADV in the last column, showing that for firms with a main activity in a non advertising intensive industry the increasing presence in high advertising sectors is associated with a negative coherence dynamics.

show that firms, far from diversifying at random, operate in related pairs of sectors characterised by vertical integration links and by similar R&D and advertising resources. Notwithstanding the sharp decrease of the number of pairwise contacts and the halving of the relatedness index from 1993 to 1996, coherence remains fairly stable. The analysis of the determinants of coherence and of coherence change shows that firms following vertical integration strategies and operating in sectors that require similar R&D investments are more coherent than the average. Firms which become a top 5 leader in at least a manufacturing sector are highly coherent while firms (with main activities in high R&D or high advertising sectors) which abandon a top 5 position are less coherent, suggesting that coherence is a strategy which allows firms to keep or to gain a leadership position. Moreover, from a dynamic perspective, firms with manufacturing activities in sensitive sectors (where EU integration is expected to substantially increase the degree of competitiveness), have a greater stimulus to increase coherence. An increase of diversification leads to a drop in coherence, while an increase in vertical integration is accompanied with a positive coherence change.

These findings are consistent with the view that coherent firms are those who are more equipped to survive in environments characterised with selective competition. Coherence is reached in turn by combining businesses which share similar technology or market characteristics, and which are positioned at different stages of the vertical chain. Thus, building laterally or vertically on the existing resources helps firms to keep their leading positions.

We end with some cautionary remarks. First, our analysis shows that firms active in industries with an high average R&D intensity are recording relatively low levels of coherence. This can be due to the particular industrial specialisation of Italian manufacturing, too much focussed on low advertising and low R&D sectors. Studies for other countries or based on samples of European firms could well find that, other than similarity of R&D resources, the average R&D intensity is good for coherence too. Second, we noticed that, within the less coherent group, some firms were diversified according to a precise (and at first sight coherent) industrial logic. While representing an improvement over the traditional indices of relatedness based on standard industry classifications, the measures introduced by Teece et al (1994) imply that some idiosyncratic diversification patterns which are not shared by other firms in the sample are translated into very low values of relatedness and coherence (see also the discussion of Vonortas (1999) in section 2). This unpleasant property can be partially responsible for the relatively weak results obtained for exits in table 6. Keeping the above caveats in mind, this first set of findings seem to encourage future work in this area.

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Table 1 - Relatedness measures

	Number of 3 digit industries	1993	1996
Simple Average	**95**	**0.40**	**0.18**
Min*		-1.98	-1.91
Max*		12.20	11.94
Standard Deviation		1.65	1.58
Non-differentiated sectors*	**50**	**0.28**	**0.08**
Differentiated sectors*	**45**	**0.53**	**0.28**
- High R&D*	26	0.65	0.35
- High ADV*	9	0.27	0.08
- High R&D and High ADV*	10	0.46	0.28
Non sensitive Sectors**	**64**	**0.39**	**0.15**
Sensitive sectors**	**31**	**0.41**	**0.22**
- High technology public procurement industries**	3	0.67	0.33
- Traditional public procurement industries**	7	0.46	0.26
- Industries with moderate non tariff barriers**	21	0.36	0.19

* High R&D industries are industries in which R&D expenditures are greater than 1% of total industry sales (but the ratio advertising expenditures/sales is lower than 1%). High ADV industries are industries in which advertising expenditures are greater than 1% of total industry sales (but the ratio R&D expenditures/sales is lower than 1%). High R&D and high ADV industries are industries in which both R&D and advertising expenditures are greater than 1% of total industry sales. Traditional sectors are industries in which both R&D and advertising expenditures are lower than 1% of total industry sales.

** Following the classification proposed by Buigues et al (1990), high technology public procurement industries are office machines, telecommunication equipment and medico-surgical equipment, traditional public procurement industries are pharmaceuticals, railway equipment, wine, brewing and soft drinks, electrical wires, electrical equipment, shipbuilding, while examples of industries with moderate non tariff barriers are electronic equipment, domestic appliances, motor vehicles, clothing, agricultural machines, transmission equipment, aerospace, textiles, basic chemicals, rubber, and so on.

Table 2 - Sectoral Breakdown of Relatedness

	1993		1996	
	Average Relatedness	**Relatedness among neighbouring industries**	**Average Relatedness**	**Relatedness among neighbouring industries**
Food and Beverages	0.38	5.56	0.14	5.47
Textiles and Clothing	0.10	3.21	0.01	3.32
Leather and Leather products	-0.12	2.56	-0.13	2.59
Wood Products	-0.06	6.32	-0.09	6.01
Paper, Printing and Publishing	0.50	4.95	0.16	5.00
Chemicals and Pharmaceuticals	0.57	4.04	0.27	3.71
Rubber and Plastics	0.30	3.27	0.08	2.78
Mineral Products	0.15	2.07	0.00	2.61
Metal Manufacturing and Metal Products	0.50	2.17	0.18	1.86
Mechanical Engineering	0.54	2.53	0.43	2.66
Electrical and Electronic Goods, Office Machines and Instruments	0.68	2.96	0.38	2.74
Motor Vehicles and Transport Equipment	0.74	2.49	0.31	1.96
Other industries	0.06	1.83	0.01	1.65
Simple Average	**0.40**	**3.29**	**0.18**	**3.17**

Table 3 - The determinants of relatedness

	1993	**1996**
Constant	0.132***	-0.037
	(3.168)	*(-0.952)*
ADV	0.219**	0.274***
	(2.311)	*(3.051)*
R&D	-0.279***	-0.451***
	(-2.801)	*(-4.764)*
SIMADV	1.333**	1.398***
	(2.475)	*(2.702)*
SIMR&D	1.147***	1.104***
	(8.163)	*(8.330)*
SIMADVR&D	0.552*	0.666**
	(1.795)	*(2.163)*
FVI	0.964***	1.146***
	(7.279)	*(8.594)*
BVI	0.781***	0.620***
	(7.180)	*(5.893)*
R^2	0.14	0.15
F	102.7	110.7
Observations	4465	4465

Dependent variables are $RELAT_{93}$ e $RELAT_{96}$. t student in parentheses. Standard errors are corrected for heteroskedasticity (White consistent).
***Significant at 1%;**Significant at 5%, *Significant at 10%.

Table 4 - Coherence with respect to the principal activity

	Coherence 1993	Coherence 1996	Number of Firms 1993	Number of Firms 1996
Average Value	4.54	4.53	229	230
Max	12.22	11.94		
Min	0.03	-0.01		
Standard deviation	2.55	2.45		
State Owned firms	3.31	3.74	7	7
Foreign firms	4.29	4.01	72	75
Joint ventures	3.08	4.78	4	6
Private National Firms	4.75	4.83	146	142

Table 5 - Different measures of coherence

	COH_A 1993	COH_A 1996	COH_{MAX} 1993	COH_{MAX} 1996	COH_P 1993	COH_P 1996	$COH93_{r96}$	$COH96_{r93}$
All firms	4.32	4.32	5.38	5.57	4.54	4.53	4.30	4.40
Survivals	4.33	4.21	5.45	5.51	4.55	4.44	4.42	4.38
Entrants		4.88		5.88		4.99		4.50
Exits	4.30		5.05		4.45		3.65	

Between 1993 and 1996 36 diversified firms entered the matrix and 38 diversified firms exited the matrix. Moreover, 1 surviving firm de-diversified and became a single product firm and 4 survivors became diversified. As a result of the above dynamics, the sample comprehends 229 diversified firms in 1993 and 230 diversified firms in 1996, of which 190 are diversified survivors.

Table 6 - The determinants of corporate coherence in the 1993 sample

	All sample	Big firms	Small firms	Firms with main activity in HR&D/HADV	Firms in traditional industries
Constant	3.401***	4.075***	2.327	4.432***	1.835
	(4.225)	*(2.968)*	*(1.127)*	*(4.115)*	*(1.389)*
SIZE	0.462***	0.518***	0.483	0.317**	0.523***
	(3.541)	*(2.527)*	*(1.342)*	*(2.044)*	*(2.557)*
DIVER	0.002	-0.055	0.188	-0.007	0.103
	(0.017)	*(-0.548)*	*(0.593)*	*(-0.052)*	*(0.315)*
STATE	-1.010*	-0.954*	-3.720***	0.463	-1.553
	(-1.641)	*(-1.641)*	*(-5.041)*	*(0.821)*	*(-1.400)*
PRIVATE	0.444	-0.231	0.994**	-0.193	1.625***
	(1.282)	*(-0.445)*	*(2.066)*	*(-0.537)*	*(2.566)*
EXITS	-0.161	0.664	-0.538	-0.741*	0.032
	(-0.411)	*(1.519)*	*(-0.995)*	*(-1.624)*	*(0.049)*
ADV	0.490	0.431	0.164	1.162*	0.250
	(1.009)	*(0.644)*	*(0.259)*	*(1.777)*	*(0.110)*
R&D	-1.230***	-1.251**	-1.376**	-1.047	2.476
	(-3.073)	*(-2.391)*	*(-2.410)*	*(-1.512)*	*(1.157)*
DIFADV	-0.240	-0.710	0.542	-1.047**	1.807***
	(-0.544)	*(-1.142)*	*(1.031)*	*(-1.996)*	*(2.934)*
DIFR&D	-3.200***	-3.857***	-2.856***	-3.073***	-4.365***
	(-9.987)	*(-7.455)*	*(-6.598)*	*(-6.735)*	*(-5.357)*
VERTIN	1.323*	-0.172	2.533**	1.695**	0.774
	(1.771)	*(-0.172)*	*(2.051)*	*(2.181)*	*(0.609)*
Observations	229	114	115	107	122
R^2	0.33	0.41	0.34	0.45	0.32
F	10.62	7.16	4.88	7.82	5.30

The dependent variable is $COH_{MAX}93$. t student in parentheses. Standard errors are corrected for heteroskedasticity (White consistent). ***Significant at 1%;**Significant at 5%, *Significant at 10%.

Table 7 - The determinants of corporate coherence in the 1996 sample

	All sample	Big firms	Small firms	Firms with main activity in HR&D/HADV	Firms in traditional industries
Constant	2.875***	2.361	1.926	4.556***	0.760
	(3.406)	*(1.112)*	*(1.217)*	*(3.962)*	*(0.557)*
SIZE	0.583***	0.714***	0.620**	0.380**	0.792***
	(4.705)	*(2.690)*	*(2.240)*	*(2.469)*	*(4.502)*
DIVER	-0.257**	-0.224**	-0.406	-0.263**	-0.254
	(-2.483)	*(-2.141)*	*(-1.559)*	*(-2.113)*	*(-0.734)*
STATE	-0.783	-1.078	-1.357*	0.152	-1.459*
	(-1.214)	*(-1.408)*	*(-1.666)*	*(0.327)*	*(-1.806)*
PRIVATE	0.461	-0.380	1.463***	-0.017	1.293**
	(1.447)	*(-0.929)*	*(2.930)*	*(-0.050)*	*(2.205)*
ENTRIES	0.628*	1.306***	0.113	0.937**	0.154
	(1.636)	*(2.925)*	*(0.212)*	*(2.149)*	*(0.210)*
ADV	0.131	0.871*	-0.868	0.605	-2.870
	(0.292)	*(1.658)*	*(-1.058)*	*(0.879)*	*(-1.195)*
R&D	-1.522***	-1.541***	-1.288**	-1.665**	2.320
	(-3.995)	*(-3.257)*	*(-2.226)*	*(-2.191)*	*(1.140)*
DIFADV	0.278	-0.994	1.946***	-0.335	2.576***
	(0.640)	*(-1.475)*	*(3.758)*	*(-0.602)*	*(3.571)*
DIFR&D	-2.730***	-2.511***	-2.729***	-2.611***	-3.759***
	(-7.944)	*(-4.563)*	*(-5.779)*	*(-5.850)*	*(-4.593)*
VERTIN	2.110***	1.522*	3.672***	1.938***	2.635*
	(2.957)	*(1.752)*	*(3.019)*	*(2.758)*	(1.790)
Observations	230	115	115	111	119
R^2	0.30	0.33	0.38	0.36	0.31
F	9.53	5.22	6.50	5.59	4.95

The dependent variable is $COH_{MAX}96$. t student in parentheses. Standard errors are corrected for heteroskedasticity (White consistent). ***Significant at 1%;**Significant at 5%, *Significant at 10%.

Table 8 - The determinants of coherence dynamics

	All sample	Highly coherent firms	Lowly coherent firms	Firms with main activity in R&D/HADV	Firms in traditional industries
Constant	0.944***	2.868***	0.515**	0.875**	0.959***
	(3.699)	*(4.164)*	*(1.973)*	*(2.168)*	*(2.614)*
COH_{MAX93}	-0.134***	-0.324***	-0.149*	-0.183***	-0.084**
	(-4.004)	*(-4.136)*	*(-1.755)*	*(-4.399)*	*(-1.973)*
SENSITIVE	0.272*	-0.057	0.495***	0.425**	0.032
	(1.668)	*(-0.228)*	*(2.802)*	*(1.992)*	*(0.133)*
$DIVER_{93}$	-0.114*	-0.220*	0.021	-0.105*	-0.251
	(-1.719)	*(-1.797)*	*(0.210)*	*(-1.838)*	*(-1.585)*
DDIVER	-0.512**	-1.095***	-0.030	-0.069	-1.036***
	(-2.093)	*(-2.883)*	*(-0.120)*	*(-0.416)*	*(-2.724)*
ADV_{93}	0.206	-0.022	0.453*	0.412	1.027
	(1.009)	*(-0.076)*	*(1.808)*	*(1.422)*	*(0.563)*
DADV	2.678**	0.935	2.778*	3.485***	-8.709**
	(2.042)	*(0.315)*	*(1.896)*	*(3.340)*	*(-2.103)*
$R\&D_{93}$	-0.641***	-0.944***	-0.318	-0.547*	-1.090
	(-3.181)	*(-3.027)*	*(-0.998)*	*(-1.832)*	*(-1.168)*
DR&D	-3.994***	-6.181*	-3.802***	-5.118***	-0.653
	(-5.033)	*(-1.625)*	*(-4.380)*	*(-8.863)*	*(-0.230)*
$VERTIN_{93}$	1.136***	1.600***	-0.012	1.436***	0.930
	(2.702)	*(3.042)*	*(-0.018)*	*(3.434)*	*(1.207)*
DVERTIN	3.328***	2.671*	2.663	1.015	7.138**
	(2.764)	*(1.704)*	*(1.318)*	*(1.460)*	*(2.580)*
Observations	190	95	95	88	102
R^2	0.24	0.33	0.28	0.49	0.22
F	5.60	4.18	3.28	7.44	2.58

The dependent variable is $DCOH_{MAX}$. t student in parentheses. Standard errors are corrected for heteroskedasticity (White consistent). ***Significant at 1%;**Significant at 5%, *Significant at 10%.

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